



# REFLECTIONS

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**Departments of Science & Commerce**

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# REFLECTIONS

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# A Study of the Superstitious Attitude in Relation to Locus of Control in Young Adults

Supriya Chaturvedi and Debolina Chatterjee

## ABSTRACT

*Superstition refers to any belief or attitude that is inconsistent with the known laws of science but is generally considered true and rational in a particular society. This may include belief in charms, omens and supernatural power. Superstitious attitude is generally based on mysterious and irrational fear of the unknown. Locus of control is the degree to which individuals feel that they have control over reinforcements or outcomes of behaviours and acts as a stable individual difference. It has two dimensions – internal and external, influencing behaviour in different contexts. The present study aims at understanding the superstitious attitude and locus of control among young adults and also assessing the relationship between the two. 240 young adults (both boys and girls) in the age group of 18 to 25 years, pursuing graduation and post-graduation in various streams have been selected through purposive sampling. Data have been analysed using quantitative methods such as mean, standard deviation, t-test, ANOVA and correlation. The findings revealed that a significant difference was there among the male and female respondents in the dimension of Internal Locus of Control, along with a significant difference found between the students of arts and science in both Internal Locus of Control and Superstitious Attitude, with students from the Arts stream scoring low in Internal Locus of Control and high in Superstitious Attitude. The results of the study also found that a negative correlation exists between Superstitious Attitude and Locus of Control.*

**Keywords:** External Locus of Control, Internal Locus of Control, Superstitious Attitude, Young Adults

## Introduction

Webster's Dictionary (2010) defines superstition as 'any belief or attitude that is inconsistent with the known laws of science but is generally considered in the particular society as true and rational such as belief in charms, omens and supernatural power etc.' Superstitious attitude can thus be said to be based on mysterious and irrational fear of unknown. Instead of having scientific attitude towards life, people take decisions totally based on superstitions. They do not think rationally and logically and thus take wrong decisions. Such attitude makes man totally rely or dependent on their fate which in turn has effect on their physical and mental health. Superstitious beliefs can also make a man very skeptical regarding his decisions and actions. It may lead him to believe that certain things are under his control and while others are not. This negative or positive attribute given to a situation under a man due to superstitious belief or attitude can be linked with locus of control.

According to Rotter (1990), Locus of Control, is the degree to which individuals feel that they have control over reinforcements or outcomes of behaviors. One would have internal locus of control if he or she feels as though consequences of his or her actions are contingent on their own personal behaviors or characteristics. On the other hand, an individual with an external locus of control would expect that the outcome or reinforcement

is a function of luck, fate or chance and that its consequence is generally unpredictable.

On the basis of a few studies done by Shrivastav, Manasvi (2018) and Dayal, Kaur and Kaur (2015), the objectives of the present study were formulated that included finding out whether young adults have a superstitious attitude and whether they have more internal or external locus of control. The study also aimed to determine whether there is a relationship between superstitious attitude and locus of control, both internal and external.

## Methodology

The present study was conducted in Kolkata and the sample was drawn from four selected colleges and institutes offering courses in science, arts and commerce at the undergraduate and postgraduate level. The sample size of the study was 240 participants. Two standardized questionnaires were used to conduct the study including, Superstitions Attitude Scale by Dr. (Smt.) ShailajaBhagwat (2006) and Locus of Control Scale by Dr. Yodida Bhutia and Ms. Samayalangki Nongdu. The scores of both the scales were computed by the like rt scale with options of Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree.

The hypotheses included stating no significant difference will be found in Superstitious Attitude among young adults on the basis of their gender,

Streams and Educational Qualification along with stating no significant difference will be found in Locus of Control among young adults on the basis of their gender, Streams and Educational Qualification and the last one stating there will be no significant relationship between Superstitious Attitude and Locus of Control.

## Results and Discussion

Table 1: Difference in Superstitious Attitude based on Streams

Source of Variance	Sum of Squares (SS)	Degrees of Free-dom (df)	Mean Squares (MS)	F-Value	F-Crit Value	Interpretation
Between Groups	3849.375	2	1924.687			
Between Groups	3849.375	2	1924.687	14.577	3.033	Significant
Within Groups	31291.275	237	132.030			

The results of the sample in Superstitious Attitude, based on their different streams showed that the F-value was found to be 14.577 which was greater than the table value, 3.033 at 0.05 level of significance which indicated that the Hypothesis stating no significant difference in Superstitious Attitude among young adults on the basis of their streams stood rejected. Therefore, significant difference was seen in Superstitious Attitude among young adults on the basis of their streams. As the ANOVA results showed that between the three

For all hypotheses, statistics including Mean scores were taken out. The mean provided the central tendency for each stream studied. For testing of hypothesis, t-test and ANOVA were used. In order to determine the impact of one variable on another, Karl Pearson's Correlation Coefficient was used.

streams there was a significant difference, separate t-tests were also run between Science and Arts, Arts and Commerce and Science and Commerce. The separate t-test revealed significant differences between Science, Arts and Commerce with the highest differences seen between Science and Arts. However, under the first objective, no significant differences were found in Superstitious Attitude on the basis of Gender and Educational Qualifications respectively.

Table 2: Difference in Locus Of Control Based On Gender

Locus Of Control	Streams	N	Mean	SD	df	t-value	t-crit
Internal Locus of Control	Male	120	76.59166	10.8855	119	2.534	1.980
	Female	120	79.60833	8.5801			
External Locus of Control	Male	120	60.525	9.1127	119	1.455	1.980
	Female	120	62.0333	7.6300			

In the results obtained from the Locus of Control, it was found that the t-value was 2.534 which is greater than the table value, 1.980 at 0.05 level of significance. This further indicated that the Hypothesis was rejected for Internal Locus of

Control. Therefore, significant difference was seen in Internal Locus of Control among young adults on the basis of their gender. However no significant difference was found in External Locus of Control on the basis of their gender.

Table 3: Difference in Internal Locus of Control Based on Streams

Source of Variance	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Squares (MS)	F-Value	F-Crit Value	Interpretation
Between Groups	769.075	2	384.537			
Within Groups	22638.525	237	95.521	4.025	3.033	Significant

The results of the sample in Locus of Control, based on their Different streams showed that, the F-value was found to be 4.025 which is greater than the table value, 3.033 at 0.05 level of significance which

indicated that the Hypothesis stating; no significant difference would be seen in Internal Locus of Control among young adults on the basis of their streams stood rejected. Therefore, significant difference

was seen in Internal Locus of Control among young adults on the basis of their streams. This further indicated that the Hypothesis was rejected for Internal Locus of Control. Therefore, significant difference was seen in Internal Locus of Control among young adults on the basis of their streams. As the ANOVA results showed that between the three streams there was a significant difference, separate t-tests were also run between Science and Arts, Arts and Commerce and Science and Commerce. The separate t-test revealed no significant differences between Science and Commerce but revealed significant differences between the streams of Science and Arts and Arts and Commerce where the highest difference was seen between Science and Arts. However, no significant differences were seen in External Locus of Control on basis of Gender and Streams and Educational Qualification along with and no significant difference was found in Internal Locus of Control in Educational Qualification.

For the present study, in order to see the impact of one variable on another variable, Correlation method was used. The results indicated the presence of a negative correlation between Superstitious Attitude and Internal Locus of Control, and between Superstitious Attitude and External Locus of Control, that is, -0.3009 and -0.3001 respectively. According to the magnitude of correlation it was also seen that it falls under the 'Weak' category which indicated that if one variable is increasing the other is decreasing drastically, and vice versa. This also further indicated that the hypothesis was accepted because no relationship was seen between Superstitious Attitude and Locus of Control among young adults.

## Conclusion

The findings of present the study revealed that 81% respondents had Superstitious attitude falling under the levels of extremely, highly, above average and average levels of superstition along with 19% who fell under levels of below average, low and extremely low superstitious attitude. Exploring the Locus of Control (Internal and External), it was found that 58% respondents possessed more internal locus of control being in the levels of extremely high, high, above average and average, along with 42% respondents who were had lower locus of control constituting the levels of below average, low and extremely low. In External Locus of Control it was seen that 60% respondents out of 240 sample size had higher external locus of control with levels of extremely high, high, above average and average, however, the remaining 40% had low

locus of control with falling under the levels of below average, low and extremely low.

The study, however, revealed that there was no significant difference in Superstitious Attitude between girls and boys. Similarly, no significant difference in superstitious attitude was found on the basis of educational qualification among the young adults in the sample of 240 respondents and the students in undergraduate and post-graduate courses thus did not show any significant difference in superstitious attitude. It is to be noted that the study revealed a significant difference on the basis of the different streams namely, Science, Commerce and Arts.

From the results of the tests to understand Locus of Control, it was found that a significant difference was found among the male and female respondents in the dimension of Internal Locus of Control. However, in the dimension of External Locus of Control, no statistical significance was proved through which we can conclude that there was no significant difference. The study also made a comparison Locus of Control among the respondents pursuing graduation and post-graduation in Science, Arts and Commerce. It was seen that on the basis of their streams, there was no significant variation among young adults in the External Locus of Control. However, a significant difference was found among the respondents in case of Internal Locus of Control where the table values were less than F- Value, hence proving the presence of a statistical significance. The means of the three streams also showed that Science had the highest no of respondents in the dimension of Internal Locus of Control followed by Commerce and then Arts with the falling in the least category with Internal Locus of Control. The analysis further found out that no significant difference exists in both the Internal and External Locus of Control on the basis of their educational qualification, as the table values were greater than the t-values and F- Values, proving no statistical significance. Thus the students pursuing under graduate and post graduate courses showed no significant difference in their measure of internal as well as external locus of control.

The final objective of the study was to see whether Superstitious Attitude and Locus of Control are related to each other. After calculating the correlation between both Internal Locus of Control and Superstitious Attitude along with a correlation between External Locus of Control and Superstitious Attitude, it was seen that both of them have a

Negative Correlation between them. This meant that as one variable increases, the other decreases and vice versa.

In the present study it was seen that even though the sample was from the urban youth of a metropolitan city, 81% young adults had superstitious attitude and 60% out of the sample were more inclined towards the External locus of control which means they expect that the reinforcement or outcome of their behaviour is a function of chance, luck, or fate, is under the control of powerful others, or is simply unpredictable. After further analysis however, it was found that a significant difference existed among the male and female respondents in the dimension of Internal Locus of Control. It was also seen that between the two variables, a negative correlation was found and a significant difference was only found between the students of Arts and Science in both Internal Locus of Control and Superstitious Attitude, with the students from the Arts stream scoring low in Internal Locus of Control and high in Superstitious Attitude.

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## ABSTRACT

The New Encyclopaedia Britannica defines euthanasia (also called mercy killing) as the putting to death of incurable or terminally ill patients painlessly and at their request. The two essentials elements being focused are terminal illness and voluntariness on part of the patient to die. Some school of thoughts believe that euthanasia, also known as physician assisted suicide or physician aid in dying is a merciful act. On the contrary, others believe that this method is a form of murder. Thus evolves the controversy and debate, attitude associated with this debate is based on many personal and moral factors that shapes one's perception about euthanasia. India's Supreme Court has issued a landmark ruling in 2018 allowing "passive euthanasia", declaring individual's Right to die under strict guidelines, this verdict has sparked difference of opinion among many in the diverse country like India. The present research aims to study what kind of attitude the young and middle Indian adults hold towards euthanasia. For this purpose euthanasia attitude scale was prepared, consisting of items under seven domains namely: general orientation, age of patient, condition of patient, relationship with patient, religion, economic factor and legal factor. The sample comprised of 170 young adults male and female (85 and 85 respectively) and 170 middle adults male and female (85 and 85 respectively). The results revealed that young adult females has pro euthanasia attitude as compared to middle adult females. The same result was found comparing the males. Analysing the seven domains separately also it was found that young adult males and females have a positive attitude towards euthanasia as compared to middle Adult male and female

**Keywords:** Attitude, Euthanasia, Living Will, Terminal Illness

## Introduction

The perception of human beings towards life, aging and death has been said by (Charles Churchill 1731–64) in the following words:

"Old age, a second child, by Nature cursed  
With more and greater evils than first,  
Weak, sickly, full of pains; in every breath  
Railing at life and yet afraid of death"

According to the traditional standards a human being is dead when his or her heart and lungs have irreversibly ceased to function. In certain cases, permanent loss of consciousness may precede cardiac pulmonary failure.

Medical science and technology have made great strides in recent years. It now allows not only living but dying to be prolonged. Indian Urologist (Colabwala 1987) has thrown light on the impact of advances in medical science and technology in the following words: "The phenomenal advances in medical science and technology have not been without a significant impact on society. They have brought into relief issues which are altering the pattern of human living and societal values. Peripassu with their changes is the upsurge of affirmation of human rights, autonomy and freedom of choice. These issues compel us to re-evaluate our concepts of societal and medical ethics and value systems".

(Caddell 2003) too talks about how medical ethics is threatened by the advances in medical science and technology "Problems associated with organ donation, genetic testing, foetal tissue testing and in-vitro fertilization are examples of how technology has outstripped ethics. It is believed that medical science has the power to prolong not only life but death as well. A question definitely arises that, is such a life reconsidered worth-living?

Every human being has right to life so should they be given right to die is the question. Gerald (1996), highlighting the medical context of euthanasia and the critical importance of its legalization has written: "not all long-lived individuals die peacefully some die painful, torturous deaths. When the pain and discomfort rob life of its meaning and significance some people cry out for release through death - a good death through euthanasia or physician assisted suicide."

Euthanasia is definitely a topic of controversy and debate, not solely because of the many moral dilemmas associated with it, but also because of its definition. At one end of disagreement, some school of thoughts believe that euthanasia, also known as physician assisted suicide or physician aid in dying, is a merciful act of dying. At the other end, there are opponents of euthanasia who believe that this method is a form of murder. Euthanasia raise crucial questions regarding the value of life; the goodness

of death; and an individual's right to determine the length of his or her life, and the circumstances of his or her death and dignified way of death?

Euthanasia was practiced in Ancient Greece and Rome. In order to hasten the death of an individual, a flower called hemlock was employed which used to be found in the Island of Kea, Rome.

The term "Euthanasia" was coined long after it was practiced by the Philosopher Francis Bacon in the Seventeenth century.

Etymological meaning of euthanasia is derived from the Greek word "euthanatos" meaning "good death" and it refers to the practice of ending a life in a manner which relieves pain and suffering. Thus, it literally stands for 'easy death'. It simply means a death without suffering from disease or injury. In general context usually people refer easy death of an elderly person who has died without suffering from serious illness requiring without being cared or served by his relatives as most fortunate exit from life.

The Oxford Dictionary, defines it as:

A gentle and easy death
A means of bringing about such a death
the action of bringing about such it as a release from incurable disease.

Besides, it emphasizes that euthanasia may be performed especially when the patient requests for it, i.e., the voluntariness on the part of the patient becomes an ingredient of euthanasia."

The debate over the issue of euthanasia goes on according to the meaning which has been given by various debaters. However, euthanasia refers to the causing of a death of a human being by a deliberate action or inaction on the ground of mercy in order to avoid his/her further suffering.

"In modern times, euthanasia or mercy killing, as it is called has been used to refer to any action or inaction taken with the intent to hasten the death of terminally ill and suffering patients with the motive of protecting them from further suffering. Gillon (1986) says that euthanasia is "the art of painlessly putting to death person suffering from incurable conditions or diseases." The term euthanasia may also refer to the deliberate killing of a human being (or other living creature where so specified) whether effected by action or inaction, with the primary intent

of minimizing and ending that individual's suffering. In India Dr.Tharien (1995) founder of Christian Fellowship Hospital, Tamil Nadu, posits: "Euthanasia is the deliberate bringing about a gentle and easy death, making the last days of the patient as comfortable as possible. This is to ensure a calm and peaceful death, within the context of relieving incurable suffering in terminal illness or disability." The different meanings have only led to debate but has also influenced the legal status in many countries.

Globally, many people have expressed their opinion either in favour of or against euthanasia. This topic has been a source of debate not only in countries where Euthanasia is illegal but also in countries where it has been a law. This debate and attitude associated with this debate is based on many personal and other moral factors that shapes one's perception about euthanasia. Although India's Supreme Court has issued a landmark ruling in 2018 allowing "passive euthanasia", declaring individual's Right to die under strict guidelines, this verdict has sparked difference of opinion among many. Harmala Gupta, the founder of the organization "Can Support" said that the judgment was truly essential and a landmark judgment as it considered the idea of death with dignity. However in this context it may be said that in India majority of people, especially the poor hardly have knowledge about proper health care, in this context if Euthanasia is legalized they may be pushed into a wrong direction.

## Methodology

### Hypotheses

For the present study the following Null hypotheses (Ho) are as follows:

Ho1: There is no significant difference in attitude towards euthanasia between young adults and middle adults, male and female.

Ho2: There is no significant difference in attitude towards euthanasia between young adult males and middle adult males and young adult females and middle adult females.

Ho3: There is no significant difference in attitude towards euthanasia between young adult males and young adult females.

Ho4: There is no significant difference in attitude towards euthanasia between middle adult males and middle adult females.

Ho5: There is no significant difference in attitude regarding the various domains of Euthanasia Attitude Scale among young adult and middle adult males and females.

## Sample

The sampling method used was Purposive sampling method. Purposive sampling is a non-probability sampling method and it occurs when “elements selected for the sample are chosen by the judgment of the researcher. Researchers often believe that they can obtain a representative sample by using a sound judgment, which will result in saving time and money” (Black, 2010)

Sample			
Young Adults (age: 21-40 years)		Middle Adults (age: 41-60 years)	
↓	↓	↓	↓
Male n=85 (Group 1)	Female n= 85 (Group 2)	Male n= 85 (Group 3)	Female n= 85 (Group 4)

Collection of data: The data were collected by distributing the self prepared scale on attitude towards euthanasia to the respondents who were approached individually. Each respondent who willingly agreed was briefed about the purpose of the study. The participants were assured of confidentiality and a verbal consent was sought from each of them, before initiating the survey. In total 500 Questionnaires were distributed among young adults and middle adults staying in different parts of Kolkata. However, only 340 questionnaires were returned which had the entire information being sought.

Table 1: Mean and S.D. of young adult and middle adult male and female in different domains of Euthanasia Attitude Scale.

Group	Young Adult Male		Young Adult Female		Middle Adult Male		Middle Adult Female	
N	85		85		85		85	
Domains	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
A	18.6	8.599	16.811	7.281	14.482	8.411	14.165	7.025
B	11.906	5.391	11.518	3.217	8.859	4.858	9	4.114
C	11.588	5.624	10.576	4.393	9.435	5.142	8.753	4.032
D	14.847	7.388	13.094	5.257	11.282	6.467	10.612	5.377
E	12.306	5.192	11.929	3.555	9.271	4.518	9.235	4.093
F	13.859	6.646	12.176	4.201	10.894	5.843	10.624	5.067
G	20.129	8.092	19.188	5.348	16.718	7.584	15.847	5.165
Total	110.388	44.219	95.118	27.721	77.212	41.143	78.235	31.869

(N: no. of samples & A: Related Concepts, B: Age of patient, C: Condition of patient , D: Relationship with patient, E : Religion, F: Economic factor , G: Jurisdiction and euthanasia)

The above table shows the mean and standard deviation values of four groups of subjects in the various domains of the Euthanasia Attitude Scale.

Data processing and statistical analysis: The study is cross-sectional in nature and quantitative data analysis was conducted using statistical techniques. The software used was Microsoft Excel and SPSS.

The techniques used were:

- ◆ Descriptive Statistics (Mean and Standard deviation)
- ◆ ANOVA (to find the difference between all the groups, irrespective of their age and gender)
- ◆ t-test (to find the difference between two groups taking into account, e.g., the age difference)
- ◆ Cornbach Alpha (to determine the reliability of the self-prepared scale)
- ◆ Factor Analysis (to determine the validity of the self-prepared scale)

## Results and Discussion

The topic of Euthanasia has been a matter of public debate for several decades. Review of previous researches being conducted shows that most of the studies have taken professionals from field of medicine and medical students into consideration, but hardly studies have been done to understand general public's opinion.

The present study aims at understanding the attitude towards euthanasia among young adults and middle adults respectively belonging to different professions baring medical professionals.

The results obtained after the study was conducted is given below.

However, further analyses were done to find out whether these groups differ significantly in their attitude towards euthanasia.

Table 2: F ratio of the total score of euthanasia attitude scale taking into account the four groups of the respondents into consideration

ANOVA						Interpretation	Ho1
Source of Variation	SS	df	MS	F	F crit	Significant	Rejected
Between Groups	63205.21	3	21068.4	15.5138	2.631489119		

From the above table it may be said that there is a significant difference among the two age group namely, Young adults and Middle adults males and females regarding their attitude towards euthanasia. The total scores of young adult males are highest followed by young adult females followed by

middle adult females and males respectively, this shows that young adults are significantly more pro towards euthanasia. In this context it may be said that many concepts and ideas about complex constructs changes with time and age.

Table 3: t ratio showing difference between two groups of males and two groups of females

Groups	t-ratio	t critical	Interpretation	Ho2 Accepted/Rejected
Young Adult male and Middle Adult male	5.058488269	1.988609667	Significant	Rejected
Young Adult female and Middle Adult female	3.806421205	1.988609667	Significant	Rejected

The results of the present study show that there is a significant difference between the two age groups males and females.

One of the important findings by Arnett says that , emerging adults “are self-focused in the sense that they have little in the way of social obligations, little in the way of duties and commitments to others, which leaves them with a great deal of autonomy in running their own lives. Since at this stage their career is either in the formative stage or towards

stability, while middle adults are essentially the primary care givers of the old adults and due to a close attachment with the older adults , they might find it difficult to accept euthanasia. Young adults usually want autonomy similarly they might be agreeing to the principal of individual autonomy and freedom of choice regarding end of life care and death.

The present study also intended to compare between males and females of the two groups of respondents and the following result was obtained.

Table 4: t ratio showing difference between two groups of males and two groups of females

Groups	t-ratio	t critical	Interpretation	Ho Accepted/Rejected
Young adult female and young adult male	2.762628638	1.988609667	Significant	Ho3 rejected
Middle adult female and Middle adult male	0.198294187	1.988609667	Not significant	Ho4 accepted

The above table indicated that the males and females belonging to younger age group differed significantly but there was no significant gender difference in the middle adult group.

The Euthanasia Attitude Scale in the present study consist of seven domains. Taking into consideration these domains the study aimed to find out difference between the four groups studied with regard to these domains. The result obtained from the analyses is given as follows:

Table 5: F ratio of young adult and middle adult male and female in 7 domains of Euthanasia Attitude Scale.

Domains	Young adult male Mean value	Young adult female Mean value	Middle adult Mean value	Middle adult female Mean value	d.f.	F Stat	F critical	Hypothesis
Ho5								Rejected
General orientation	18.6	16.812	14,482	14,165	3	6.004224212	2.631489119	
Age of patient	11.906	11.5186	8.8598	9	3	11.09661572	2.631489119	

Condition of patient	11.58823529	10.57647059	9.435294118	8.752941176	3	5.686926654	2.631489119	
Relationship with patient	14.84705882	13.09411765	11.28235294	10.61176471	3	8.078999901	2.631489119	
Religion	12.30588235	11.92941176	9.270588235	9.235294118	3	12.22248173	2.631489119	
Economic Factor	13.85882353	12.17647059	10.89411765	10.62352941	3	6.105942302	2.631489119	
Jurisdiction & euthanasia	20.12941176	19.18823529	16.71764706	15.84705882	3	7.769180254	2.631489119	

From the above table it has been found that the four groups of subjects, namely, young adult males and females, middle adult males and females differed significantly in all the domains of the euthanasia attitude scale being constructed in the present study. Further it can be seen that young adult male respondent have maximum pro euthanasia attitude followed by young adult females. Thus it may be said that age is a significant factor in expressing attitude regarding various aspects related to euthanasia.

## Conclusion

The word “Euthanasia” is value loaded as this has raised strong emotions and passionate debates because it involves termination of Human Life. The landmark judgement by Supreme Court of India has further created a rift between individuals who are in favour of euthanasia and those who oppose it.

The present study thus aimed to find out the attitude of young adult males and females and middle adult males and females towards the debated construct.

The study revealed that out of 340 respondents only 146 respondents favoured euthanasia.

The study found that not only these two age groups but also males and females differed in their attitude towards euthanasia. The four groups also differed significantly in all the domains of euthanasia taken up for the present study by constructing Euthanasia Attitude Scale. The younger males and females showed more favourable euthanasia attitude when compared on the basis of total score as well as domain wise.

As there was no available Indian scale on attitude towards euthanasia, a scale was prepared for the purpose of the study. Based on the data collected from 340 respondents and tabulating scores for 35 items the Cronbach alpha value obtained was 0.80 indicating a good internal consistency. Factor analysis to test validity of the scale found that the factor loading of all manifested domains exceed

0.33. Based on the nature of domain, the latent construct can be defined as Euthanasia further indicating interlink between the seven domains studied.

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# A Study of Perceived Loneliness in relation to the Personality Types among Young Adults

Zeenat Ahmed and Debolina Chatterjee

## ABSTRACT

The personality of young adults may be established but they often face conflicts within themselves which leads to perceived feelings of loneliness. The purpose of the study is to assess the personality types in relation to perceived loneliness among young adults. The sample size is 150 young adults in the age group of 18-25 years, that have been chosen through a random sampling from different colleges in Kolkata. The scales used are Eysenck's Personality Questionnaire-Revised (EPQ-R), which have given the basic individual's personality traits as Extraversion-Introversion along with Psychoticism and Neuroticism and Perceived Loneliness Scale by Dr. Praveen Kumar Jha respectively. Mean, and Correlation were used for data analysis and further inferences were drawn. Findings revealed that there exists a negative correlation between high extroversion scores and perceived loneliness and a positive correlation was found between low extroversion (i.e., introversion) and perceived loneliness.

**Keywords:** perceived loneliness, personality, young adults.

## Introduction

Loneliness is defined as the distressing experience that occurs when one's social relationships are perceived to be less in quantity, and especially in quality, than desired. The term perceive means, "become aware or conscious of (something); come to realise or understand", or "to attain awareness and understanding of." (Cherry Kendra, 2018).

Being alone and experiencing loneliness are not the same thing. People can be alone without feeling lonely and can feel lonely even when with other people. Loneliness is associated with depressive symptoms, poor social support, neuroticism, and introversion, but loneliness is not synonymous with these psychological characteristics. Loneliness is typically thought of as a stable trait, with individual differences in the set-point for feelings of loneliness about which people fluctuate depending on the specific circumstances in which they find themselves. Eysenck (1983) gave the different personality traits namely, Extroversion-Introversion, Neuroticism and Psychoticism. This reflects the personality of individuals, the term personality is derived from the Latin word, 'persona', meaning "mask". Thus, personality may be defined as the characteristic patterns of behaviour and modes of thinking that determine a person's adjustment to the environment. According to psychologist Gordon Alport "personality is the dynamic organization within the individual of those psycho-physical systems that determine his unique adjustments to his environment." (Alport 1961, p.28).

Loneliness is frequently experienced during childhood or adolescence generally as a result of a lack of friendships in school. In later life,

loneliness can be a sign of a psychological or social problem, for instance chronic depression. For most individuals, becoming an adult involves a lengthy transition period. Recently, the transition from adolescence to adulthood has been referred to as emerging adulthood or young adults, which occurs from approximately 18-25 years of age (Arnett, 2006,2007). Experimentation and exploration characterize the emerging adult. At this point in their development, many individuals are still exploring which career path they want to follow, what they want their identity to be and which lifestyle they want to adopt. It can be experienced as one of the consequences of a divorce or the termination of another form of long-term relationships – though this is normally only temporary, as loneliness can be a natural consequence of the sadness and subsequent withdrawal from the social arena while the grieving process is completed. Loneliness is also normally experienced at a time of mourning and one can feel the emotion of loneliness even while in the presence of other people. Other times that loneliness can be experienced are after the birth of a child, which is sometimes experienced as part of postpartum depression, or following any socially disruptive event such as moving to a different location, also known as homesickness. Feelings of loneliness can also follow marriage, which socially is a time of great change. Even within marriage, loneliness is possible, though mainly if the relationship is dysfunctional. In these situations, the person experiencing loneliness can also be feeling anger or resentment.

There are many ways to address loneliness. One of the main treatments is therapy, during the course of which the therapist would try to understand

where these feelings come from and to reverse the negative thoughts, attitudes and feelings that result from the root cause. Some doctors may also suggest group therapy as an alternative to individual sessions so that people who are feeling lonely can form their own social support network. Doctors may also try prescribing anti-depressants to sufferers, in conjunction with their talk therapy, as well as alternative therapies such as exercise and dieting. Other treatments for loneliness may include cognitive behavioural therapy, the aim of which is to help explore and change how to think about one's life, and free oneself from unhelpful patterns of behaviour. Another type of therapeutic involvement could be Behavioural Activation, is a therapy that encourages patients with depression to approach activities they may have been avoiding, talking therapy, where the individual is suggested to take simple steps in life which would bring smallest of happiness to him. Yet another type of therapeutic help offered to individuals to combat loneliness is Mindfulness-based Cognitive Therapy, which helps the individual to focus on their thoughts and feelings as they happen moment by moment. It involves mindfulness techniques like meditation, breathing exercises with cognitive therapy. These are some of the most used and reliable techniques. Other methods used are counselling and guided self-help as per the individualistic needs.

On the basis of a few studies done by the researchers, that is, Teppers, Klimstra, Damme & Luyckx (2013) and Chauhan and Sharma (2015), the objectives of the present study were formed that included the assessment of Persoanlity and Perceived Loneliness, other studies like done by, Upadhayay and Khokhar (2006) and Panda (2016), who also discussed about the Personality and Perceived Loneliness. Therefore, the main objectives were :

1. To assess the personality types among young adults.
2. To study the level or existence of perceived loneliness among young adults.
3. To study the relation between perceived loneliness and personality types among young adults.

## **Methodology**

The present study formed two hypotheses in order to prove the following:

H<sub>0</sub>1: There will be no significant relationship between perceived loneliness and high extroversion scores among young adults.

2: There will be no significant relationship between perceived loneliness and low extroversion (i.e. introversion) among young adults.

The sample for the present study includes 150 young adults from five co-educational colleges, pertaining to the Central and Southern part of the city of Kolkata. All the respondents were chosen using random sampling techniques keeping the objectives and criteria in mind. The sample size was 150 young adults (within the age group of 18-25 years). There were 75 females and 75 males respondents. They were pursuing under graduation or post graduation in different courses of study.

The researcher has used the following standardized scales to collect data:

1. Perceived Loneliness Scale-J by Dr. Praveen Kumar Jha - Perceived Loneliness Scale-J is the development of scale having conceptualized loneliness as an uni-dimensional psychological state of an individual, it was planned to develop a comprehensive scale to measure the extent of loneliness. Several personality factors have been linked to loneliness, it is generally believed that people tend to be more introvert and shy, more self-conscious and less assertive (Jones, Briggs and Smith, 1986). The questions in the scale were divided into positive items which would be scored from 5-1 on the basis of Strongly Agree to Strongly Disagrees and under negative items which would be scored from 1-5 under the same category as mentioned above followed under the norm table as Extremely Not Lonely to Extremely Lonely.
2. Eysenck's Personality Questionnaire-Revised (EPQ-R) - Eysenck's Personality Questionnaire-Revised is designed to measure three major dimensions of personality according to Eysenck: Extraversion/Introversion, Neuroticism, and Psychoticism. This version of the test is the revised edition available for individuals who have acquired 18 years of age. The questions were arranged under each categories namely E (Extroversion), P (Psychoticism), N(Neuroticism) and L(Lie Score) and the scoring were done accordingly. Norm Table was followed which would help in the interpretations of the data scored.

The scoring was done in MS Excel and arranged as per the different perceived loneliness and the personality types. Statistical tools for applied for each objective. For the first two objectives, the Standardized Scales were used to record the

scores from the samples. For the third objective, Correlation was used see the relation of perceived loneliness with the personality types. Then the interpretations were drawn accordingly.

## Results and Discussion

The results have been presented objective wise:

Objective 1: To assess the personality types among young adults as given by the dimensions of EPQ-R. The total sample (N=150) was further grouped mainly under introversion scores and extroversion scores, where introverts were found to be 36 and extroverts were found to be 114 in total respectively. Then further categorisation was done on gender, wherein, under introversion the male respondents were 18 and the female respondents were 18 respectively. On the other hand, under extroversion the male respondents were 57 and the female respondents were 57 respectively. Further categorisation was done on the basis of emotional stability/instability and high/low psychoticism. Emotionally stable male introverts were 18, among them 2 of them were found to be high in psychoticism and 16 of them were low in psychoticism. Among the female introverts 10 of them were found to be emotionally stable among which 10 of them were found to be low in psychoticism, whereas, 8 of the female introverts were found to be emotionally unstable, among which 3 of them were found to be high in psychoticism and 5 of them were found to be low in psychoticism. On the other hand, emotionally stable male extroverts were found to be 47, among which 5 of them were found to be high in psychoticism and 42 of them were found to be low in psychoticism, whereas, 10 of the male extroverts were found to be emotionally unstable, among which 2 of them were found to be high in psychoticism and 8 of them were found to be low in psychoticism. Among the female extroverts 32 of them were found to be emotionally stable, among which 7 of them were found to be high in psychoticism and 25 of them were found to be low in psychoticism, the emotionally unstable extrovert females were found to be 25, among which 9 of them were found to be high in psychoticism and 16 of them were found to be low in psychoticism. Since personality types were not a criterion of inclusivity in the study the analysis of dimensional scores of EPQ-R was done post data collection which explains the disparity between the number of introverts and extroverts present in the sample.

Objective 2: To analyse the perceived loneliness among young adults

The data collected was also classified as different degrees of perceived loneliness as given in Perceived Loneliness Scale by Dr. Praveen Kumar Jha.

Table 1: Degrees of Perceived Loneliness

Extremely Not Lonely	23%
Highly Not Lonely	21%
Average Lonely	16%
Above Average Level Lonely	1%
Lonely	39%

It can be seen from Table 5.1 that 23% of the respondents from the collected samples were Extremely Not Lonely, 21% of the respondents were found to be Highly Not Lonely, 16% of the respondents were found to be Average Lonely, 1% of the respondents were found to be Above Average Level Lonely and 39% of the respondents were found to be Lonely. The percentage was calculated from the collected samples which included both males and females respondents, thus, it is seen that 39% of the respondents from the collected sample size were Lonely, or in simple words, 39% of the respondents did perceive themselves to be lonely. After individual analysis of data through the EPQ-R Scale and Perceived Loneliness Scale relational analysis was conducted through Pearson's Correlation.

Objective 3: To understand the relationship between personality types and perceived loneliness among young adults.

According to  $H_01$ , there will be no significant difference between high extroversion scores and perceived loneliness.

According to  $H_02$ , there will be no significant difference between high introversion scores and perceived loneliness

To test the above hypothesis Correlation was applied on personality types and perceived loneliness.

Table 2: Correlation and Mean Scores of Personality Types and Perceived Loneliness

Group	Mean	Correlation	Interpretation
Extroversion	15.05		
Perceived Loneliness	113.90	-0.10	Negative Correlation

As it can be seen from the table above the mean scores for extroversion is 15.05 and 113.90 for perceived loneliness respectively. The value of

Pearson's Correlation is --0.10. Therefore, it can be interpreted that there is a weak, negative correlation between extroversion and perceived loneliness. This implies that when one variable increases the other variable decreases and vice versa. These findings are thereby consistent with prior researches by Chauhan and Sharma (2015), found that extroversion was negatively correlated with emerging adult's loneliness. Similarly, Teppers et.al (2013), that extroversion was a predictor of lower affinity for and greater aversion to aloneness.

Table 3: Correlation and Mean Scores of Personality Types and Perceived Loneliness.

<b>Group</b>	<b>Mean</b>	<b>Correlation</b>	<b>Interpretation</b>
Extroversion	9.11	0.11	Positive Correlation
Perceived Loneliness	115.05		

As it can be seen, from the table above the mean scores for low extroversion is 9.11 and 115.05 for perceived loneliness respectively. The value of Pearson's Correlation is 0.11. Therefore, it can be interpreted that there is a positive correlation between introversion and perceived loneliness. This implies that when one variable increases the other variable increases and vice versa. These findings are substantiated by prior researches by, Chauhan and Sharma (2015) and Teppers et.,al (2013) who found a negative relationship between extroversion and loneliness. Thus, it can be inferred that low extroversion scores may be positively related with loneliness.

To summarize the above findings it can be said that there is a negative correlation between high extroversion scores and perceived loneliness (accepting the Ho1). Inversely, there is a positive correlation between low extroversion scores (introversion) and perceived loneliness (rejecting the Ho2).

## Conclusion

The study found that 114 of the respondents were extroverts and 36 of the respondents were introverts, including males and females respondents respectively from the data inferred by using the EPQ-R Scale. On the other hand, from the data collected 39% of the respondents were 'Lonely', in simple words, 39% of the respondents from the sample size did perceive themselves to be lonely.

Thus, from the present study it was found that extroverts are more in number as compared to the introverts among the emerging adulthood (young

adults) including males and females respectively. And 39% of the respondents fell under the category of Lonely, in simple words, out of the sample collected and calculated 39% of the young adults did perceive themselves to be lonely.

After the analysis through Pearson's Correlation it was found that there is a negative correlation between high extroversion scores and perceived loneliness, according to the first hypothesis. For the second hypothesis, a positive correlation was found between low extroversion (i.e., introversion) and perceived loneliness.

The study corroborates earlier findings by Chauhan and Sharma (2015) and Tepperset.,al (2013) that also established that extroversion is negatively correlated with loneliness.

Thus, it can be said that those young adults who fall under the introversion type tend to feel lonelier than those who are fall under the extroversion type. This is because introverts are individuals who are not sociable in nature as compared to the extroverts who are outgoing and sociable in nature. The introverts as wanting to spend time alone, can perceive themselves to be lonely as in comparison to the extroverts. Today in an age in which young adults are so caught up with a fast competitive world, there remains scope to reflect upon oneself and help improve one's characteristics so that the individual may not perceive himself or herself to be lonely. The characteristics of the individual can change and develop into an individualistic character where he or she does not find or perceive himself or herself lonely. The change or effort is from the individual and only he can change his or her present scenario completely to a more stable life in the society.

The limitation that prevented this research from having its optimal results is the sample size was small and the sample was homogeneous in terms of background, educational qualification and age.

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# A Comparative Study of Situational Risk-Taking Tendency among Adolescents and Young Adults

Jyoti Shah and Geetika Sachdeva

## ABSTRACT

*Risk can be defined as undertaking an action involving a challenge a person takes in order to obtain some sort of benefit, when there is an element of uncertainty involved in the outcome. These behaviors can be threatening to the individual and aspects of their life such as their job or relationships. Risk taking tendency can either be a characteristic expressed by the individual, situational factors, or a unique interaction between both. The current study finds out which developmental age is more prone to situational risk taking and whether gender differences exist. It also aimed at which domain of risk taking is more dominant in adolescents and young adults. Data was gathered from 300 participants of whom 150 were adolescents and 150 young using Risk Taking Scale by Dr. Shubhash Sarkar. The findings of the study discusses that young adults were more inclined to risk taking tendency as compared to adolescents. Gender differences, when assessed, established that male young adults were more prone to risky tendencies as compared to male adolescents. The young adults from Science stream were more prone to risk taking tendency when compared to young adults of Humanities stream. Domain wise analysis yielded the result that there is a significant difference in the domains of Profession, Games and Adventure Risk taking among young adults and adolescents.*

**Keywords:** Adolescents, Domain, Risk-taking tendency, Young Adults

## Introduction

Risk is a subjective term and its definitions may vary from person to person. For example, to some, a claustrophobic individual going to movie is a risk taker, for some a person driving at 100km/hr when limit is 40km/hr a risk taker and for some, mortgaging his assets for education of his child who is not good academically, a risk taker. The common factor underlying all these situations is that risk taking involves uncertainty in outcome with possible benefits or costs for the physical, economic or psycho-social well-being of oneself or others. Risk taking tendencies and behaviours can be threatening to the individual, aspects of their life such as their job or relationships. Risk taking tendency can be expressed as a characteristic by the individual, situational factors, or a unique interaction between both. Irwin and Vaugh (1988) termed risk taking behaviour that result in positive consequences as “exploratory behaviour,” but this differentiation is not yet explored in the research literature. It is not a simple task to label tendencies as either risky or not risky because tendencies labelled as negative can sometimes relate to constructive outcomes (Schulenberg, 2006) and tendencies that are generally considered positive can be quite risky. Risk taking tendencies can enable one to be explorative and creative leading to benefits that were previously inaccessible, but they can also be detrimental to the safety, mental and physical health of the individual if the risk is not assessed properly. As major biological changes occur during the onset of puberty, risk taking tendency should be assessed

from that age. Adolescence is a period of great peer influence; individuals start carving out ways out of their comfort zone and possess a willingness to do what they haven't done before (which leads to risky tendency), which carries out to further life spans, majorly influencing the young adulthood period of their life. In industrialized societies, the period of adolescence and young adulthood includes prolonged education, career training, and adult role acquisition which may extend into the third decade of life. Parents provide with more independence during this interval, hence adolescents and young adults get increasing opportunities to explore behaviours, roles, attitudes, and values. This behaviour often involves risk-taking, including adventurous, sexual, substance use, driving behaviours. Hence, it results in higher rates of risk behaviour during adolescence and young adulthood than in any other developmental period. Therefore, as the topic states, a comparative study on these two developmental life spans is conducted which will assess risk taking tendency depending upon various situations (domain wise).

## Methodology

To fulfil the aim of present study, data was collected through random sampling from 300 participants of whom 150 were adolescents and 150 were young adults. The study was carried out with the adolescents of age 14-19 and young adults of the age range of 20-30 years. The respondents were both male and female individuals in equal number. The respondents consented to fill the Risk Taking

Scale (2017) by Dr. Subhash Sarkar that assesses risk-taking probability on the basis of the reaction to real life situations. For analysing the data, Ms-Excel software was used and statistical functions were applied.

## Results and Discussion

The mean score for both developmental age groups had a difference. When assessing gender wise, it was found out that mean score for risk taking for male young adults was higher when compared to male adolescents. Also, when the gender differences of adolescents were considered, it was found out that female adolescents scored higher as compared to male adolescents. (Fig 1).

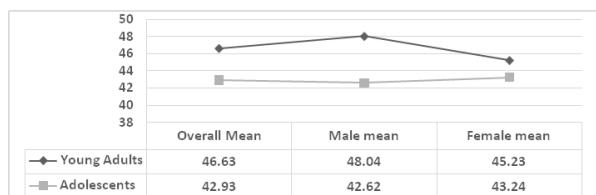


Fig 1: Plotting of Mean score of Risk taking tendency

When t-test was applied to test the significance of both the age groups for risk taking, it was found out that young adults were more inclined to take risks as compared to adolescents at 5% level of significance. The value of t-stat was more compared to the table value of t-critical, hence the hypothesis was rejected and it was found that there was a significant difference in risk taking tendency among adolescents and young adults. (Table 1).

Table 1: t-test of risk taking score between adolescents and young adults at 5% level of significance

Degrees of freedom	T-Stat	T-Crit.	Interpretation
149	3.2	1.97	Significant

When intra group gender comparisons were done, that is, when male and female of adolescents were tested, there was no significant difference in risk taking tendency between adolescent males and females (Table 2), but while interpreting their mean scores (Fig 1), it was seen that adolescent females were more inclined towards risk taking as compared to male counterparts. To test significance between male young adults and female young adults, it was seen from their mean scores that male young adults were more inclined to risk taking as compared to female young adults. To test their significance, t test was applied at 5% level of significance and it was seen that there exists a significance difference among the gender of young adults in risk taking

tendency, thereby proving that male young adults showed more of risk taking tendency as compared to female young adults. (Table 3)

Table 2: t-test between adolescent males and females at 5% level of significance

Degrees of freedom	T-Stat	T-Crit.	Interpretation
74	1.07	1.99	Insignificant

Table 3: t-test between young adult males and females at 5% level of significance

Degrees of freedom	T-Stat	T-Crit.	Interpretation
74	2.99	1.99	Significant

The risk taking was then assessed domain wise indicating which dimension of risk taking showed significant differences among adolescents and young adults. The results depict that the domains of Profession, Games and Adventure Risk taking had significant differences in risk taking tendency when young adults were compared to adolescents (Table 4).

Table 4: Domain wise comparison among young adults and adolescents at 5% level of significance

Domain	dF	t-stat	t-crit	Interpretation
Profession	149	2.88	1.97	Significant
Games	149	2.98	1.97	Significant
Adventure	149	4.41	1.97	Significant

The sample gathered from young adults were from different academic fields so that differences could be analysed among them and it was found out that Science stream showed significant difference when compared to Humanities stream. The mean score of Science stream was higher indicating Science stream students were tending towards risk taking more as compared to Humanities (Table 5).

Table 5: Stream wise comparison among young adults at 5% level of significance

Mean score of Science stream	Mean score of Humanities stream	Degrees of freedom	T-Stat	T-Crit.	Interpretation
47.88	44.26	49	2.06	2.00	Significant

## Conclusion

The present survey focused on comparative study of situational risk taking tendencies among adolescents and young adults and found out that young adults

had more risk taking tendency as compared to adolescents. Young males were prone to risky tendencies as compared to adolescent males and that the domains of Profession, Adventure and Games had significant differences among both the age groups.

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# A study of children's perception of parental expectations.

Madiha Fatma and Punam Mehra

## ABSTRACT

*Childhood is characterized by rapid development that is influenced by several factors in the child's environment. Parents are more often than not the most determining influences in a child's life. Parental expectations are a direct influence on the developing competencies of children. The current study aims to study the academic and moral expectations of parents and their children's perception of these expectations to draw a comparison between the two. This aim of the study is carried out using self-prepared questionnaires for parents and children respectively that was developed through research and a pilot study. The self-prepared questionnaire was modelled after the Perception of Parental Expectations Inventory and the Moral Value Scale. The data thus collected was analysed using t test and ANOVA to test the difference between parental expectations and children's perceptions of these expectations. The results showed no significant difference between parental academic expectations and children's perception of those. However, there was a significant difference between moral expectations of parents and children's perception of these expectations. The real and perceived expectations of two different SES included was found to be similar in terms of both moral and academic expectations.*

**Keywords:** Children's perception, Parental Expectations, Academics and Moral Behaviour.

## Introduction

Mothers and fathers are able to form a reciprocal relationship with their children, whereby they accept or respond to the behaviors of their children and on the other hand, demand certain types of behavior or control the presence or absence of certain behaviors. A related element of parental control is the level of control the parents have for the child's behavior. Is the child expected to show relatively mature behavior, or do the parents feel it's important not to expect too much too soon? Studies of such variations show that within limits, higher expectations seem to be associated with better outcomes. Obviously high expectations can be carried too far, as such, it is unrealistic and counterproductive.

Children's perception of their relationship with their parent also includes their perspective understanding of what their parents expect them to do, which at the impressionable stages of life such as, middle childhood, 9-12 years of age.

Along with parental expectations socioeconomic status can be a powerful factor in achievement- not in and of itself but through its influence on family atmosphere, on choice of neighborhood, on quality of available schooling and on parent's way of rearing children.

All these factors clubbed with this transitional period of middle childhood creates a unique combination of autonomy and reliance where children try to utilize

more of their developing reasoning while still taking cues from their parents. Thus, in such circumstance's children attempt to employ their perception of what is expected of them in different contexts and by the various constituents of their environment ranging from their parents to the larger cultural setting. A thorough understanding of the differences between real and perceived parental expectations can be fruitful for improvement of both child's performance and behavior.

## Methodology

The present study made use of self prepared questionnaires that were developed by modelling them after Perception of Parental Expectations Inventory (Saikala & Karunnidhi) and Moral Value scale (Gupta & Singh), these questionnaires focus on two important aspects of parental expectations, (1) Academic Performance and (b) Moral behavior. For each of these two categories two Likert like scales were prepared one for the child and one for parents. These parent and child scales had complimentary questions to allow for ease of comparison and analysis.

Aside from this, the Socio-Economic Status Scale (Urban & Rural) (SESS-UR-KASS) by Prof. Kalia and Mr. Sahu was also used to find out the SES of respondents.

The data thus collected was analyzed using multiple t-tests and ANOVAs.

## **Results and Discussions**

The results of the above study can be summarized as follows:

1. After analysis it was found that H<sub>01</sub> of no significant difference between perceived and actual academic expectations of parents was accepted and value of the t- stat was lower than the t- critical. This was further verified by ANOVA. This maybe because at this comparatively younger age of the children parents are directly involved in the day-to-day academic activities of the children and hence may have clear communication regarding their expectations. Also, to be noted, that graphically representation of means of perceived and actual expectations of fathers and mothers respectively showed that actual academic expectations of the fathers is closer to the perception of those expectations as compared to the mother.
2. H<sub>02</sub> that there is no significant difference between perceived and actual moral expectations of parents was rejected as the value of t-stat was higher than t-critical. This was further verified by ANOVA results. This maybe because moral values are often parted implicitly and situational, i.e. only when need arises. Also, to be noted, that graphically representation of means of perceived and actual expectations of fathers and mothers respectively showed that actual moral expectations of the fathers is closer to the perception of those expectations as compared to the mother.
3. Hypotheses regarding significance of comparison of expectations (both real and perceived) of high SES families and middle SES parents were all accepted since the F value was lower than F critical. This maybe because the data was collected from the same school and all families in the sample may have similar backgrounds, which was reflected from the scores of the SES scale that did not have too large a range.

## **Conclusion**

To conclude it can be said that there is concurrence between the academic expectations of parents and their daughters' perception of them, while the parent's expectations regarding moral behavior is not similar to their daughters' perception.

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# To Study Social Competence of Children from Different Social Background

Shahna Hussain and Krishnakali Bhattacharyya

## ABSTRACT

*Social competence is the social ability and inter – personal skill of an individual in effectively meeting a person – situation interaction or successfully dealing with ‘an individual environmental factors’ (Eisler, 1976). Social competence is defined as the ability to handle social interactions effectively. In other words, social competence refers to getting along well with others, being able to form and maintain close relationships, and responding in adaptive ways in social settings. Given the complexity of social interactions, social competence is the product of a wide range of cognitive abilities, emotional processes, behavioral skills, social awareness, and personal and cultural values related to interpersonal relationships. Social competence has received considerable attention of researchers in last couple of decades because of its importance in workplaces and especially educational settings. The present study aimed to find out difference between school going boys and girls if any, with respect to their social competence belonging to different social background. The sample consisted of four hundred boys and girls (200 in each group respectively) aged between 13 to 15 years. The tool used for the study was Social Competence Scale (SCS – SSS) Hindi/English version by V.P. Sharma, Prabha Shukla and Kiran Shukla. Results from the present study revealed that Hindu and Muslim boys and girls coming from extended and nuclear family differ significantly in social competence.*

**Key words:** extended family, nuclear family social background, social competence.

## Introduction

The development of social competence in children has been shown to be associated with many positive outcomes in adulthood, such as higher academic success and higher self-esteem.

Social competence is defined as the ability to handle social interactions effectively. In other words, social competence refers to getting along well with others, being able to form and maintain close relationships, and responding in adaptive ways in social settings. Given the complexity of social interactions, social competence is the product of a wide range of cognitive abilities, emotional processes, behavioral skills, social awareness, and personal and cultural values related to interpersonal relationships. To further complicate the understanding of this concept, social competence is dependent on developmental characteristics (i.e., expectations of social competence vary by age of person), the specific social situation (i.e., people may be socially competent in one situation but not in another, or a child may appear more competent when interacting with a socially skilled partner than with a shy person), and cultural characteristics (i.e., specific acts of social competence are bound by cultural expectations).

## Methodology

### 4.1 Hypotheses:

The hypotheses to be tested are given below:

- ◆ Ho1: There is no significant difference between Hindu, Muslim boys and girls belonging to

extended family with respect to their social competence.

- ◆ Ho2: There is no significant difference between Hindu, Muslim boys and girls belonging to nuclear family with respect to their social competence.  
If the above mentioned null hypotheses are rejected then the following hypotheses will be tested
  - ◆ Ho3: There is no significant difference in social competence among Hindu and Muslim boys belonging to extended family.
  - ◆ Ho4: There is no significant difference in social competence among Hindu and Muslim boys belonging to nuclear family.
  - ◆ Ho5: There is no significant difference in social competence among Hindu and Muslim girls belonging to extended Family.
  - ◆ Ho6: There is no significant difference in social competence among Hindu and Muslim girls belonging to nuclear family.
  - ◆ Ho7: There is no significant difference in social competence among Hindu boys and girls belonging to extended family.
  - ◆ Ho8: There is no significant difference in social competence among Hindu boys and girls belonging to nuclear family.
  - ◆ Ho9: There is no significant difference in social competence among Muslim boys and girls belonging to extended family.

- ◆ Ho10: There is no significant difference in social competence among Muslims boys and girls belonging to nuclear family.

#### 4.2 Sample:

After finalizing the objectives of the study various (10) schools of Kolkata were approached. However; out of the 10 schools 5 schools had given consent for the collection of data from their students of Class VII to IX.

The details of the sample are as follows:

Sample n=400							
Boys 200 n=200				Girls 200 n=200			
↓ Extended n=100	↓ Nuclear n=100	↓ Extended n=100	↓ Nuclear n=100				
Hindu n=50	Muslim n=50	Hindu n=50	Muslim n=50	Hindu n=50	Muslim n=50	Hindu n=50	Muslim n=50

Some other characteristics of the sample were:

1. The age range of the participants was from 13 to 15 years.
2. All the students are able to read and write English.
3. Monthly income of the family is more than Rs. 40,000/-
4. All the respondents were studying in English medium convent school.
5. The participants were studying in class VI/VII/VIII/IX.
6. The participants' students were Hindu or Muslims.
7. They either belonged to nuclear or extended family.

#### 4.3 Data Collection Method: Obtaining permission

from the schools and fixing the date and the time of collection of data within the school hours Social Competence Scale was distributed to the students of specific class. They were given the instructions in details and were provided any help required for filling up the questionnaire by the researcher. In this regard it may be mentioned that students were not discriminated on the basis of religion or any other variable and the data was collected from the classes in entirety. Then the data was sorted according to the objectives of the study.

The description of the tool used for the study is as follows: Social Competence Scale (SCS – SSS) Hindi/English by V.P. Sharma, Prabha Shukla and Kiran Shukla. will be administered to children from different social background This scale consists of 50 items. This scale is meant for school going children from 10 - 15 years class VI to IX.

The scoring techniques were as follows: The final form of the social competence scale consisting of 50 items measuring 18 factors of social skills and behavior has been designed for Indian pupils between the age of 10 to 15 years of both the sexes. The investigators prepared 5 items of each of these 18 factors on a Five Point Scale ranging from 'Very High, High, Average, Low and Very Low. The scoring system is as follows:

Table 1: Scoring System for Social Competence Scale

Very High	High	Average	Low	Very Low
5	4	3	2	1

Norms: Norms have been presented in Table 2 under five levels of social competence (i.e. very high, high, average, low and very low) along with means and SDs.

Table 2: Age Norms On Social Competence Of Indian Children

Very High	195					
	10	11	12	13	14	15
	N=112	N=91	N=113	N=88	N=100	N=96
Very High	195	197	201	203	204	209 & above
High	179	183	185	185	186	193
Average	163	169	170	167	168	177
Low	147	155	155	149	150	161
Very Low	131	141	140	131	132	145 & below
Mean	162.77	169.42	170.21	167.39	167.99	177.09
SD	16.52	14.21	15.88	18.31	18.21	16.17
Range	145.48-179.29	155.21-183.63	154.33-186.09	149.08-185.7	149.78-186.2	160.92-193.26

**Reliability of the Scale:** The coefficient of interrater reliability has been found to be  $rtt=67$ . Which are significant at 0.01 level of significance.

**Validity of the Scale:** Apart from the item-validity as analyzed above the SC scale (English version) has been validated against Kohn's Social Competence Scale and a predictive validity to the extent of  $r = 0.72$  was obtained. Further the English and Hindi version of the SC scale was found to be correlated to the extent of  $r=.84$ . (Significant at 0.01 level of significance).

**4.4 Method Of Data Processing & Analysis:** After the collection of data, it was arranged according to the religion and family size in order to calculate the results. With the help of Microsoft Excel the following statistics were computed.

- ◆ Mean,
- ◆ Standard Deviation,
- ◆ ANOVA, and
- ◆ Student's t-test (independent t of equal sample size).

## Result and Discussion

Social competence is defined as the ability to handle social interactions effectively. In other words, social competence refers to getting along well with others, being able to form and maintain close relationships, and responding in adaptive ways in social settings. (Orpinas, 2010)

The development of social competence in children has been shown to be associated with many positive outcomes in adulthood, such as higher academic success and higher self-esteem. From the present study the following results were obtained.

Table 3: Mean and SD of the four groups of respondents ( $n=400$ ) belonging to extended and nuclear family on Social Competence Scale

Extended Family	Mean	SD	Nuclear Family	Mean	SD
Hindu Boys	157.22	17.96	Hindu Boys	182.82	17.80
Hindu Girls	150	17.74	Hindu Girls	188.72	15.90
Muslim Boys	176.08	16.40	Muslim Boys	162.36	18.23
Muslim Girls	182.04	11.46	Muslim Girls	153.28	12.2

From the above table it is seen that mean score of all the groups in social competence is within the average range (ref: Table 2). Thus it may be said that all the respondents are more or less socially competent.

In order to determine the significant difference between boys and girls coming from extended family and belonging to two different religion one way ANOVA was done.

Table 4: F ratio between Hindu and Muslim boys and girls belonging to extended family

Source of Variance	Sum of Squares (SS)	Degree of Freedom (df)	Means Squares (MS)	F Value	P Value	F Critical	Interpretation	Null Hypothesis Ho1
Between Groups	34576.375	3	11525.45	44.42	5.98	2.65		
Within Groups	50850.18	196	259.43				Significant	Rejected

From the above table it may be said that there is a significant difference between Hindu and Muslim boys and girls belonging to extended family. In this regard it may be further said that Muslim boys and girls have higher mean score in social competence than Hindu boys and girls (Table3). However, none

of the groups have very low social competence (ref. Table 2, norm table).

In order to find out the significant difference between the children coming from nuclear family and belonging to two different religions one way ANOVA was calculated.

Table 5: F ratio between Hindu and Muslim boys and girls belonging to extended family

Source of Variance	Sum of Squares (SS)	Degree of Freedom (df)	Means Squares (MS)	F Value	P Value	F Critical	Interpretation	Null Hypothesis Ho1
Between Groups	41991.535	3	13997.17	53.26	3.16	2.65		
Within Groups	51501.06	196	262.76				Significant	Rejected

From the above table it may be said that there is a significant difference between Hindu and Muslim boys and girls belonging to nuclear family. In this regard it may be further said that Hindu boys and girls have higher mean score in social competence than Muslim boys and girls (Table 3). However, none of the groups have very low social competence (ref. Table 1).

Many factors that plays a vital role in the developmental of social competence in children. Factors like social sensitivity, social maturity, social skills, social relations, social commitment,

social involvement, social respectability, social leadership, social cooperation and compliance, social acceptability, social tolerance, social competition, social authority, social participation and pro-social attitude.

Social competence is acquired through social interaction and cultural integration in different socio-cultural settings students coming from different family size and belonging to different religion are brought up in different socio-cultural setting which is expected to have some impact on their social competence, so further analysis was done to find out the difference between them.

Table 6: t value of the different groups being compared

Groups	Family Size	Religion	t-value	Ho
Accepted/Rejected				
Boys	Extended	Hindu & Muslim	5.21	Ho3 Rejected**
Boys	Nuclear	Hindu & Muslim	5.89	Ho4 Rejected**
Girls	Extended	Hindu & Muslim	10.99	Ho5 Rejected**
Girls	Nuclear	Hindu & Muslim	12.72	Ho6 Rejected**
Boys & Girls	Extended	Hindu	1.97	Ho7 Rejected*
Boys & Girls	Nuclear	Hindu	1.59	Ho8 Accepted
Boys & Girls	Extended	Muslim	2.09	Ho7 Rejected*
Boys & Girls	Nuclear	Muslim	3.08	Ho8 Rejected**

\*\* $\geq 0.01$  & \* $\geq 0.05$

From the above table it may be said that except Hindu boys and girls coming from nuclear family all the groups differed significantly when being compared. This difference in social competence may have its root in family size and also in the religion they belong to. Thus it may be said that how many members are there in the family and the interacting between them contribute to the development of social competence.

## Conclusion

All children are born social but have to learn and develop many social aspects to adapt in the society and get along well with others. One such important aspect is social competence. The concept of social competence is not new While (1963) developed the concept of social competence to depict a person's transaction with the social environment, and enable him to acquire successful experiences of others that may produce desirable effects. Goldfriend and D'Zurilla (1967) considered it as the effectiveness or adequacy which an individual is capable of responding to the various problematic situations which confront him.

However, the concept has not lost its value in the present context also. social competence is an important ingredient of modern civilization; and is the essential attribute of the members of a progressive onwards moving society. Thus the present study have taken up the school going boys and girls coming from different social background to see how competent they are socially. It also aimed to study difference among them and found that there is a significant difference between Hindu and Muslim boys and girls coming from extended family as well as Hindu and Muslim boys and girls coming from nuclear family in social competence.

Among the participants coming from extended family Muslim girls have highest level of social competence as compared to other groups. On the other hand, Hindu girls belonging to nuclear family have the highest level of social competence. Another significant finding from the study is that only Hindu boys and girls belonging to nuclear family did not differ significantly with respect to social competence indicating that their level of social competence as equal.

Overall, it was found from the present study that social competence Hindu and Muslim students of Class VII-IX studying in convent co-education schools of central Kolkata is within average range. This result from the present study is expected to bring positive outcome as social compliance is a major factor in enhancing social integration.

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# **Effect of Fruit Peel Formulated Natural Fertilizer on the Soil Fertility and Plant Growth**

*Nandini Rohatgi and Adrija Sarkar*

## **ABSTRACT**

*This investigation was elucidated to determine the effect of fruit peels (sweet lime, pomegranate and banana peels) as natural fertilizer on soil fertility and plant growth. The peels were dried, grounded and incorporated into the soil in various combinations using the method of backyard composting. Fenugreek plants were grown in the prepared soil samples. Results showed that the application of fruit peel formulations lead to improved soil quality and increased plant growth. Improved soil fertility was attributed to increased organic matter and higher microbial count of the soil samples as a result of application of fruit peel formulated fertilizer. Hence, the study concluded that inputs of organic fertilizers in agricultural fields has significant environmental benefits over the use of chemical fertilizers.*

**Keywords:** Backyard composting, Banana peels, Natural fertilizer, Pomegranate peels, Sweet lime peel

## **Introduction**

The global population has been increasing exponentially over the past few decades. In 1990, the world population was around 5.3 billion and it is expected to reach 11.2 billion by 2100 (United Nations Population Division, 2019). Feeding a growing world population requires continuous increase in food production, but arable land remains a limited resource. Hence, the farmers have increased the use of chemical fertilizers in order to increase the crop yield (Vanlalmawii and Awasthi, 2016). Although, widespread and intensive use of chemical fertilizers has increased the crop production, it has led to environmental degradation by adversely affecting the soil microbiology, soil fertility as well as the surface water and ground water quality (Kapoor et al., 2015). Moreover, production of chemical fertilizers requires burning of fossil fuels which has led to depletion of non-renewable resources and air pollution. Furthermore, as the food production and consumption has increased substantially, the quantities of organic food waste that is generated per year is also increasing significantly.

In order to overcome this situation, agricultural science has been looking for various alternatives. At present, researchers have suggested the use of organic fertilizers in place of chemical fertilizers as a suitable alternative that can improve the crop yield and soil fertility without negatively impacting the environment. Unlike chemical

fertilizers, organic fertilizers are cheap, non-hazardous, easily available and they reduce the dependency on fossil fuels. Moreover, organic fertilizers are slowly broken down into simpler components by soil microorganisms which lead to complete fixation of these components into the soil thereby improving soil fertility (Meenambalet al., 2003). This also allows complete usage of these components by the plants over a prolonged period of time. In addition, development of organic fertilizers aims to manage, recycle and convert biodegradable solid waste and acts as a soil amender or nutrient-rich medium for plant growth. Hence, this research focuses on the conversion of organic food wastes (such as fruit peels) into valuable compost for improving the crop yield and effectively addressing the issues of waste disposal.

## **Methodology**

Soil, earthen pots, chemical fertilizer, and fenugreek seeds were bought from the local nursery. Sweet lime (*Citrus limetta*) peels, pomegranate (*Punica granatum*) peels and banana (*Musa paradisiaca*) peels were collected from various households. The fruit peels were washed, sun-dried and ground to a coarse powder. The pH of the fruit peels was determined and various formulations were made. The compost was prepared by using the method of backyard composting. The fruit peels were added to the soil in a ratio of 1:9.

Table 1: Composition of the soil formulations

<b>Formulations (in 2 kg soil)</b>	<b>Ground sweet lime peel (g) (SL)</b>	<b>Ground pomegranate peel (g) (P)</b>	<b>Ground banana peel (g) (B)</b>	<b>Chemical fertilizer (g)</b>
Negative control	—	—	—	—
Positive control	—	—	—	10
Formulation 1	200	—	—	—
Formulation 2	—	200	—	—
Formulation 3	—	—	200	—
Formulation 4 (SL:P:B = 1:1:1)	67	67	67	—
Formulation 5 (SL:P:B = 2:1:1)	100	50	50	—
Formulation 6 (SL:P:B = 1:2:1)	50	100	50	—
Formulation 7 (SL:P:B = 1:1:2)	50	50	100	—

The prepared soil mixture was kept in open for 15 days to allow complete decomposition of the organic matter (fruit peels) into mature and stable compost. During this duration, the soil mixture was turned manually daily to allow proper aeration. After 15 days, fenugreek seeds were soaked overnight and sown in the prepared soil. The soil was watered twice a day and the growth of the plants was monitored daily.

#### Studied Characteristics

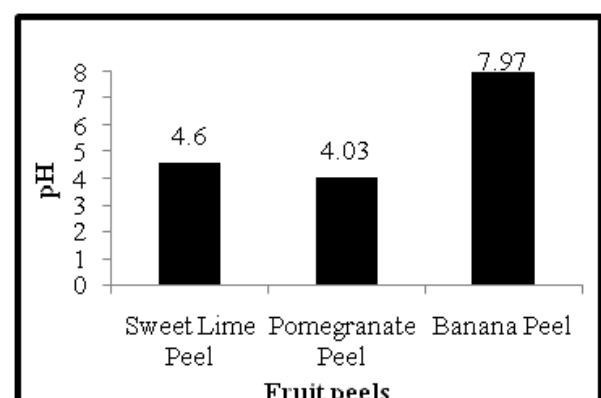
The following parameters were studied:

- ◆ Soil pH: The pH of the soil was determined by shaking the soil in distilled water (1:9) for 30 minutes. The pH was measured using pH meter.
- ◆ Nutrient levels in soil: After 3 months of preparation of the formulations, 3 soil samples (positive control, negative control and formulation 6) were sent to laboratory for analysis of total nitrogen, phosphorus, potassium and carbon levels in the soil. The procedure that was followed were as follows:
- ◆ Total nitrogen levels: IS 14684 (1999) test method given by BIS was used.
- ◆ Available phosphorus levels: The method given in the Methods of Soil Analysis, Part II (Soil Science Society for America) was used.
- ◆ Potassium levels: The method given in the Methods of Soil Analysis, Part II (Soil Science Society for America) was used.
- ◆ Carbon levels: IS 2720 (Part 22) 1972 test method given by BIS was used.

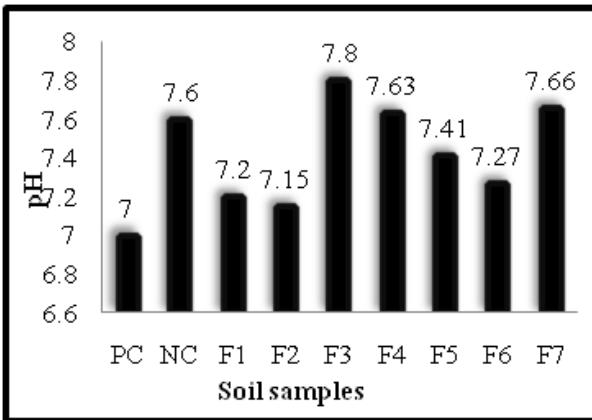
Rate of plant growth: The growth of plants were regularly monitored in order to determine the most effective formulation. After 6 months, the length of the plants were determined by randomly selecting 10 plants from each formulation and then measuring the length between the tip of the shoot to the tip of the root. An average was taken. The mean value was calculated and expressed in centimetres.

#### Result and Discussion

pH of fruit peels and soil pH: The pH of sweet lime and pomegranate peels was found to be acidic due to the presence of sufficient quantities of organic acids whereas the pH of banana peels was found to be alkaline due to the presence of large quantities of potassium which is alkaline in nature (Sagar et al., 2018).



Graph 1: pH of fruit peels



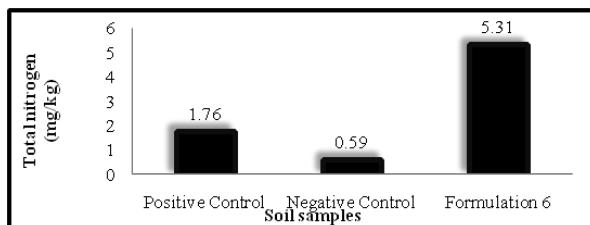
Graph 2: Soil pH

In order to provide a variety of nutrients to the plants, various formulations were made in such a manner so as to attain a desirable soil pH. The pH of all the soil formulations was found to be desirable for plant growth.

Soil pH is very important as it affects the availability of nutrients to plants as well as the survival of microorganisms in the soil which, in turn, would affect the soil fertility (Gentili et al., 2018). There was only a slight difference between the pH of various soil formulations when compared with the control. This may be because little quantities of fruit peels were added in large quantities of soil.

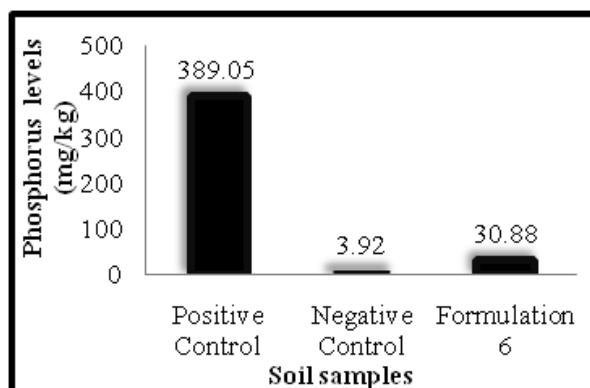
Nutrient levels in soil: After 3 months, the nitrogen, phosphorus, potassium and carbon levels of the soil were determined.

Total nitrogen levels: The total nitrogen content of formulation 6 was higher when compared with the two controls. The incorporation of organic matter in formulation 6 had led to an increase in the proportion and activity of nitrogen-fixing bacteria in the soil. These bacteria had resulted in increased nitrogen fixation in legumes and hence, enhanced plant metabolism (Sreekumar, 2014). Although the chemical fertilizer contains huge amounts of nitrogen, the nitrogen levels were found to be low in the positive control. The application of chemical fertilizers may have led to a decrease in the activity of microorganisms responsible for nitrogen fixation which may have resulted in increased nitrogen losses from the soil (due to volatilization, leaching, etc.) (Zhou et al., 2017).



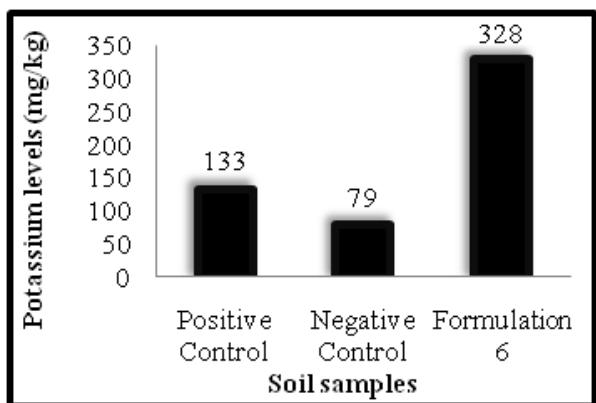
Graph 3: Total nitrogen levels in soil samples (mg/kg)

- Available phosphorus levels: The available phosphorus level in formulation 6 was found to be higher than the negative control but lower than the positive control. The increase in phosphorus content of formulation 6 may be due to the incorporation of large quantities of organic matter and the desirable pH of the soil as availability of phosphorus depends upon the pH of the soil (Pan et al., 2012). High phosphorus content in the positive control may be because the chemical fertilizer contains huge quantities of phosphorus in readily available form. Such high levels of phosphorus are undesirable as it might lead to zinc immobilization and deficiency in plants along with phosphorus toxicity thereby, resulting in stunted plant growth (Soltangheisi et al., 2013).



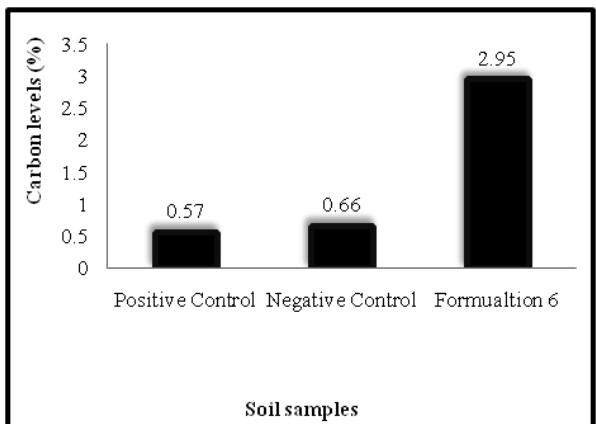
Graph 4: Available phosphorus levels in soil samples (mg/kg)

Potassium levels: The potassium content of formulation 6 was found to be higher than the two controls. The incorporation of organic matter into the soil significantly increases the activity of soil microorganisms. Hence, the increase in potassium levels may be due to the degradation of enormous quantities of potassium present in the banana peels (Hussein et al., 2019; Sreekumar, 2014). The potassium content of the negative control was found to be satisfactory. This may be because of the presence of sufficient quantities of naturally occurring potassium in the soil. Most heavy soils (clay soils) contain adequate quantities of naturally occurring potassium (Barre et al., 2008).



Graph 5:Potassium levels in soil samples (mg/kg)

◆ Carbon levels: The carbon level in formulation 6 was found to be higher than the two controls. The increase in carbon content may be because of the incorporation of organic matter into the soil. Organic materials are a rich source of simple and complex sugars and dietary fibre which makes them a good source of food for the microorganisms (Ahmed and Basumatary, 2008). Hence, addition of organic material into the soil may have increased the activity of microorganisms that are responsible for degradation of complex organic matter into simpler and stable forms, thereby increasing the reduced carbon pools in the soil (Fliessbach & Mader, 1997; Pathak et al., 2017). The carbon levels were found to be low in the positive control which may be due to the fact that chemical fertilizers are a poor source of organic matter (Rai et al., 2014).



Graph 6:Carbon levels (%) in soil samples

Plant growth: Formulation 6 had achieved maximum plant growth. Furthermore, the plants grown in this formulation 6 were denser, sturdier and consisted of more number of branches and seed pods as compared to other soil formulations. Hence, this formulation was found to be quite suitable for plant

growth which may have been due to increased soil fertility and improved plant nutrition as a result of the application of fruit peels in the soil (Sagar et al., 2018). Moreover, amongst the two controls, the plant growth seen in positive control was more when compared with the negative control. Least growth was observed in Formulation 3 and the plants died before completing their life cycle. This may have been due to the toxic build-up of potassium in the soil. Banana peels are rich in potassium and the potassium level in this formulation may have been much higher than that desired for plant growth. This may have resulted in build-up of potassium in the soil thereby, resulting in cation imbalance and deficiency of other minerals (such as magnesium and calcium) in the soil (Arienzo et al., 2009).

## Conclusion

The study concluded that the incorporation of fruit peel formulated natural fertilizer into the soil not only led to improved soil fertility but also resulted in better growth of plants. Hence, fruit peels may be effectively used as a natural fertilizer in order to increase the soil fertility and promote plant growth.

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# In vitro investigation of commercially available dairy and non-dairy probiotic beverages

Shrayasi Bhowal and Anindita Deb Pal

## ABSTRACT

*Probiotics for human consumption including Lactobacillus sp., Acetobacter sp and Bifidobacteria sp. are of increasing interest due to the growing evidences of health advantages associated with their use. These beneficial bacteria must survive in the acidic gastric environment and colonize the small intestine thereby imparting their benefits. It is desirable that probiotics are safe and confer functional effects. Thus the study aims to comparatively analyze the survivability and functional properties of commercial probiotic drinks in simulated gastrointestinal environment through in vitro processes. To accomplish the objectives, the sample drinks were divided into two sections viz.; Dairy and Non-dairy that contained Lactobacillus sp. and Acetobacter sp. Properties including numbers, gram character, NaCl tolerance, bile salt tolerance, optimal pH for growth and amount of organic acid produced by the probiotics were analyzed in the drinks. Viability and activity in simulated gastrointestinal environment was evaluated by subjecting the above samples to an in vitro digestive treatment using a combination of enzymes and digestive solutions. It was observed that amongst all the probiotic bacteria present in the different samples, Lactobacillus sp present in the dairy drink displayed the highest probiotic potential. Knowledge of the above may enable the consumer in making a careful selection of the desirable food product to gain maximum health benefits.*

**Keywords:** Dairy, non-dairy, probiotics, resistance, survival, viability

## Introduction

Health awareness is on a constant rise among consumers. Natural, functional and convenient products that can deliver nutritional benefits without compromising the taste continue to thrive in the beverage market. Probiotic drinks are becoming an increasingly popular option due to the evolving dietary habits and accelerating social perception towards healthy gut and positive functional attributes (Kechagia. M. et. al., 2013). Due to the marketing strategy of renowned commercial brands, consumers are now looking for healthy probiotic counterparts. Probiotics, primarily defined as living microorganisms with beneficial functioning, are capable of promoting or supporting the balance of the autochthonous microbial population of the gastrointestinal tract. Although these organisms may not be constantly present in the gut, yet they should impose a positive health effect (Holzapfel et. al., 2001). A healthy gut has always been linked to a better immune system. Probiotic drinks are marketed as healthy liquids that can help in weight loss, depression; infectious diseases as well as allergic disorders (Lye, H. S. et.al., 2016) (Kechagia, M. et. al., 2013). Globally, these drinks are being commercialized in many different forms and are generally either milk or fruit based (Céspedes, M; 2013). While dairy based probiotic drinks are known for their traditional taste and aroma; non-dairy probiotics, especially those containing fruit juices are also being accepted

due to their flavor and appearance (Ranadheera, C. et. al., 2017). Organoleptic properties as well as the viability of the probiotics used in fermented products of dairy and non-dairy origin are important parameters to satisfy the consumer demands and confer suitable health benefits. (Hemaiswarya S., 2013). In order to impart positive health effects, the probiotic bacteria should possess the ability to colonize the small intestine post resistance of the deleterious effects of gastric acidity, bile salts, elevated osmolarity and action of digestive enzymes. Moreover, sufficient numbers of these organisms are required in the viable state to bring about the expected outcomes (Toscano, M. et. al., 2013). Therefore, determination of the survival of these species in the gastrointestinal tract is essential for assessment of the effectiveness of the same inside the human body. A range of in vitro static models of digestion have been developed for the evaluation of probiotic survival in the GI tract (Borchers, A. T. et. al., 2009). Probiotic bacteria that are delivered through food systems have to firstly survive during the transit through the upper gastrointestinal (GI) tract, and then persist in the gut to provide beneficial effects for the host. The present study comparatively evaluates the survival of probiotic bacteria including Lactobacillus acidophilus and Acetobacter xylinum present in commercial dairy and non-dairy beverages in the stomach and upper intestinal chambers. In order to provide a realistic and predictive simulation

of human gastric and duodenal processing, the gastrointestinal juices were simulated using the major chemical components of the in vivo digestive juices. Hence, the drinks were tested for the probiotic activity and survival in simulated gastrointestinal environment. Awareness of the survival of and viability of probiotic bacteria in commercial dairy and non-dairy beverages may help the consumer in make a cautious choice of an appropriate product to avail the desired health outcomes.

## Methodology

### 2.1 Sample selection

The study was conducted for probiotics of both dairy and non-dairy origin owing to their popularity and usage within the world population. For the study, *Dairy Lactobacillus* sp. and *Acetobacter* sp. were coded as DL1 and DA1, whereas those species of non-dairy source were coded as NDL1 and NDA1. Three samples of each category were selected for analysis based on random sampling method analyzed.

### 2.2 Extraction and identification of probiotic species from commercial drinks

The probiotic species were extracted from the drink by serial dilution and inoculated into MRS (DeMan, Rogosa, Sharpe) broth and *Acetobacter* broth for the growth of *Lactobacillus* sp. and *Acetobacter* sp respectively. These microorganisms were identified using gram staining; catalase-oxidase test and sugar metabolizing pattern (Yun, J. H. et.al., 2009).

### 2.3 Determination of NaCl tolerance and bile salt tolerance and organic acid production

*Lactobacillus* sp. and *Acetobacter* sp. were treated with different concentrations of NaCl (ranging from 1-9%) in the growth medium for 24 hours at 37°C. The survival was estimated by measuring the Optical Density (O.D) at 560 nm. In order to check bile salt tolerance, overnight MRS broth or *Acetobacter* broth cultures were inoculated with 2.0% bile salts and incubated for 24 hours at 37°C. The survival was estimated by measuring the Optical Density (O.D) at 560 nm (Succi, M. et. al., 2005).

### 2.4 Determination of optimum pH of growth and organic acid production

Determination of Optimum pH for growth was evaluated by estimating the survival of the

probiotics isolated from the samples at different pH. The above microorganisms were grown in the respective mediums ranging from pH 2 to pH 6.5 for 24 hours at 37°C. The desired pH was obtained by addition of the required amounts of 1M HCl or 1M NaOH to the culture broths and monitoring the pH using a pH meter (Environmental and Scientific Instruments Co, India). The survival was calculated by measuring the Optical Density (O.D) at 560 nm. The amount of organic acid produced by the probiotics was measured by titration, keeping the lactic acid as standard (Hasan M.N. et.al., 2014).

### 2.5 Survival during Gastrointestinal Digestion

#### 2.5.1 Survival during Gastric digestion

Simulated gastric juice was formulated using glucose (3.5 g/liter), NaCl (2.05 g/liter), KH<sub>2</sub>PO<sub>4</sub> (0.60 g/liter), CaCl<sub>2</sub> (0.11 g/liter), and KCl (0.37 g/liter), adjusted to pH 2.0 using 1 M HCl, and autoclaved at 121°C for 15 min. 25ml of the respective cultures mediums were inoculated with 1% (vol/vol) bacteria and incubated overnight (16 hours). The cultures were subsequently centrifuged at 7,000 g at 4°C for 15 min, washed once in an equal volume of cold 0.25 Ringer's solution, and subsequently centrifuged (7,000 g at 4°C for 15 min). Pellets were then re-suspended in an equal volume of simulated gastric juice at 37°C and incubated for 90 min with constant stirring. Samples were taken at 0, 10, 30, 60, and 90 min, serially diluted in maximum-recovery diluent, plated on MRS medium, and incubated at 37°C for 72 h. The survival of each strain was evaluated by determination of the optical density (OD) 560nm in a spectrophotometer and was analyzed using ANOVA analysis.

#### 2.5.2 Survival during digestion by Bile

Simulated bile solution was prepared dissolving OxoGall (Difco laboratories, India) in distilled water. All solutions were sterilized at 1210 C for 15 min. 9.0 ml simulated bile solution (0.5% or 2.0%) and was vortexed for 20 s for complete dispersion of the cells. Samples (0 h) were taken immediately after mixing to determine the viability of the culture. The mixtures were then incubated at 370 C with manual shaking periodically for 30 minutes to 90 minutes. The viability was evaluated by determination of the optical density 560nm in a spectrophotometer and was analyzed using ANOVA test.

#### 2.5.3 Survival during Intestinal digestion

Pancreatic juice solution was prepared by using NaCl (125.0 mM), CaCl<sub>2</sub> (0.6 mM), MgCl<sub>2</sub> (0.3

mM), trypsin (11 U/mL),  $\alpha$ -chymotrypsin (24 U/ml) and pancreatic lipase (590 U/mL). The cultures were then incubated at 37°C with manual shaking periodically for 30 minutes to 90 minutes. The survival was calculated by determination of the optical density 560nm in a spectrophotometer and was analyzed using ANOVA table.

## 2.6 Statistical analysis

Statistical analysis was done using the Data Analysis Software pack of MS Excel 2010. The attributes of the data was initially quantified and listed in a tabular format, after which it was analysed using the ‘Regression Model’ and ANOVA of the analysis pack.

## Result and Discussion

**3.1 Extraction and identification of probiotic species from commercial drinks-** The isolates were grown in DeMan, Rogosa and Sharpe (MRS) medium at pH 6.5 and Acetobacter broth at pH 7.4 respectively. All the isolates produced small, irregular and round shape with shiny whitish cream or brown colored colonies being morphologically similar to *Lactobacillus* sp and *Acetobacter* sp. *Lactobacillus* sp. were identified as gram positive, catalase as well as oxidase negative. *Acetobacter* sp. Were gram negative, catalase positive and oxidase negative. Also, *Lactobacillus* sp. and *Acetobacter* sp. produced lactic acid and acetic acid respectively (Table 2).

Table 1: Identification of probiotic bacteria from commercial drinks

Parameter	<i>Lactobacillus</i> sp.	<i>Acetobacter</i> sp.
Gram Character	Positive	Negative
Catalase test	Negative	Positive
Oxidase test	Negative	Negative
Acid Production	Lactic acid	Acetic acid

**3.2 Determination of NaCl and bile salt tolerance**  
High salt tolerance is a desirable property for organism to be used as probiotics and hence it is expected that the probiotic bacteria, either from dairy or from non-dairy source, will provide constant affectivity even at salt concentration as high as 9%. It is known that NaCl is an inhibitory substance which may inhibit growth of certain types of bacteria and hence the tolerance test was conducted to check the efficiency of the microbial species as probiotics. *Lactobacillus* sp and *Acetobacter* sp. were able to tolerate 1-9% NaCl. To determine the NaCl tolerance of the isolates, optical density was measured at 560 nm and the data was plotted. Isolated DL1, DA1, NDL1 and NDA1 grew well in 1% NaCl concentration. Figure 1A showed that maximum growth (O.D) of isolates DL1 and NDA1 were found 0.992 and 0.984, respectively in 1% NaCl. High salt tolerance is a desirable property for organism to be used as probiotics and hence it is expected that the probiotic bacteria, either from dairy or from non-dairy source, will provide constant affectivity even at salt concentration as high as 9%.

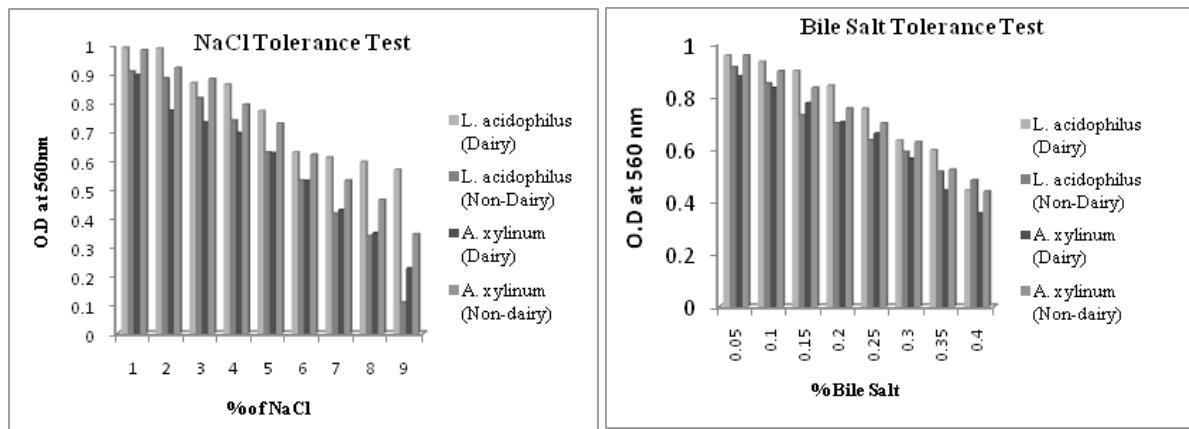


Figure 1: NaCl Tolerance Test (A) and Bile Salt Tolerance Test (B)

Table 2: ANOVA Test for NaCl and Bile Salt Tolerance

Source of Variation	NaCl Tolerance Test				Bile Salt Tolerance Test			
	SS	df	F	P-value	SS	df	F	P-value
Conc. Of NaCl	0.045	2	39.229	0.0003	0.847	7	126.40	1.02E-15
O.D value of individual probiotics	0.067	3	39.275	0.0002	0.051	3	17.98	5.15E-06
Error	0.003	6			0.020	21		
Total	0.116	11			0.918	31		

Bile tolerance was further evaluated by using 0.05-0.4% of bile concentration in order to mimic the human intestinal tract which can possess a maximum of 0.3% bile. Therefore, the probiotic bacteria in the food sample should possess the capability to survive at the above conditions. It was observed that although all samples were able to survive at bile concentrations of 0.05%, 0.1%, 0.15%, 0.2%, 0.25%, 0.3%, 0.35% and 0.4%, yet most of them displayed hampered multiplication of cell numbers in the above conditions. Optical density was measured at 560 nm and the data was plotted. All isolates were seen to grow well at 0.05% bile salt concentration. Maximum growths (OD) of samples DL1 and NDA1 were found at 0.05%. The growth rate was decreased with an increase in bile salt concentration. Results portrayed DL1 to have the highest potential for use as probiotic organism followed by NDA1 ( $P<0.05$ ), because these were resistant and able to grow in 0.3% bile salt concentration (Figure 1B). DL1 Was found to perform best in terms of NaCl as well as bile salt tolerance. The ANOVA table (Table 2) displayed the results to be statistically significant.

### 3.3 Determination of optimum pH of growth and organic acid production

Recent studies have shown that a low final pH during bacterial growth induces an acid tolerance response. As shown in figure 2A, samples DL1 and NDA1 were able to grow up pH ranges from 2.0-6.0 and 2-5.5 respectively. Optical density was measured at 560 nm and the data was plotted (Figure 2A). Maximum growth (O.D) of DL1 and NDA1 were found 0.989 and 0.956, at pH 6.0 and 5.5 respectively. These

microorganisms were able to grow at pH between 2.0 and 6.0 but the optimum growth was observed at pH between 4.5 and 5.5 when grown in MRS broth and Acetobacter broth at 37°C. The results therefore display that the growth rates of Lactobacillussp. and Acetobactersp., decrease after the optimum pH. Furthermore, Lactobacillussp. showed better survival ability compared to Acetobactersp. even under alkaline conditions. A low final pH during bacterial growth induces an acid tolerance response. Probiotic bacteria produce a variety of substances with antibacterial properties including organic acid,  $H_2O_2$ , bacteriocins that affect bacterial metabolism or toxin production. The organic acids produced by Lactobacillus sp. and Acetobacter sp. were found to be lactic acid and acetic acid respectively. The results indicated that organic acid production was increased with the incubation time but at the same time pH of the media decreased with the increasing acid production. From the result (Figure 2B), highest acidity and lowest pH 3.64 was observed after 72 h incubation at 37°C for probiotic Lactobacillus sp. isolated form DL1. Other probiotic bacteria isolated from other samples (i.e. NDA1, NDL1 and DA1) showed the highest acidity 1.83, 1.67 and 1.81% and lowest pH 3.9, 3.68 and 3.65, respectively after 72 h incubation. Hence it can be concluded that DL1 exerted better probiotic activity by producing high amount of organic acid along with displaying better NaCl tolerance compared to other bacteria. Lactobacillus sp. was found to be more efficient than Acetobacter sp. with respect to the above parameters. The data was also found to be statistically significant as indicated in Table 3.

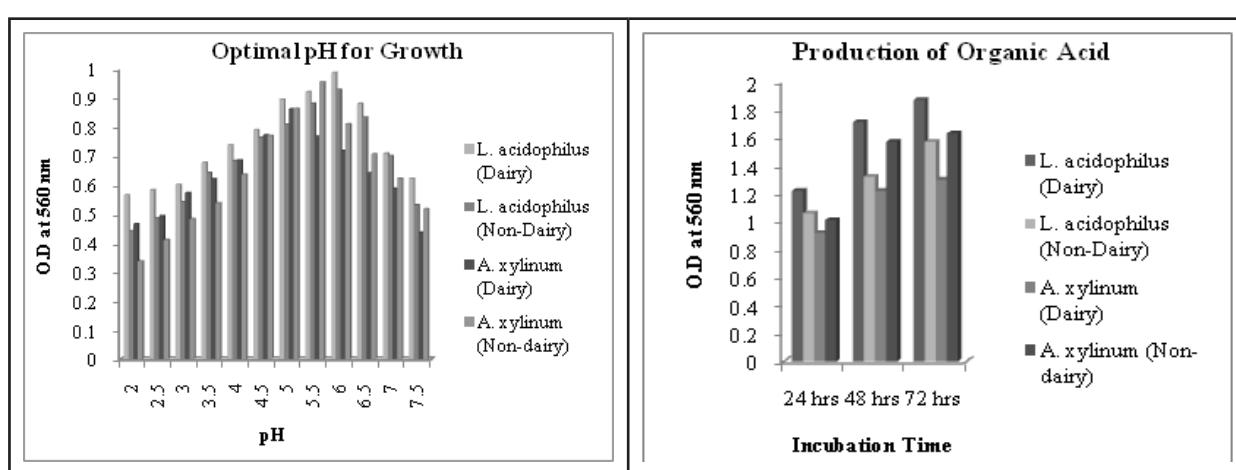


Figure 2: Optimum pH for growth (A) and Production of Organic Acid (B)

Table 3: ANOVA Test for Optimum pH for growth and Production of Organic Acid

Optimum Growth for pH					Production of Organic Acid			
Source of Variation	SS	df	F	P-value	SS	df	F	P-value
pH/Production of organic acid	0.913	10	29.614	7.7E-13	0.630	2	43.366	0.001
O.D. value of individual probiotics	0.088	3	9.474	0.001	0.320	3	14.688	0.003
Error	0.092	30			0.044	6		
Total	1.093	43			0.994	11		

### 3.4 Survival during gastric and bile digestion

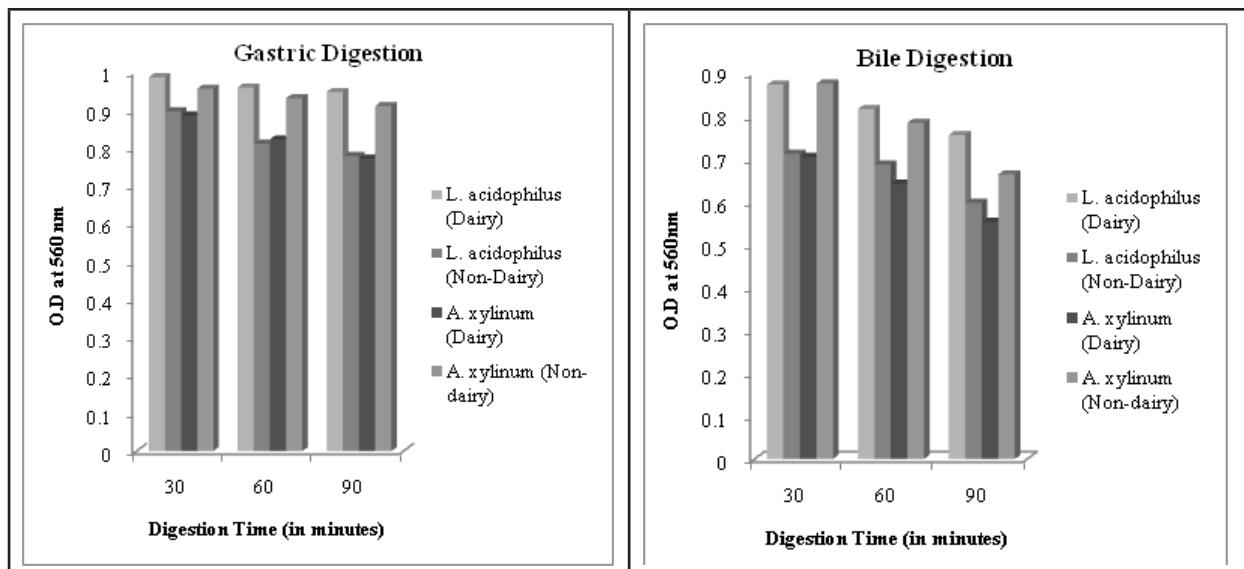


Figure 3: Survival during Gastric Digestion (A) and Bile Digestion (B)

To be used as dietary adjuncts, probiotics must survive transit through the stomach and colonize the intestine. Lactobacillus sp. and Acetobacter sp. have been found to be susceptible to acids. A steady decline in the number of Lactobacillus sp. and Acetobacter sp. was observed at 60 and 90 minutes with virtually no survival of Acetobacter sp. after 2 h. In this study, survival of free cells exposed to the simulated gastric juices was examined. The survival of free cells in the stimulated gastric juice (pH 2.0) decreased as the exposure time increased (Figure 3A). Being capable to survive bile concentrations produced in the human small intestines and to take up residence and multiply in human large intestine is another important characteristic of Lactobacillus sp. and Acetobacter sp. to be used as probiotic dietary adjuncts. Sample DL1 showed significantly high

(P<0.05) survivability in bile solution even at 90 mins, when compared to DA1, NDL1 and NDA1 (Figure 3B). Probiotics must survive in the acidic gastric environment if they are to reach the small intestine and colonize the host, thereby imparting their benefits. Lactobacillus sp. is considered intrinsically resistant to acid. The acid tolerance of Lactobacillus is attributed to the presence of a constant gradient between extracellular and cytoplasmic pH. When the internal pH reaches a threshold value, cellular functions are inhibited and the cells die. The F0F1-ATPase is a known mechanism that gram-positive organisms use for protection against acidic conditions. The ANOVA table (Table 4) displayed the results to be statistically significant.

Table 4: ANOVA Test for Survival during Gastric and Bile Digestion

Survival during Gastric Digestion					Survival during Bile Digestion			
Source of Variation	SS	df	F	P-value	SS	df	F	P-value
Time of exposure to gastric & bile juice	0.012	2	13.087	0.006	0.044	2	39.229	0.0003
O.D. value of individual probiotics	0.045	3	30.854	0.001	0.067	3	39.275	0.0002
Error	0.002	6			0.003	6		
Total	0.061	11			0.116	11		

**3.5 Viability during simulated intestinal digestion**  
 From Figure 4, it can be suggested that DL1 survived better in intestinal environment than NDA1. DL1 showed an optical density of 0.522 whereas NDA1 showed an O.D value of 0.489 at 30 minutes of digestion. Evidence suggests that some commensal bacteria enhance intestinal epithelial homeostasis and barrier integrity. Indeed, probiotic bacteria regulate a number of host processes, including nutrition, development, and immune responses, that are relevant for both health and disease. Recent studies indicate that some *Lactobacillus* sp. function as probiotics and induce sustained remission in ulcerative colitis and pouchitis. From the comparative study using ANNOVA table (Table 5), it was observed that DL1 gives the highest survivability among other samples under simulated gastrointestinal environment.

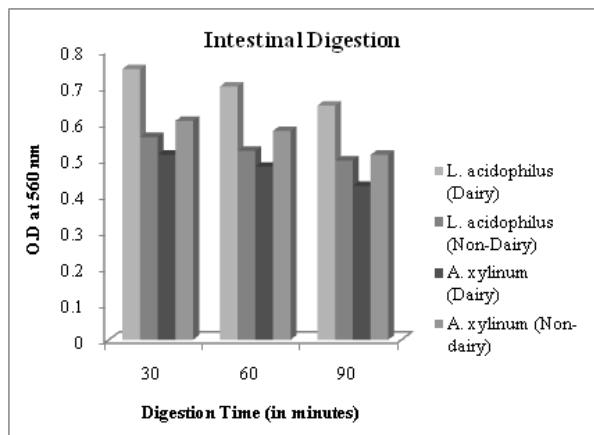


Figure 4: Viability during Intestinal Digestion

Table 5: ANOVA Test for Viability during Intestinal Digestion

Viability during Intestinal Digestion				
Source of Variation	SS	df	F	P-value
Time of Exposure to intestinal juice	0.015	2	77.517	5.17E-05
O.D. value of individual probiotics	0.084	3	288.933	7.09E-07
Error	0.001	6		
Total	0.099	11		

## Conclusion

The viability and effectiveness of probiotics has been known to be dependent on the carrier matrix. Additionally, bacterial strain identification is also a key requirement for the above. The study aims to comparatively analyze the survivability and functionality of probiotics of dairy and non-dairy commercial probiotic drinks in simulated gastrointestinal environment through in vitro

processes. The sample drinks were divided into two sections— Dairy and Non-dairy that contained probiotic species *Lactobacillus* sp. and *Acetobacter* sp. Properties including numbers, gram character, NaCl tolerance, bile salt tolerance, optimal pH for growth and amount of organic acid produced by the probiotics were analyzed in the drinks. *Lactobacillus* sp present in dairy drinks displayed the best probiotic potential in terms of tolerance towards gastric acids and bile salts. Moreover, these samples also displayed maximum survival during simulated in vitro gastric and intestinal digestion. Therefore, the qualities of different probiotic drinks vary and are dependent not only on the medium but also on the microorganism used. Hence, thorough knowledge of the above may help the consumer in effectively selecting a probiotic product according to their requirements.

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# Formulation and Nutritional Evaluation of Moringa Incorporated Health Mix For The Geriatric Population

Protity Shuvra Dey and Adrija Sarkar

## ABSTRACT

Aging leads to disease and disability and healthy ageing is very important but the nutrition of the elderly is often neglected. Moreover Moringa leaves is used as a food fortificant to improve the nutritional value of staple foods since it alleviates micronutrient deficiencies and acts as a functional food to protect from several chronic degenerative disorders. Hence the research study was conducted to develop a health mix with moringa leaves for the geriatric population and compare its nutritional profile with basic porridge mix. The developed products was then evaluated organoleptically and biochemically. The study showed that the developed product had better nutritional profile as compared to basic porridge mix. On the sensory point of view, the product was highly acceptable. So, the moringa enriched porridge mix is found to be nutritionally superior in comparison basic porridge mixes which will help the geriatric population to fulfill their nutritional needs and combat age related problems.

**Keywords:** Antioxidant, geriatric, malnutrition, millets, minerals, Moringa leaves, porridge mix, protein

## Introduction

In Austad, Handbook of the Biology of Aging, 2005, ageing is defined as “a process of intrinsic, progressive, and generalized physical deterioration that occurs over time beginning at about the age of reproductive maturity”. As people age, they become more susceptible to disease and disability due to various factors like low immunity, decreased functionality of cells, DNA damage, higher incidence of inflammation, etc. Healthy ageing is very important. The nutrition and health of the elderly is often neglected. Nutritional interventions could play an important part in the prevention of degenerative conditions of the elderly and an improvement of their quality of life. On the other hand, Moringa oleifera is used as a food fortificant to improve the nutritional value of staple foods in many parts of the world since drumstick leaf incorporation into the diet through fortification not only alleviates micronutrient deficiencies, but acts as a functional food and protects from several chronic degenerative disorders.

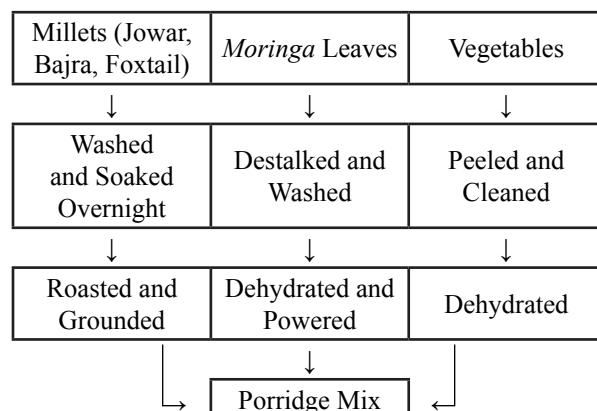
## Methodology

The study was carried out in J.D Birla Institute, Kolkata.

### 2.1 Collection of raw materials

Fresh, disease free, edible grade leaves of moringa leaves, properly packed good quality millets (Foxtail millet, pearl millet, sorghum millet), good quality spices (turmeric, mustard seeds, red chilli, bay leaf, coriander, fennel etc) and herbs (curry leaves, etc) were bought from the local markets of Kolkata.

### 2.2 Processing of the raw materials



### 2.3 Formulation and composition of the porridge mix

Table 1: Composition table of the porridge mix

Ingredients	Amount
Foxtail millet	47.5g
Sorghum	23.7g
Pearl millet	23.7g
Carrot	2.5g
Peas	2.5g

Dehydrated moringa leaves were incorporated in increasing amounts and the variations were made in both the flavours.

Variations	1A	1B	1C	1D	1E	1F	1G
Moringa leaves (g)	+10	+15	+20	+25	+30	+35	+40

2.4 Sensory analysis- The sensory analysis was done by the geriatric population and they did not receive

any professional training. The prepared porridge mix with different variations of moringa leaves in two different flavours were evaluated for the quality attributes like appearance, including flavor, taste, texture, consistency, color, and overall acceptability by 70 panel members by following the using the 9-point hedonic scale (9 = liked very extremely, 8 = liked very much, 7 = like moderately, 6 = liked slightly, 5 = neither liked or disliked, 4 = disliked slightly, 3 = disliked moderately, 2 = disliked very much, and 1 = disliked extremely) for color, flavor, texture, and taste.

## 2.5 Statistical Analysis

The data collected from sensory analysis were subjected to statistical analysis. Statistical tests like coefficient variation and ANOVA was were performed, in order to analyze the data.

According to the sensory analysis, the best variation was selected and was subjected to biochemical analysis.

## 2.6 Biochemical analyses

The procedure used for biochemical estimation of the samples, as described below are according to The FSSAI Manual of methods of analysis of foods (2016)

Table 2: Biochemical Analyses and the method used

Nutrient	Method	Reference
Carbo-hydrate	Anthrone method	Hedge, J E and Hofreiter, B T (1962)
Protein	Kjeldahl method	AOAC, 2000
Fat	Soxhlet method	AOAC, 2000
Moisture	AOAC, 2000	AOAC, 2000
Ash	AOAC, 2000	AOAC, 2000
Crude fiber	Maynard, A J (Ed) (1970)	Maynard, A J (Ed) (1970)
Calcium	o-Cresolphthalein Complexone method	Gitelman, H.J (1967) Baginski, E.S.(1973)
Iron	Ferrozine method	Siedel, J., et al (1984)
Antioxidant	1,1-diphenyl-2-picryhydrazyl (DPPH) method	Shirwaikar, Rajendran, and Punithaa (2006)
Total Phenol Content	Folin-Ciocalteau Method	Folin O & Denis W. (1912)
Ascorbic acid	DCPIP(2-6-dichlorophenol indophenol) method	Roe, J.H. and Kuether, C.A. (1943)

## Result & discussion

### 3.1 Sensory analysis

The sensory analysis is carried out by finding the mean, Standard deviation and coefficient of variation of each attributes. The variation with the highest mean and least or lowest coefficient of variance is considered to be the best product amongst the rest. From Table-3, it can be interpreted that amongst the 7 variations of both curry and masala flavor, variation 3 is found to be the best variation as the coefficient of variation is the lowest for variation 3 and the mean is the maximum. This variation contains 20g moringa leaves. The best variations also had better values than basic recipe. Thus it is interpreted that the overall rating and acceptability of the newly developed porridge mix of both the flavours are considered to be highly acceptable by the population.

### 3.2 Biochemical analysis

#### 3.2.1 Moisture and ash content:

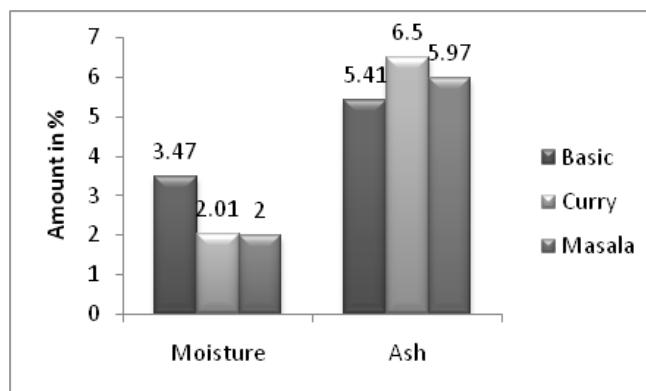
From Graph-1 it can be analysed that -

The basic recipe has the highest moisture content amongst the three variations. The developed product reported low moisture content due to the incorporation of dehydrated moringa leaf powder. A similar study by Sengev et al. (2013) also had reported of a decrease in moisture content in bread with an increase in concentration of moringa leaf powder. For proper maintenance of quality of dried food products moisture content <10% is desirable.

Moringa leaves and fruits are good sources of iron, zinc and calcium (Aida C. Mallillin, et.al 2014). The two developed moringa enriched porridge mix has higher ash content than that of the basic. Moreover, the millets are also rich in minerals like calcium and iron. Hence synergistically, they resulted in increased ash content of the variations. Which makes it a better food source for minerals.

Table 3: Mean $\pm$  S.D. and coefficient of variance (cv) of the ratings given to the different attributes of the sensory evaluation

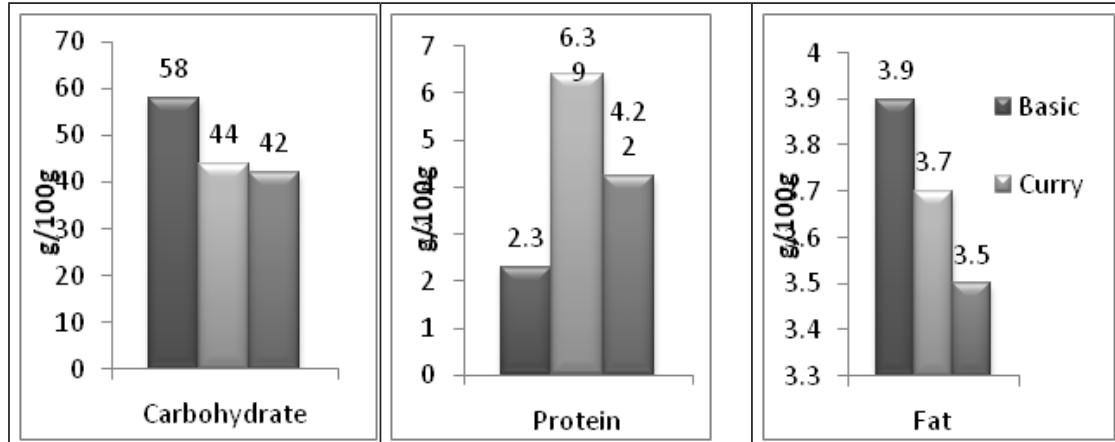
Types of variations	Appearance		Colour		Taste		Texture		Aroma		Overall rating	
	Mean $\pm$ SD#	Cv*	Mean $\pm$ SD#	Cv*	Mean $\pm$ SD#	Cv*	Mean $\pm$ SD#	Cv*	Mean $\pm$ SD#	Cv*	Mean $\pm$ SD#	Cv*
Basic	6.01 $\pm$ 0.83	13.7	5.44 $\pm$ 0.5	9.19	6.58 $\pm$ 0.49	7.5	7.1 $\pm$ 0.45	6.4	6.38 $\pm$ 0.42	6.09	6.58 $\pm$ 0.57	8.76
Curry flavour												
Variation 1	7.56 $\pm$ 0.53	7.2	7.47 $\pm$ 0.5	7.80	7.25 $\pm$ 0.5	7.5	7.37 $\pm$ 0.5	7.67	7.08 $\pm$ 0.44	7	7.32 $\pm$ 0.5	8.1
Variation 2	7.3 $\pm$ 0.63	8.12	7.87 $\pm$ 0.5	7.14	7.47 $\pm$ 0.6	7.8	7.56 $\pm$ 0.47	7.2	7.47 $\pm$ 0.5	7.8	7.71 $\pm$ 0.5	7.1
Variation 3	8.06 $\pm$ 0.5	6.24	8.12 $\pm$ 0.5	6.67	8.55 $\pm$ 0.43	5.56	8.72 $\pm$ 0.44	5.79	8 $\pm$ 0.44	6.15	8.38 $\pm$ 0.46	5.88
Variation 4	7.8 $\pm$ 0.5	6.7	7.70 $\pm$ 0.5	7.05	8.04 $\pm$ 0.49	6.21	7.98 $\pm$ 0.46	6.08	7.72 $\pm$ 0.5	6.8	7.78 $\pm$ 0.4	6.14
Variation 5	6.35 $\pm$ 0.7	11.6	6.11 $\pm$ 0.8	13.2	5.7 $\pm$ 0.5	9.3	6.65 $\pm$ 0.5	8.43	7.01 $\pm$ 0.6	8.91	6.38 $\pm$ 0.6	10.4
Variation 6	4.11 $\pm$ 0.5	13.4	4.35 $\pm$ 0.6	14.1	3.8 $\pm$ 0.5	15.1	3.65 $\pm$ 0.5	13.8	3.6 $\pm$ 0.4	13.7	3.8 $\pm$ 0.47	10.6
Variation 7	2.38 $\pm$ 0.5	21.7	1.37 $\pm$ 0.4	35.5	1.5 $\pm$ 0.4	25.9	1.6 $\pm$ 0.4	27.7	2.58 $\pm$ 0.5	20.2	1.74 $\pm$ 0.44	25.3
Masala flavour												
Variation 1	7.56 $\pm$ 0.53	7.2	7.47 $\pm$ 0.5	7.80	7.25 $\pm$ 0.5	7.5	7.37 $\pm$ 0.5	7.67	7.08 $\pm$ 0.44	7	7.32 $\pm$ 0.5	8.1
Variation 2	7.3 $\pm$ 0.63	8.12	7.87 $\pm$ 0.5	7.14	7.47 $\pm$ 0.6	7.8	7.56 $\pm$ 0.47	7.2	7.47 $\pm$ 0.5	7.8	7.71 $\pm$ 0.5	7.1
Variation 3	8.12 $\pm$ 0.5	6.647	8.5 $\pm$ 0.5	5.6	8.7 $\pm$ 0.43	5.56	8 $\pm$ 0.44	6.1	8.2 $\pm$ 0.44	5.7	8.2 $\pm$ 0.46	5.9
Variation 4	7.6 $\pm$ 0.5	6.5	7.50 $\pm$ 0.5	7	7.98 $\pm$ 0.50	6.10	7.98 $\pm$ 0.46	6.08	7.72 $\pm$ 0.5	6.8	7.78 $\pm$ 0.4	6.14
Variation 5	7.56 $\pm$ 0.53	7.2	7.47 $\pm$ 0.5	8.80	7.25 $\pm$ 0.5	7.5	7.37 $\pm$ 0.5	7.67	7.08 $\pm$ 0.44	7	7.32 $\pm$ 0.5	8.1
Variation 6	3.67 $\pm$ 0.5	14.4	3.77 $\pm$ 0.4	11.2	3.62 $\pm$ 0.6	17	3.75 $\pm$ 0.4	11.5	3.72 $\pm$ 0.4	12.01	3.75 $\pm$ 0.6	15.9
Variation 7	1.8 $\pm$ 0.4	25.3	1.9 $\pm$ 0.4	21.2	1.55 $\pm$ 0.5	35.6	1.7 $\pm$ 0.5	27.2	1.8 $\pm$ 0.3	19.89	1.9 $\pm$ 0.3	18.25
S.D#= standard deviation , *cv= coefficient of variance												



Graph 1 -Plot showing the Moisture And Ash Content

### 3.2.2 Macronutrient

From Graph-2 it can be analysed that



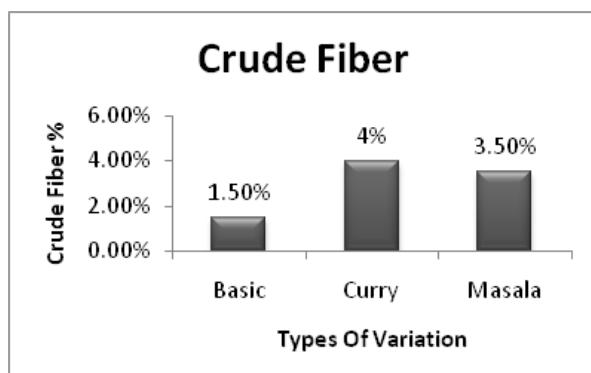
Graph 2 –Plot showing the Macronutrient content

The carbohydrate content of the basic was higher compared to the two variations due to the fact that leaves have comparatively lower carbohydrate than cereals. Furthermore, the carbohydrate content of the Foxtail millets (used in case of the variations) are less than broken wheat (used in basic recipe). Hence, together they result in less carbohydrate in the newly developed moringa enriched porridge mix. Carbohydrates are the main source of energy obtained from foods but too much carbohydrate consumption can lead to weight gain or obesity resulting in various metabolic disorders.

Protein content of the variations that are enriched with moringa leaves has higher protein content than the basic. Moreover, the protein content of the curry leaves flavoured sample is higher than that of the masala flavor due to the inclusion of curry leaves and mustard seeds as flavouring agents. Hence, the high protein content in the developed moringa enriched porridge mix will help the geriatric population to combat protein deficiency due to sarcopenia, muscle wastage and also help in preventing malnutrition.

Fat is important for body's regular function, but excessive fat is not. Fat content are almost similar to each other but still the newly developed moringa enriched porridge mix has lower fat content than the basic. The variation of the curry leaf flavor has higher fat content than the masala flavor since the flavouring agents, i.e, the curry leaves and mustard seeds were sauted in oil. Even the mustard seeds have fat in it. Thus it can be concluded that the moringa enriched porridge mix has low fat content which may help the geriatric population, since a low-fat diet can help prevent serious medical conditions, including heart disease, high cholesterol, diabetes, etc.

### 3.2.3 Crude fiber

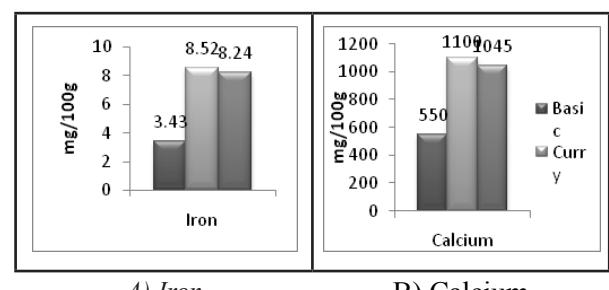


*Graph 3 – Plot showing the Crude Fiber Content*

From Graph- 3, it can be concluded that the variations of moringa enriched porridge mix have higher fiber content than that of the basic. The increase in the amount of crude fiber can be accounted to the addition of moringa leaves, the millets and also due to the presence of vegetables like carrots and peas.

All these properties of the mix developed in the present study contribute to increased fiber content in the diet as it helps the geriatric population to combat problems like constipation, cardiovascular diseases, diabetes, etc

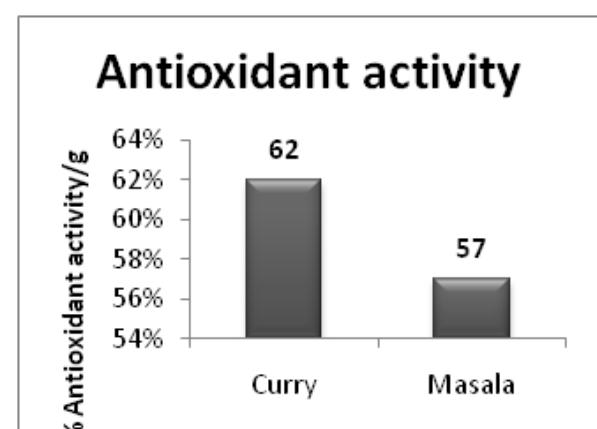
### 3.2.4 Minerals



*Graph 4- Plot showing the Mineral content*

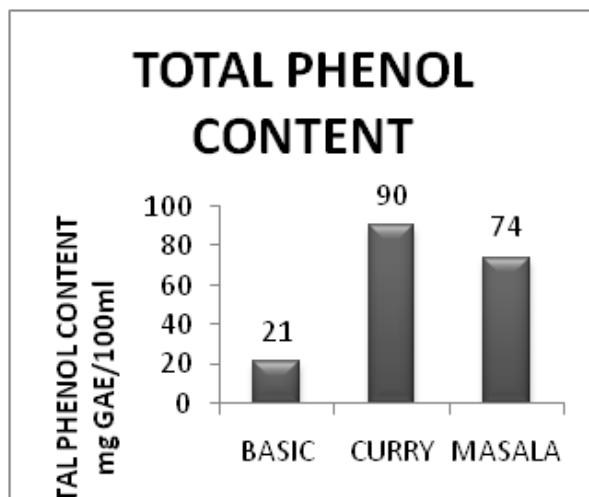
From Graph-4 it can be analysed that the iron and calcium content of the two variations are higher compared to the basic. This is due to the incorporation of moringa leaves in the variations. Moringa leaves are great sources of the minerals-iron and calcium. Iron deficiency anaemia is prevalent in older age and iron is one of the most important minerals for them. Similarly, with age there is bone loss and deficiency of calcium is seen. Hence, the presence of high iron and calcium in the newly developed moringa enriched porridge mix will help the geriatric population to combat their problems and have a healthier life.

### 3.2.5 Antioxidant activity



*Graph 5- Plot showing the Antioxidant activity*

From Graph-5, it can be analyzed that the two variations of the newly developed moringa greens enriched porridge mix have shown to have very good antioxidant activity. On the other hand, incase of the basic sample, no activity was observed and hence it was concluded that it doesnot have any antioxidant. The variations have higher antioxidant activity due to the presence of moringa greens which are rich in antioxidants like quercitin, chlorogenic acid, etc. Hence the product is expected to be a great source of antioxidant for the geriatric population which will help them fight various diseases like cancer, etc since the geriatric population produces a lot of free radicals due to oxidative stress and also due to less sysnthesis of endogenous antioxidants.



Graph 6- Plot showing the Total Polyphenol Content

### 3.2.6 Total Phenol Content

From graph 6 it can be analysed that the total polyphenol content of the two variations of the newly developed moringa greens enriched porridge mix was higher compared to the basic. The increase in total phenol content was seen to be higher due to the incorporation of moringa greens.

### 3.2.7 Vitamin-C

Vitamin-C was estimated and the result found was negligible because of the dehydration process as vitamin-C is heat labile.

### 3.3 Shelf life

There was no visible discolouration or change in consistency of the product till 4 months. From this it may be concluded that the product has a good shelflife. The high shelf life of the product is because the moisture content of the product is low. Furthermore, the product is fortified with moringa leaves and in studies like Arora et al., 2013, has reported that moringa seeds, coat, bark,

leaves possess antimicrobial potential. This helps in reducing the chances of microbial growth and thus also increases shelf life. The shelf life could be checked only till 4 months due to time constraints.

### 3.4 Costing

The cost of a product varies in different countries depending on the availability of raw materials but the cost of the newly developed moringa enriched porridge mix is low and affordable by all socio-economic group. The cost is low because of the easy availability of moringa and other ingredients like carrot, peas, curry leaves, millets. The cost of the product is Rs. 13/ 100g for both the flavours.

Other methods of using the product

To avoid monotony, the product can be prepared in different ways. It can be used as a batter for chilla preparation, or can be eaten as savoury ladoo, even it can be mixed with foods like roti, paratha dough and increase the nutritional valur of the food.

### Conclusion

Finally to conclude, the physical changes, increasing comorbidities, malnutrition, incidents of hospitalization, etc. results in an alarming situation causing the need to design a food product specifically for the geriatric population that caters to their nutritional requirements since it is not only important to treat the problems pharmacologically but also through dietary interventions. The powerful anti-inflammatory, antioxidant, and tissue-protective properties of moringa leaves makes it an ideal ingredient for a product made for this population. Hence this study developed the moringa enriched porridge mix which is found to be nutritionally superior and helps the geriatric population to fulfill their nutritional needs and combat age related problems.

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# Formulation and Evaluation of Thermally Processed Black Garlic and its incorporation in Whole Wheat Bread

Alisha Dhanani and Damanjeet Kaur

## ABSTRACT

The aim of the present study was to develop thermally processed black garlic and to incorporate it in whole wheat bread. The black garlic was prepared in 5 stages of thermal processing 7 days, 14 days, 21 days, 28 days and 35 days respectively and the black garlic whole wheat bread was made from the prepared black garlic samples. The result showed that the Black garlic sample processed for 28 days and black garlic whole wheat bread made from 21 days black garlic sample most found to be most acceptable among sensory panelist. The total phenol for black garlic was (1690.5 mgGAE/100gm), Flavonoid content (985.76 mg/100gm), Free radical scavenging activity (67.6%), S-allyl cysteine (1.2mg/gm) and allicin (0.61 mg/gm) and for whole wheat bread made from 21 days black garlic has 9% protein, total phenol (1385.5 mg/100gm), fat (7.9 gm/100gm) and the free radical scavenging activity (60.21%). There was a decrease in the antioxidant levels and increase in the reducing sugar content observed in the 35days of thermal processing of black garlic. The shelf life of the bread stored in refrigerator was found to be more than a week in comparison to the one stored at room temperature.

**Keywords:** allicin, antioxidants, S-allyl cysteine, shelf-life, thermal processing

## Introduction

In 1999, Mr. Kamimura in Mie prefecture Japan created the miracle vegetable with multi-biological functions "Black garlic". Black garlic has been named as the "ingredient of the moment" at gastronomic area and has gained popularity due to its taste among the consumers. It is consumed in countries like South Korea, Japan, and Thailand for centuries, and has now been introduced into Taiwan and India. Black garlic (BG), the newly recognized functional food is the fresh garlic (*Allium sativum*) that undergoes thermal processing for a period of time at a high temperature (60-90°C) under a high humidity of 80% without addition of any other treatment or additives. The process turns garlic cloves dark, giving it a sweet taste, and alters its consistency to chewy and jelly-like. There is enhanced bioactivity of black garlic due to change of physicochemical properties. It had been analysed in several studies that daily consumption of black garlic extract demonstrates several functions, such as anti oxidative activity, anti allergic, anti diabetes, anti-inflammation, and anti-carcinogenic effects.

## Methodology

Processing of Black Garlic: The present study focussed on preparing black garlic at different stages of thermal processing at home scale level which was divided into five stages starting from the first stage which was for the seven days till the fifth stage which was for thirty five days (Choi, et al., 2014) and comparing the nutrient and the sensory profile

of the samples. The prepared black garlic samples incorporated in whole wheat black garlic bread.

Table 1: Stages of thermal processing of black garlic based on the number of days

Serial No.	Stages	Sample Code	No. of Days	Temperature
1.	Stage 1	BG1	7 days	60-80oC
2.	Stage 2	BG2	14 days	60-80oC
3.	Stage 3	BG3	21 days	60-80oC
4.	Stage 4	BG4	28 days	60-80oC
5.	Stage 5	BG5	35 days	60-80oC

300-350 gms of compact, unbroken and disease free garlic were taken and cleaned with a tissue napkin to remove mud and dust. Then, the cleaned garlic was put uniformly inside the heat resistant polyethylene plastic pouch and sealed, which was placed inside the vessel of the rice cooker. The rice cooker was covered using a steel lid and the temperature was maintained at 60-80°C. After completion of each stage of thermal processing the garlic was peeled and stored in an air tight container in refrigerator for the sensory evaluation and nutrient analysis.

Preparation of whole wheat bread: A standard garlic bread recipe was used for the preparation of bread in which the raw garlic was substituted with black garlic powder (Kidd, 2013).

Organoleptic Evaluation: The raw garlic, prepared black garlic samples of different stages which had

undergone thermal processing for 7, 14, 21, 28 and 35 days respectively were evaluated for the quality attributes like appearance, colour, taste, texture, odour and overall acceptability by a panel of 30 panel members by following the 9 point Hedonic scale. Sensory Evaluation was also conducted for whole wheat raw garlic bread and black garlic whole wheat bread made from the prepared black garlic samples.

### Nutrient Analysis

**Moisture content-** It was determined by keeping the black garlic samples (RG, BG1, BG2, BG3, BG4, BG5) and black garlic bread samples (RGB, BGB1, BGB2, BGB3, BGB4, BGB5) in hot air oven for 12 hours and measuring the weight loss using a moisture analyzer.

**pH-** 1gm of garlic samples and was blended in 100 mL distilled water, the pH of heated garlic sample was then measured using a pH meter.

**Colour Estimation-** The apparent color of garlic samples was measured using a DC-P3 colorimeter. Color was expressed in CIE L\* (lightness), a\* (redness and greenness) and b\* (yellowness and blueness) coordinates. The color coordinates of the uniform color space CIE-LAB L\*, a\*, b\* were determined by its reflectance and chromaticity.

**Reducing sugar content-** was determined according described by Miller (1959). This method is based on the reaction of reducing sugar with 3.5-dinitrosalicylic reagent (DNS).

**Total polyphenols content-** In brief, an aliquot of diluted black garlic (0.5mL) was mixed with Folin-Ciocalteu reagent (2.5mL, 10%), the reaction was then allowed to proceed for 3 min, followed by the addition of  $\text{Na}_2\text{CO}_3$  solution (2mL, 7.5%). Subsequently, the mixtures were incubated in the dark for 30 minutes. After incubation, the absorbance was recorded at 765 nm. Gallic acid was used as a standard for the calibration curve.

**DPPH-** 1ml of the black garlic extracts (RG, BG1, BG2, BG3, BG4, BG5) and black garlic whole wheat bread extracts (RGB, BGB1, BGB2, BGB3, BGB4, BGB5) were taken and added to 2ml DPPH (5mg dissolved in 100ml of ethanol solution). The solution was kept at room temperature for incubation in the dark for 30 min, then absorbance was measured at 517 nm, and the radical scavenging activity was expressed as percent inhibition.

**Allicin-** A spectrophotometric assay developed by Han et. al. (1995) is used to quantify allicin in the sample.

**S-allyl Cysteine-** It was estimated by high performance liquid chromatography (HPLC) method.

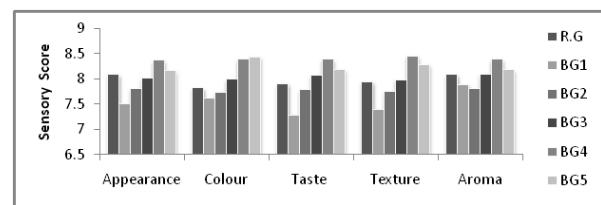
**Carbohydrate Estimation -** The concentration of the carbohydrate in black garlic whole wheat bread samples (RGB, BGB1, BGB2, BGB3, BGB4, BGB5) were estimated using anthrone method.

**Fat Estimation-** 5gm of the black garlic bread samples (RGB, BGB1, BGB2, BGB3, BGB4, BGB5) were taken and the fat was extracted in soxhlet apparatus using petroleum ether (AOAC). Shelf life testing of Raw Garlic & Black Garlic Whole Wheat Bread

One slice of each stage of black garlic whole wheat breads (RGB, BGB1, BGB2, BGB3, BGB4, BGB5) was kept in refrigerator and at room temperature for the analysis of the shelf life.

### Result & Discussion

**Organoleptic Evaluation for Black Garlic:** The raw garlic and black garlic was evaluated based on the various parameters, for its overall quality.



Graph 1: Effect of different stages of black garlic samples on the mean sensory score

It can be seen that the sensory score was the highest for Black garlic sample (BGB 4) which was thermally processed for 28 days. The appearance scored (8.38), colour (8.40), (8.4) for taste, (8.47) for texture which is higher than the raw garlic sample as it scored (8.1) in appearance, (7.83) in colour, (7.9) for taste and (7.96) for texture. In a study it is seen that the black garlic produced at 70°C gives the best quality of the black garlic in terms of flavour and colour during the thermal processing (Zhang et. al., 2015). In the present study similar results are obtained as seen in the graph. The black garlic which is processed at 28 days is found to be idle since it is neither bitter nor pungent as seen in case of raw garlic. Thus, the sensory panelist found the BG 4 sample to be the most acceptable black garlic

in comparison with the other thermally processed black garlic.

pH: The pH of raw garlic (RG) is 6.16, which reduces with each stage of thermal processing. It was seen that the pH of BG4 was the least (3.42) making it acidic comparatively.

Moisture: The moisture content increased with increase in the number of days of thermal processing. The moisture content of raw garlic was 39.6%. During the last stage that is (BG5) 35 days of thermal processing the moisture content of the heated garlic samples decreased to 58.9% making the black garlic chewy and drier in texture.

Colour estimation: The pure white or light yellow colour of raw garlic is changed to dark brown colour and eventually black during the thermal processing.

Table 2: Change in colour due to thermal processing of food

Colour	Thermal Processing Period					
	RG (0 Day)	BG 1 (7 Days)	BG 2 (14 Days)	BG 3 (21 Days)	BG 4 (28 Days)	BG 5 (35 Days)
L* (White-ness)	38.61	27.41	15.77	10.635	4.71	3.97
a* (Red-ness)	3.36	6.51	5.45	4.15	3.03	2.97
b* (Yellow-ness)	25.14	10.53	2.32	2.04	-0.681	-0.081

The inside colour of the garlic sample was found to have an uneven distribution of white flecks. From 14 to 21 days, the colour development of the garlic sample was from pale brown to dark brown with some white flecks inside. From 28 to 35 days, the colour of the garlic sample turned black, the making the garlic sticky and jelly like due to fragmentation of sugar-amine.

Total Phenols: The phenolic content of black garlic was influenced by different stages of thermal processing. It was found that the black garlic processed for 28 days (BG 4) had the highest phenolic content of 1890.5 mg GAE/100gm. The lowest level of phenols was observed in the raw garlic (control) i.e., 914.6 mg GAE/100gm. In a study it was found that the total phenolic content continuously increased during the processing at 60°C, indicating that the accumulation rate of total phenols exceeded its consumption rate throughout the processing (Zhang et. al., 2015).

Flavonoids: The content of flavonoids in black garlic was influenced by different stages of thermal processing and was found to be highest in the black garlic which was processed for 28 days (BG4) with 985.76 mg RE/100gm. During heat treatment, total flavonoids content increases and decreases in food products depending on the processing conditions (Choi, et. al., 2014).

Free Radical Scavenging Activity (% Inhibition): The free radical scavenging activity for black garlic was affected due to various stages of thermal processing and the number of days of the treatment. A higher % inhibition was observed with the increase in the number of days. The inhibition was found to be significantly highest in 28 days black garlic sample (BG4) with an inhibition rate of 67.6%. The lowest inhibition was observed in control sample that is the raw garlic (RG) with an inhibition rate of 44.2%.

In a research it had been demonstrated that upon administration of black garlic, its active component passes through the blood brain barrier into para ventricular nucleus to scavenge the excessive oxidative free radicals, which results in the decline of high blood pressure via abolishing the potentiation of angiotensin II (Ang II) and cardiac sympathetic afferent reflex (CSAR). Therefore, the black garlic has great potential to prevent the pathogenesis of hypertension (Miao et al., 2014).

Allicin: A change in the allicin content in was observed in the black garlic during the thermal processing. Generally it is seen that the fresh raw garlic contains 345mg/100gm allicin whereas the black garlic sample has 0.61mg/gm allicin which has significantly decreased (Ryu et al., 2017).

S allyl cysteine (SAC): The amount of S-allyl cysteine has increased significantly during the progress of the thermal processing. The 28days black garlic sample (BG4) contains 1.2mg/gm of S allyl cysteine which is significantly higher than the fresh garlic (11.4mg/100gms) (Ryu et al., 2017).

In one of the study the antidiabetic effects of SAC have been demonstrated in both type 1& 2 diabetic rodent models. The results in streptozotocin induced diabetes have suggested that the black garlic improves glutathione antioxidant system by increasing leptin and adiponectin secretion, inhibiting hepatic gluconeogenesis, and suppressing

nuclear factor- $\kappa$ B (NF- $\kappa$ B)-mediated inflammatory signaling (Kim et al., 2016).

**Reducing Sugar:** During the black garlic processing, the reducing sugar content in black garlic depends upon two factors that is the polysaccharide content in raw garlic which was degraded to reducing sugar and the reducing sugar which was consumed during the Maillard reaction (Zhang et al., 2016). The highest content is observed in the 28days garlic sample (BG 4) which later decreased while reaching 35days (BG 5). The reducing sugar content showed a rising trend during the whole process, indicating that the rate of formation of reducing sugar was faster than its rate of consumption. After 28 days, black garlic did not have the appropriate sweet flavour because of the large amount consumption of reducing sugar.

**Organoleptic Evaluation for Black Garlic Whole Wheat Bread:** The raw garlic whole wheat bread and black garlic whole wheat bread was evaluated based on the various parameters, for its overall quality.

Table 3: Effect of different samples of black garlic whole wheat breads on the organoleptic properties

Attribute	Mean Sensory Score					
	RGB	BGB 1	BGB 2	BGB 3	BGB 4	BGB 5
Appearance	7.9	7.8	8	8.39	8.13	7.2
Colour	7.81	7.83	8.09	8.19	8.4	7.41
Taste	7.82	7.6	7.82	8.42	8.25	7.29
Texture	8.1	7.9	8.04	8.40	8.23	7.86
Aroma/Odour	8.02	7.72	7.91	8.23	8.14	8.01
Overall Acceptability	7.96	7.82	7.94	8.35	8.23	7.88

RGB: Raw Garlic Whole Wheat Bread, BGB 1: Black garlic whole wheat bread containing black garlic processed for 7 days, BGB2: Black garlic whole wheat bread containing black garlic processed for 14 days, BGB3: Black garlic whole wheat bread containing black garlic processed for 21 days, BGB4: Black garlic whole wheat bread containing black garlic processed for 28 days, BGB 5: Black garlic whole wheat bread containing black garlic processed for 35 days.

The highest sensory score (8.35) for overall acceptability was obtained for black garlic whole wheat bread sample (BGB 3) which had 21 days dehydrated black garlic powder. The BGB 4 which had 28 days dehydrated black garlic powder was also accepted well by the sensory panelist. This may be due to the presence of sweet-sour taste, pleasant flavour, aroma, black colour and appearance. The appearance scored (8.39), colour (8.19), (8.42) for taste, (8.4) for texture which is higher than the raw garlic sample as it scored (7.9) in appearance, (7.8) in colour, (7.81) for taste and (8.1) for texture. The

black garlic whole wheat bread produced from 21 days of black garlic samples produced the best quality of bread in terms of flavour, texture and taste during. The black garlic whole wheat bread sample which was made from 35 days of black garlic sample was not found to be idle since it had bitter taste, texture was hard and was extremely dark in colour. Thus, the sensory panelist found the BGB 3 to be the most acceptable black garlic in comparison with the other thermally processed black garlic (Bhatt et. al., 2015).

**pH:** The raw garlic whole wheat bread (RGB) was seen to have higher pH being alkaline in nature compared to the black garlic whole wheat bread samples. The pH of raw garlic whole wheat bread (RGB) was 6.1 thus decreasing the pH to 4.01 in BGB 4 stage which was found to be more acidic. It is generally seen that at a pH of 4.2 there is less chance of microbial contamination thus, helping in increasing the shelf life of bread.

**Moisture:** The moisture content of the whole wheat bread made with raw garlic was highest that is 42.59% whereas it decreased with addition of different thermal treated black garlic in the whole wheat bread. The lowest moisture content was found to be 23.16% in 35 days of treatment of black garlic added to the whole wheat bread. In the first stage the breads produced were soft and crumbly due to high moisture content but later with decrease in moisture content the bread became soft and porous in texture.

**Colour Estimation:** Color plays an important physicochemical property affecting consumer's perception about a food product.

Table 4: Estimation of colour based on different stages of raw garlic & black garlic whole wheat bread samples

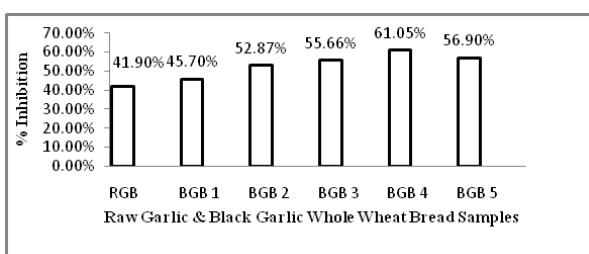
Colour	Thermal Processing Period					
	RGB (RG)	BGB 1 (7 Days)	BGB 2 (14 Days)	BGB 3 (21 Days)	BGB 4 (28 Days)	BGB (35 Days)
L* (Whiteness)	23.73	21.15	17.17	12.65	7.73	5.36
a* (Redness)	2.89	2.55	1.69	1.16	0.89	0.49
b* (Yellowness)	10.29	10.41	10.624	15.66	18.96	24.5

The production of coloured compounds such as HMF always needs at least one dehydration step during the maillard reaction and caramelization, so that the excess water induces an inhibition of browning reaction by the products. The colour of

the raw garlic whole wheat bread and the black garlic whole wheat bread varied greatly among each other. The colour of Black garlic whole wheat bread samples (BGB 4 and BGB) was dark brown to blackish while the colour of the raw garlic whole wheat bread was light brown. The initial stage of baking produces colourless intermediates compound arising from sugar-amine condensation and amadori rearrangement.

**Total Polyphenol :** The phenolic content of the black garlic whole wheat bread was found highest in 28 days (BGB 4) with 1385.5 mg GAE/100gm. The lowest level of phenols was observed in the whole wheat bread made with raw garlic (RGB) i.e., 631.6 mg GAE/100gm. According to Xu et al., heat treatment of the phenolic compounds increased the free fraction of phenolic acids, whereas it decreased the ester, glycoside, and ester-bound fractions, leading to an increase in free phenol forms thus, decreasing the total polyphenol contents at the later stage (BGB 5). Thus, in the present the overall polyphenol content of the black garlic whole wheat increased significantly leading to production of more antioxidant rich compounds which is not seen in case of raw garlic whole wheat bread.

**Free Radical Scavenging Activity (% Inhibition):** Most of the antioxidant potential in plant foods is due to the properties of phenolic compounds, especially SAC, which can act as reducing agents, free radical scavengers and hydrogen donors. The inhibition was found to be significantly highest in black garlic whole wheat bread stage 4 (BGB 4) in which the black garlic which was treated for 28 days was added with an inhibition rate 61.05%. The lowest % inhibition was observed in control sample of bread which was made with raw garlic with a level of 41.9%.



Graph 2: Effect of different black garlic whole wheat bread samples on free radical scavenging activity

**Reducing Sugar:** The reducing sugar content in black garlic depends upon two factors that is the polysaccharide content in raw garlic and the reducing sugar which was consumed during the

Maillard reaction production. The highest content is observed in the black garlic whole wheat bread made with 28 days garlic sample (BGB 4) which decreased in the black garlic whole wheat bread which was made from 35 days black garlic sample (BGB 5). The reducing sugar content showed a rising trend in the bread samples because of the production of reducing sugar compounds during the fermentation process, thus increasing the rate of maillard reaction.

**Carbohydrate content:** The amount of carbohydrate varied among the different samples of raw garlic and black garlic whole wheat bread. The carbohydrate content of the black garlic whole wheat bread (BGB 4) was found high 60.21 gm/100gms. The lowest level of fat was observed in the raw garlic whole wheat bread (RGB) that is 49.1gm/100gms. There has been an increase trend in the content of carbohydrate in the bread samples probably because of the non-enzymatic chemical reactions which produces reducing sugars and amino acids, proteins, and/or other nitrogen-containing compounds.

**Fat content:** The fat content of the raw garlic whole wheat bread was found high in raw garlic whole wheat bread (RGB) 15.4 gm/100gms. The lowest level of fat was observed in the black garlic whole wheat bread (BGB 4) that is 7.5gm/100gms. There has been a downward trend in the content of fat because aged black garlic contains more water-soluble organic sulfur containing compounds such as S-allyl cysteine and S-allyl mercaptocysteine and less fat soluble compounds.

One of the study showed that black garlic extract was effective, in improving blood lipid profiles, especially triglycerides, and blood glucose levels in rats which were given a high fat diet, as evidenced by decreasing the expressions of SREBP-1c and its related enzymes, along with increased expression of CPT-1 (Ha et al., 2015).

**Shelf-Life Testing:** In the present study the shelf-life of the bread room temperature was up to 3 days and on the fourth day there was growth of micro-organism of the surface of the black garlic whole wheat bread samples.

The black garlic whole wheat bread when stored in refrigerator was found to be mould free up to 12 days. After 12 days there was growth of mould observed in the bread samples. Thus, the shelf-life of the black garlic whole wheat bread is comparatively higher in comparison with the normal breads.

## Conclusion

In this investigation efforts are made to produce black garlic and black garlic whole wheat bread using slow process of thermal heating. Organoleptic evaluation suggested that the best black garlic obtained from the 28 days (BG 4) of thermal processing recorded highest overall acceptability by the panel members. During the thermal processing there was an increase in the activity of total phenol content, flavonoids content, free radical scavenging activity, S-allyl cysteine content and reducing sugar content.

Organoleptic evaluation suggests that, the best black garlic and black garlic whole wheat bread was obtained from the 21 days of thermal processing of black garlic. In the biochemical analysis it was found that black garlic whole wheat bread made from 28 days black garlic sample (BGB 4) gave the highest antioxidant activity in comparison to all other samples of raw & black garlic whole wheat bread.

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# **Effect of Composite Edible Coating on Antimicrobial and Antioxidant Properties of Sapota**

*Adrita Banerjee and Jincy Abraham*

## **ABSTRACT**

*Composite edible coating made up of natural gums and polysaccharides is an emerging field of food preservation that can extend the shelf life and reduce spoilage of fresh produce. This research work was designed with the objective to determine the effect of a composite edible coating on sapota fruit. The coating was effective in minimizing weight loss and overall spoilage of the fruit. Physical and microbial assay of whole sapota fruits coated with the developed coating was performed. The objective of this work was also to study the consumer awareness and acceptance of edible coatings on fruits. The results of the survey showed that consumers majorly preferred edible coatings due to enhanced stability and better quality. Socio-economic status, age, knowledge level of the consumers influenced their preference and acceptability of edible coatings. This study demonstrates the use of composite multilayered edible coatings as a potential means to decrease the post harvest losses for sapota fruit and increase its shelf life.*

**Keywords:** Basil seed gum, Composite edible coating, Consumer acceptance, Post harvest loss, Sapota

## **Introduction**

Harmful effects of synthetic packaging on human health and environment have made way for the emergence of biodegradable edible packaging. Edible packaging broadly denotes edible films and coatings. Edible films and coatings may be defined as protective layers created around food surface by applying solutions made from edible polymers like polysaccharides, proteins, lipids or their combinations. The protective layer thus created, acts as a barrier between the food surface and spoilage causing factors thereby enhancing the shelf life of the food. This results in improvement of gas and moisture barrier properties, mechanical properties, sensory quality and even the nutritional characteristics of coated or wrapped food. An edible coating or film is formulated with substances that are legal as per the standard food laws and must not interfere with the sensory profile or other quality attributes of the food. It may also be used as a carrier for bioactive compounds like flavors, nutraceuticals, antimicrobials etc. which improves the functional or nutritional qualities of the coated food. Recent advances related to edible films and coatings have resulted in significant improvement of their physical and barrier properties thus paving the way for their consideration as an alternative to synthetic packaging materials.

The disadvantages of the techniques being used to preserve fresh produce and increasing negative environmental impact have created urgency for the invention of alternative packaging techniques such

as edible coatings. Many years of research have been conducted to develop a material that would coat fruit so that an internal modified atmosphere would develop. Studies have shown that ripening can be retarded, color changes can be delayed, water loss and decay can be reduced, and appearance can be improved by using a simple and eco friendly technology, edible coating.

Edible coatings produced from polysaccharides (cellulose, starch, pectins, seaweeds, gums, chitosan and pullulan) have been widely used in the food industry in the last few years, while lignocellulosic materials have been recently proved to be suitable for edible coating production. On food models, it was found that edible coatings based on bi-component formulations demonstrate effective microbial spoilage inhibition. Composite coatings did not obstruct fruit gas exchange or caused accumulation of off flavor volatiles (Elena Poverenov et. al, 2014). Polysaccharide gums have been recently studied in their possibilities as edible coatings and films promoters due to their sustainable, biodegradable and bio-compatible characteristics. The seeds of *Ocimum basilicum L.*, also known as basil, contain a considerable amount of gum composed by two major fractions of polysaccharides (43 % glucomannan and 24.3 % xylan) with outstanding functional properties in developed edible films. Studies on physico-mechanical properties of basil seeds reported optimal extraction conditions of gum from basil seeds, in terms of pH, temperature and water/seed ratio (Razavi et. al., 2009).

In India, fruits are grown on an area of 5.78 million hectares with a production of 63.50 million tonnes. The important fruits are mango, citrus, banana, sapota, apple, litchi, guava and pomegranate. Despite a phenomenal increase in the production of fruits and vegetables, the much needed nutritional status of the population has not improved much. One of the main reasons for low per capita availability is the enormous losses of fruits which are estimated to be 15 to 50% that occur at different stages of handling, transport, storage, processing and distribution (Gajanana et al., 2011). Sapota is a climacteric fruit characterized by its rapid postharvest ripening and senescence followed by spoilage is due to high rate of ethylene liberation. So far, there has been no cited literature on the effect of composite edible coatings on sapota fruit with usage of basil seed gum as a novel ingredient, hence in this regard, a research work was undertaken to develop a composite edible coating using basil seed gum extract as a novel ingredient, along with xanthan and tragacanth gum and to study its effect on the physio-chemical, antimicrobial and antioxidant properties of sapota.

Research has previously been conducted to establish the benefits of edible coatings in increasing market opportunity for fruits, as well as in extending their post harvest shelf life. But little research has so far examined the consumer acceptance of these products, especially regarding their application on widely used fruits. Therefore, a Knowledge, Attitude and Practice (KAP) survey was also conducted to understand the consumer acceptance of edible coatings.

### **Methodology**

**Materials:** The basil seeds, xanthan gum and tragacanth gum were obtained from the local market in Kolkata, West Bengal, India. Sapota (Manilkara achras Mill. cv. Kalipatti) fruits were obtained from a commercial fruit grower at Baruipur, West Bengal.

**Extraction of Basil seed gum:** This procedure was followed to extract gum from basil seeds. Swollen seeds were stirred in a hot plate magnetic stirrer. Separation of the gum from the swollen seeds was achieved by cold centrifugation followed by manual filtration with cheesecloth to filter out any insoluble residue present.

**Preparation of the coating:** To prepare the coating solution, 0.1 M NaOH solution was added drop

wise to all the basil seed gum extracts until a pH of 9 was reached. Similarly, a solution was made of commercial xanthan gum powder with double sterilized water (water to xanthan gum ratio- 10:1). Glycerol (6 % w/w) was added as a plasticizer in all the solutions. The solutions were then stirred on a magnetic stirrer for 30 minutes to obtain uniform solution.

**Preparation of the Sapota fruits for coating application:** The fruits were first washed in a solution containing sterilized water and sodium hypochlorite as a sanitiser. They were then divided into three sets (5, 10 and 15 layers) of coating treatments each having three variations with one control as follows:

- i) Variation 1: xanthan gum (XG)
- ii) Variation 2: xanthan gum + basil seed gum extract (XG+BG)
- iii) Variation 3: xanthan gum + basil gum extract + tragacanth gum (XG+BG+TG)
- iv) Control: sterilized water + sanitizer (without any coating)

### **Application of the coating on sapota**

Each batch of sapota fruits were subjected to coating treatments by the method of dipping. Post dipping, samples were stored in sterilized zip lock bags at room temperature and under dry conditions for further analysis.

### **Physico-chemical and Microbial Analysis of the sapota samples**

The coated and control sample were analysed to measure parameters such as weight loss percentage (WLP), colour, pH, total soluble solids (TSS), total phenol content and antioxidant capacity to interpret the effectiveness of the developed composite coating on the sapota samples. Microbiological analysis of the coated and control fruits was carried out using the method described by The International Commission on Microbiological Specifications for Foods (ICMSF).

**Shelf life:** The shelf life of fruits was calculated by counting the days required for the fruit to reach the last stage of ripening, but up to the stage of their marketability. The shelf life of the fruits was considered on the basis of their visual appearance.

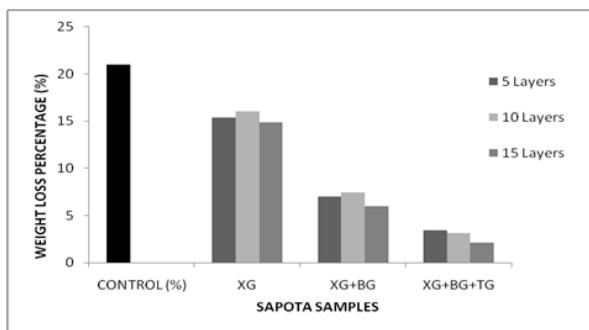
**Statistical Analysis of the results obtained:** Statistical analysis was performed using SPSS Statistics (Version 26). Analysis of Variance (ANOVA) was used to assess the statistical significance at P-value < 0.05.

KAP Survey Procedure: A Knowledge, Attitude and Practice Questionnaire was prepared with ten relevant questions in each section. The questions were framed on the basis of estimating consumer knowledge and attitude towards edible coatings.

## Results & discussions

The coated and uncoated sapota samples were analysed for different quality parameters:

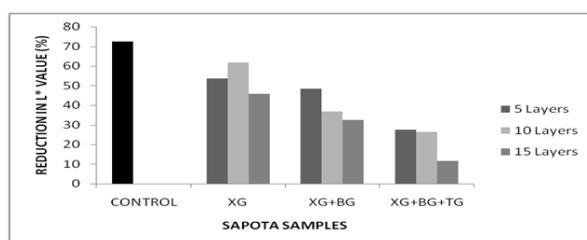
**Weight loss:** There was a significant weight loss for the control sample at the end of the storage period, and the weight loss percentage was higher compared to the coating treatments. There was no significant weight loss in the coated samples until the 8th day of storage while the uncoated samples (control) lost weight much faster.



Graph 1. Graph represents the Weight loss % between 5, 10 and 15 layer coating treatments.

The results obtained indicated that the variation having combination of three gums, Xanthan, Basil seed and Tragacanth significantly ( $p<0.05$ ) reduced weight loss and acted as a barrier against water loss from sapota.

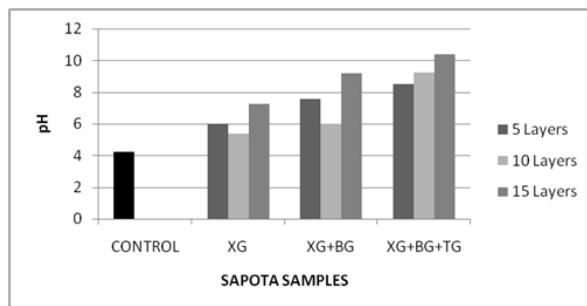
**Colour measurements:** All coating treatments significantly retained the color of the fruit as compared to the uncoated control sample. The reduction in lightness ( $L^*$ ) values were low in the coated sapotas during storage time whereas it was higher in the control sample starting from the third day of storage. This could refer to the changes in epicuticular wax of the fruit as a result of the varying coating treatments. Ripening of sapota fruit is associated with loss of carotenoids and chlorophyll (Rastegar, 2015). The relatively higher  $L^*$  value of the coated sapotas in this study could be attributed to the ability of edible coatings in delaying chlorophyll catabolism and synthesis of carotenoids.



Graph 2. Changes in colour (lightness,  $L^*$ ) of coated and uncoated Sapota samples

The results clearly describe the effectiveness of the composite coating in improving the aesthetic look of the sapota fruit by maintaining the higher  $L^*$  values till the end of the storage period. Similar findings were reported where tomatoes coated with gum arabic delayed color change due to reduced respiration rates.

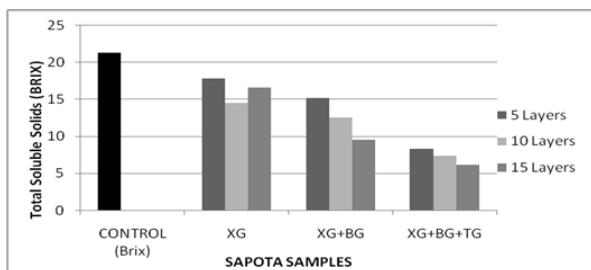
**pH Measurement:** Coated sapota fruit retained higher pH values, as compared to the control. The changes in pH values in all three coating treatments showed variation during their storage period. It was consistently decreasing in the control sample with the increase of storage time and reached to the minimum value at the end of storage period.



Graph 3. Changes in pH of coated and uncoated samples between three coating treatments.

The 15 layer coating treatment was found to be most effective in preventing the decrease of acidity thereby maintaining the pH levels.

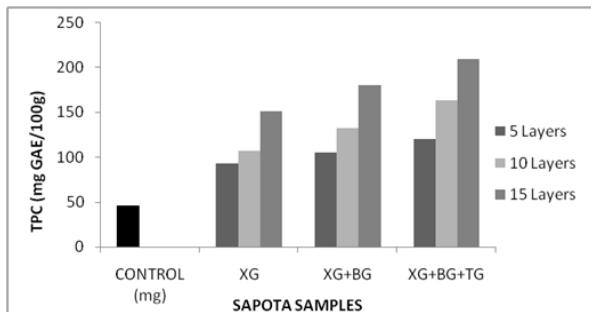
**Total Soluble Solids (TSS):** Total Soluble Solids content of coated sapota samples and control (uncoated) sample during their storage increased significantly in the control, but was low in case of the 15 layer coating treatments at the end of storage time.



*Graph 4. Changes in Total Soluble Solids of coated and uncoated samples*

The lower total soluble solids values of the coated samples at the end of storage period as compared to the control may be attributable to the fact that the immersion of the sapotas in XG+BG+TG coating may have retarded the rate of respiration, thereby suppressing the synthesis and use of metabolites, resulting in lower soluble solids due to slower hydrolysis of carbohydrates to sugars.

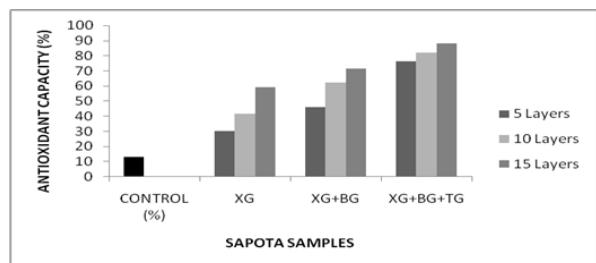
**Total Phenol Content (TPC):** Changes in total phenolic content in the coated and control samples were determined during storage period (graph 5).



*Graph 5. Changes in Total Phenol Content in coated and uncoated samples*

After two days of storage, the content of total phenolics was estimated higher in the coated samples than that measured in the control. This trend continued till the end of storage period, where the phenol content reduced maximum in the control, whereas it was significantly ( $p<0.05$ ) increased in the 15 layer coated samples.

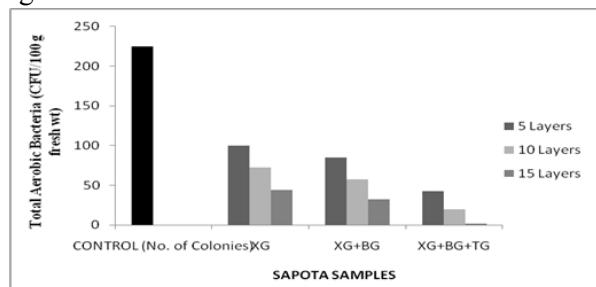
**Antioxidant Capacity:** It was observed that the coating treatments had a significant ( $p<0.05$ ) effect on the antioxidant capacities of the sapota samples, whereas the control sample did not show a desirable antioxidant level.



*Graph 6. Changes in antioxidant activity in coated and uncoated Sapota samples*

The edible coatings of XG+BG+TG prevented the loss of antioxidant capacity of the fruit, and also maintained it throughout the storage period which could be attributable to the ability of this composite coating to enhance the antioxidant capacity.

**Microbial Analysis:** The composite edible coating exhibited potential to be an effective antimicrobial agent.



*Graph 7. Changes in activity of Total Aerobic Bacteria in coated and uncoated sapota samples*

The 15 layer coating treatment showed significant ( $p<0.05$ ) efficiency in preventing microbial spoilage at the end of eight day storage period in both the agar mediums.

**Shelf life Analysis:** The combined effect of xanthan, tragacanth and basil seed gum altogether with the 15 coats showed the most effective result by delaying the ripening and extending the shelf life up to ten days at room temperature.

The second part of this study includes findings of the KAP survey conducted to understand the consumer acceptability of edible coatings.

Consumer perception of edible coatings based on their knowledge, attitude and practice levels:

The survey was based on estimating the overall knowledge, attitude and practice levels of the consumers towards accepting the application of edible coatings on fresh produce especially fruits. The results revealed that the overall knowledge

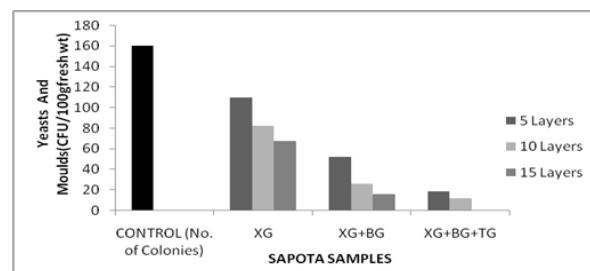
levels of the consumers about edible coatings as a packaging and preservation method depends on different factors such as their socio economic status, education, age and awareness levels. Consumers from high income group were more inclined to using edible coatings on a widespread level. It was observed that most of the consumers above the age of 25 did not want to buy the highly priced edible coatings or were not aware of its applications.

Almost 65% of the respondents were aware of the use of edible coatings and films as a packaging method. This could be due to the increased level of awareness among people regarding advancements in the field of sustainable food packaging and preservation techniques publicized through mass media. Some of the respondents indicated that they have heard about edible coatings but they were not sure of the composition of the coatings and their exact application. Although, rest of the respondents did not know about edible coatings in general, indicating a lack of knowledge.

Results showed that many of the consumers believed that edible coating could be an effective means of decreasing post harvest losses of fruits by acting as a natural packaging material. They know the use of edible coating as an alternative means of packaging fresh fruits which indicated good knowledge levels among them. About 60% of the consumers had knowledge of the added benefits of using edible coatings in fruits. They were aware of the presence of various bioactive and functional components in the natural coating applications. The respondents, who answered negatively, knew that edible wax was used to coat some fruits like apples, but were not sure of the specific benefits of the wax. When asked if they were willing to buy the coated fruits at a higher price than normally available in the market, about 70% responded positively. This suggests that these consumers are aware of the added benefits of the edible coatings that naturally increase its cost when compared to normal fresh fruits available in the market.

Overall, it was found from the knowledge, attitude and practice survey that currently consumers who are conscious about their eating habits and are aware of the recent advancements in the field of health and technology, are willing to accept the widespread use of edible coatings on fresh produce and also believe that it is going to benefit them. Those who were not aware of the presence of edible coatings were either skeptical of accepting this new technique or already

had a pre-conceived notion about it. They perceived edible coatings to be artificial in nature and some even viewed it as adulteration.



*Graph 8. Changes in activity Yeasts and Moulds in coted and uncoated sapota samples*

## Conclusion

Edible coatings come as an environment friendly solution to the problem of food spoilage. On the basis of the results obtained it is concluded that the 15 layer treatment of the developed composite edible coating is effective in enhancing the shelf life and retaining the physio-chemical quality parameters of sapota. It can be concluded from the Knowledge, Attitude and Practice survey conducted on consumer acceptance of edible coatings that the industry should put emphasis on marketability and commercialization of this natural and alternative source of post harvest preservation and packaging, since there is sufficient knowledge amongst consumers, but a lack of awareness of the usage.

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# **Analysis of Nutritional and Functional Properties of Mushroom before and after cooking**

Namrata Banerjee and Manika Das

## **ABSTRACT**

*Mushrooms are the rich source of polysaccharides, essential amino acids, various vitamins, minerals and phytonutrients. Usually mushrooms are consumed either cooked or it is processed to numerous culinary dishes industrially or at home. It is well established, that potential effect and the content of nutrients, various phytonutrients vary depending on the cooking methods. Most of the nutrients are unstable to heating and mushroom, being the rich source of various nutrients it is important to know the retention of nutrients after cooking. Researches have been done to find nutritional and functional properties of mushroom. But, the retention of nutrients, phytonutrients after cooking methods has not been investigated. The present study aimed to investigate the effect of numerous culinary/cooking treatments on nutritional and functional properties of mushrooms. Treatments include boiling, microwaving, frying and sautéing. Macronutrients and micronutrients that are analyzed in this study are the following: carbohydrate, protein, fat, moisture, ash, vitamin A and vitamin C respectively. Functional properties that are analyzed are the following: qualitative and quantitative test for phytonutrients, antioxidant property and prebiotic property. From the study, result revealed that boiling induces huge loss in vitamin content of mushroom (i.e. vitamin A and vitamin C) while comparing with raw mushroom. Frying treatment also causes loss of nutrients in the mushrooms except fat. Fried mushroom are rich in fat. Qualitative analysis of mushroom extracts established presence of various health promoting bioactive phytochemicals which includes anthraquinones, flavonoids and phenolic components. From the result, it was indicated that microwaved and sautéed samples of mushrooms retains highest amount of flavonoids and phenolic compounds leading to high antioxidant property. While boiling and frying significantly decreases the same. Being the vital bank of polysaccharides, mushroom possess high prebiotic property which increases the growth of probiotic bacteria.(in this study Lactobacillus sp. and Bifidobacterium sp. were used.) Obtained result revealed that, there was increase in the growth of probiotic bacteria while using mushroom extract. On the other hand, out of four cooked samples of mushroom, highest growth of probiotic bacteria was observed in microwaved sample of mushroom, followed by sautéed sample. It has been proved that, cooking methods significantly affect the nutritional and functional property of mushrooms. So, selecting the proper cooking method is one of the vital factors in the retention of various nutrients.*

**Keywords:** Antioxidant property, Cooking methods, Mushrooms, Nutritional property, Prebiotic property.

## **Introduction**

Mushrooms are the rich source of polysaccharides, essential amino acids, various vitamins, minerals and phytonutrients. Apart from being a valuable source of nutrients, having various therapeutic effects, mushrooms are very useful for vegetarians because of the presence of essential amino acids which found in animal protein. Mushrooms also incorporated in a wide variety of foods such as health tonics, tinctures, teas, soups, and healthful food dishes, as well as herbal formulas.<sup>(1)</sup> Like other vegetables, mushrooms are generally cooked before being consumed. . Mushrooms are prepared on the basis of convenience and taste preference rather than retention of nutrients and health promoting components.<sup>(2)</sup> It is well established, that potential effect and the content of nutrients, various phytonutrients vary depending on the cooking methods. Most of the nutrients are unstable to heating and mushroom, being the rich source of

various nutrients it is important to know the retention of nutrients after cooking. Researches have been done to find nutritional and functional properties of mushroom. But, the retention of nutrients, phytonutrients after cooking methods has not been investigated. So, it is very essential to analyse the nutritional and functional properties of mushroom before and after cooking.

## **Methodology**

**Collection of sample:** The samples (cultivated mushrooms) were bought from the local market of Kolkata, West Bengal; India. One raw sample and four cooked samples(boiled, microwaved, fried, sautéed) were selected for the study.<sup>(3)</sup> Samples were cut into small pieces, dipped in ethanol for 48 hours. After that, extracts were filtered through Whatman no. 1 filter paper and then the filtrates were used for the analysis.

Estimation of macronutrients and micronutrients: Carbohydrate, protein and fat, vitamin C, Vitamin A content were estimated by Anthrone method<sup>(4)</sup>, biuret method<sup>(5)</sup>, Soxhlet method<sup>(6)</sup>, titration<sup>(7)</sup> and Spectrophotometric method<sup>(8)</sup> respectively.

**Phytochemical analysis:** (Qualitative study): Qualitative analysis of mushroom extract was done. Phytonutrients that were tested qualitatively includes: Phenols, Anthraquinones, Flavonoids, Alkaloids, Saponins and tannin.<sup>(9)</sup>

#### Quantitative Study:

- a) Determination of total phenolic content:  
The total phenolic content was determined spectrophotometrically with Folin Ciocalteau's phenol reagent.<sup>(9)</sup>
- b) Determination of antioxidant property:
  1. Determination of reducing power property:  
The reducing property of the extract was assessed according to the method of Oyaizu.<sup>(10)</sup>
  2. Hydroxyl radical inhibitory potential: This was assayed using the modified method of Oboh and Rocha. In this method, 40ml of the freshly prepared extracts (0.2-1.0mg/ml) was added to a reaction mixture containing 20 ml 20nM deoxyribose, 80mL of 0.1M phosphate buffer, 10 ml of 500mM FeSO<sub>4</sub>. Final volume was made up to 200mL with the addition of distilled water. The reaction mixture was initiated at 37°C for 30 minutes and stopped by the addition of 50ml of 2.8% TCA (Trichloroacetic acid). This was then followed by the addition of 50mL of 0.6% thiobarbituric acid solution. The resulting mixture was then incubated in boiling water for 20 minutes. Absorbance was read at 532 nm in a microplate reader. The same procedure was done for a standard antioxidant by replacing the extracts with ascorbic acid (0.2-1.0mg/mL), and the IC50 value was calculated from the calibration curve.<sup>(11)</sup>
  3. DPPH inhibition: The assay was performed according to a modified method described by Shirwaikar, Rajendran, and Punittha (2006). Firstly, DPPH solution was prepared by dissolving 6mg of DPPH in 100 ml ethanol. Then 1ml of mushroom extracts was added into the test tubes containing 2ml of DPPH solution. Control was prepared by adding 1ml of ethanol to 2ml of DPPH solution. Ascorbic acid was used as standards. The mixture was then shaken vigorously and

was left to stand in the dark for 30 minutes. The absorbance of resulting solution was measured spectrophotometrically at 517nm. The scavenging activity of the mushroom extract on DPPH radical was calculated using the following equation:

$$\text{Scavenging activity (\%)} = \frac{(1 - \text{absorbance of sample})}{\text{absorbance of control}} \times 100$$

**Prebiotic potential:** Culturing of Lactobacillus sp. and Bifidobacterium sp.: Lactobacillus sp. and Bifidobacterium sp were done in the MRS broth. Assess the growth of Lactobacillus sp. and Bifidobacterium sp. in presence and absence of mushroom extract.

a) Qualitative study: First the study was done with raw mushroom sample and then with the cooked mushroom samples. Three petriplates were used for each sample, of which one was used as 'Control' plate; others were used as 'Test' plates containing 0.5 ml and 1ml of mushroom extract along with MRS agar. The petri plates were prepared by pour plating and were incubated at 37°C. Microbial growths were observed after 24 hours.

b) Quantitative study: (Determination of growth curve of Lactobacillus sp. and Bifidobacterium sp.): This is also done by sample first and then with the cooked samples. MRS broth was poured into four clean 500 ml clear glass Nephelo culture flask and labelled as follows: 1) Blank 2) control 3) Test. In 'control' plate only culture was added and in the 'test' plate culture along with mushroom extracts was added. Flasks were cotton plugged and kept in the incubator at 37 degree Celsius. Flasks were taken out at different time intervals to measure optical density. This was continued up to 20 hours.<sup>(12)</sup>

## Result and discussion

**Effect of cooking on the content of macronutrients and micronutrients:** The result indicated that, out of four cooking methods, highest retention of carbohydrate and protein is seen in the microwaved sample followed by sautéed sample. Lowest retention of protein is seen in boiled sample. This could be due to the fact that, leaching and solubilization of protein takes place during boiling. On the other hand, vitamin C, being a water soluble and temperature sensitive vitamin, is lost during boiling but highest retention is seen in microwaved sample. In microwaved cooking, due to short treatment, there is less destruction of mushroom cell wall leading to highest retention of nutrients. (Table 1)

Table 1: Effect of cooking on the macronutrients and micronutrient content of mushroom

Nutrients	Mushroom variations				
	Raw	Boiled	Fried	Sautéed	Microwaved
Carbohydrate (g/100g)	50.13	20.17	32.9	42.1	47.13
Protein (g/100gm)	14.19	7.02	8.23	13.42	13.5
Fat (g/100gm)	1.24	1.22	2.45	1.5	1.01
Vitamin A (mg/100gm)	15.12	8.19	7.17	9.1	13.15
Vitamin C (mg/100gm)	1.88	1	1.1	1.53	1.67

Qualitative analysis: The phytochemical analysis performed for anthraquinones, flavonoids, phenols, saponins, tannins and alkaloids. Results showed that, mushroom is rich in various phytonutrients. It

was indicated by the result that, highest retention of phytonutrients is seen in microwaved sample followed by sautéed sample. Lowest retention is seen in boiled sample. (Table 2)

Table 2: Qualitative analysis of phytonutrients of mushroom

Compound Tested	Result				
	Raw	Boiled	Microwaved	Fried	Sautéed
Anthraquinones	++	+	++	+	+
Flavonoids	++	+	++	+	++
Phenols	+++	-	+++	+	++
Saponin	-	-	-	-	-
Tannins	+	-	-	-	-
Alkaloids	++	+	+	+	+

Quantitative analysis of phenol content: Phenolic components can not be retained in high temperature. These are susceptible to render at high temperature and oxidative degeneration. During boiling, mushrooms are cooked at 100°C. So, retention is low. The result indicated that, in microwaved

sample the retention of phenol is highest. This could be due to the fact that, in microwaved cooking, there is short treatment time which results in minimal cell destruction in mushroom and this will help in the retention of phenols in mushroom. (Table 3)

Table 3: Effect of cooking methods on the phenol content of mushroom

Nutrients	Mushroom variations				
	Raw	Boiled	Fried	Sautéed	Microwaved
Phenol(µg GAE/100mg)	172.99	50.12	70.12	168.19	171.01

Quantitative analysis of antioxidant activity: To estimate the antioxidant activity Percentage DPPH inhibition, reducing power potential and hydroxyl radical inhibitory potential were estimated. It was seen that, microwaved sample has the highest

retention of antioxidant activity and lowest retention is seen in the boiled sample. This can be because of the fact that, microwaved cooking retains more polyphenol than boiling method. (Table 4)

Table 4: Quantitative analysis of antioxidant activity

Functional properties	Mushroom variations				
	Raw	Boiled	Fried	Sautéed	Microwaved
Antioxidant activity (% DPPH inhibition)	45.23	20.12	26.71	40.19	43.22
Reducing power property (µg/ml)	150	52.12	60.19	120.91	139.5
Hydroxyl radical inhibitory potential (µg/ml)	90.12	42.01	45.19	78.92	85.98

Study of prebiotic potential: assess the growth of *Lactobacillus* sp. and *Bifidobacterium* sp. in presence and absence of mushroom. (Qualitative study): The result indicated that, mushroom extract enhances the growth of probiotic bacteria.

Counting isolated colony: 0.1ml of cooked mushroom sample was taken to count the isolated colony. (Table 5 and Table 6)

Table 5: Number of isolated colony of *Lactobacillus* sp. present in mushroom

Mushroom sample	Number of colony
Raw mushroom sample	1020 CFU/ml (approx.)
Boiled mushroom sample	300 CFU/ml (approx.)
Fried mushroom sample	426 CFU/ml (approx.)
Sautéed mushroom sample	740 CFU/ml (approx.)
Microwaved mushroom sample	991 CFU/ml (approx.)

Table 6: Number of isolated colony of *Bifidobacterium* sp. in different mushroom samples

Mushroom sample	Number of colony
Raw mushroom sample	350 CFU/ml (approx.)
boiled mushroom sample	105 CFU/ml (approx.)
fried mushroom sample	125 CFU/ml (approx.)
Sautéed mushroom sample	181 CFU/ml (approx.)
Microwaved mushroom sample	216 CFU/ml (approx.)

The result indicated that boiled sample has lowest number of colonies and microwaved sample induces highest growth of probiotic bacteria followed by fried and sautéed sample. This is due to the fact, that retention of polysaccharides and polyphenol is best in microwave cooking method compared with other four techniques.

Determination of growth curve of *Lactobacillus* sp. and *Bifidobacterium* sp. in the presence and absence of mushroom: The flasks were taken out at regular time interval and its absorbance was measured at 680 nm in a colorimeter upto 20 hours. A graph was plotted with absorbance against time (Figure 1 and Figure 2).

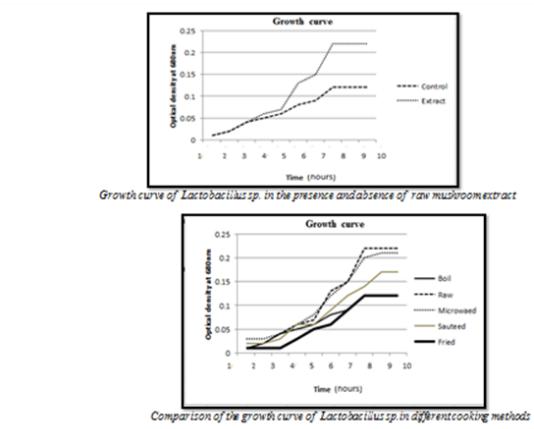


Figure 1: Growth curve of *Lactobacillus* sp. in the presence and absence of mushroom

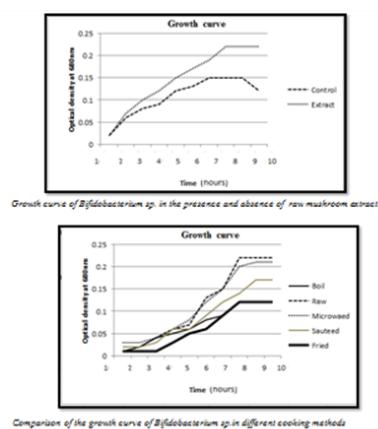


Figure 2 - Growth curve of *Bifidobacterium* sp. in the presence and absence of mushroom

The result indicated that, in the boiled sample the bacterial growth rate is least. While in microwaved sample highest growth rate of probiotic bacteria has been seen followed by fried and sautéed sample. This is due to the fact, that retention of polysaccharides and polyphenol is best in microwave cooking method compared with other four techniques. Dietary polyphenols contribute to the maintenance of gastrointestinal health by interacting with epithelial cells and largely by modulating the gut microbiota composition. Polyphenols may act as promoting factors of growth, proliferation, or survival for probiotics mainly *Lactobacillus* strains and thus exerting prebiotic actions and inhibiting the proliferation of pathogenic bacteria such as *Salmonella* and *Helicobacter pylori*. (Hervert-Hernandez and Goni, 2011).<sup>(13)</sup>

## Conclusion

This study assessed the effects of four cooking methods (boiling, microwaving, sautéing, and

frying) on the macronutrients, micronutrients, antioxidant activity and prebiotic potential in the most consumed mushroom worldwide i.e. Agaricus bisporus. From present study it can be conclude that the edible mushrooms Agaricus bisporus were affected by different cooking techniques. From the study, it has been seen that, each nutrients, bioactive components affected by the different type of cooking techniques. In boiling, as mushroom is boiled at a temperature of almost 100°C, most of the nutrients and phytonutrients gets destroyed. Highest retention of carbohydrate is seen in the microwaved sample whereas lowest retention is seen in the boiled sample. In case of protein retention is highest in the microwaved sample followed by sautéed sample. In boiled sample there is least retention of protein compared to the other samples. This could be due to the fact that nitrogenous compounds leached in the boiling water, also in the high temperature protein gets denatured. Retention of phenolic compounds, antioxidant activity and other nutrients is least in boiling than other four cooking techniques. While, at the same time microwaving mushroom could retain most of the nutrients, phenolic compounds and also antioxidant activity, prebiotic potential followed by sautéing and frying technique. Mushroom also has reducing power due to the presence of free radical scavenging components like flavones, flavonoids, phenols etc. Because of the presence of high amount of polysaccharides, polyphenols mushroom exerts the prebiotic potential. From the result, we can suggest that mushrooms should be cook at lowest appropriate temperature to conserve not only nutrients but also phytochemicals, particularly phenols. In general, it can be concluded that boiling depletes radical scavenging ability and prebiotic potential of mushrooms. Thus it is also vital to consume water used for cooking mushrooms so that leaching losses can be minimized from diet. Phenolic content was not much affected in sautéed samples indicating sautéing as a cooking option might be useful in improving health properties of mushrooms. So, finally we can conclude by saying that, microwaving and sautéing were the more adequate culinary treatments to preserve the nutritional and functional properties of mushrooms. Therefore, the result clearly indicated that, the cooking technique influences the nutritional value and the functional property of mushrooms so that the adequate selection of the culinary method is one of the most important key factors to preserve the nutritional profile of this highly consumed food. My study finding would be a valuable database to the food manufacturers as it might encourage the food

industry to recommend particular cooking methods to preserve or improve the nutritional quality and functional property in the edible mushrooms. This would also benefit the consumers who wish to adopt cooking techniques that could deliver the maximum health benefits.

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# **Development and Evaluation of Food Microgreens incorporated Product**

*Nandita Bubna and Manika Das*

## **ABSTRACT**

*Fortification of food products has been a common practice. a process of enrichment or to add on to the nutritional value to food. Similar has been the aim behind this project. Microgreens also known as “vegetable confetti” are young, tender edible crops harvested at the leaf stage along with the stem and cotyledons. These microgreens are known to have superior nutritive value than their full grown counterparts. Microgreens fall under the category of a health food that are dense in various nutrients- vitamins, minerals, and antioxidants having a potential to prevent diseases and deficiency on its consumption. Therefore, Microgreens were used as a fortificant, which could be incorporated into food products in varied ways. Amaranth, cilantro and mustard microgreens were put to study in the form of paste and mixed in raw mango juice, which then underwent sensory evaluation in multiple combinations, and the most liked variation was further put to nutritional analysis to enumerate its nutrient enhancement. The results being, microgreens showing positive impact on fortification increasing the antioxidant, minerals and vitamins value of the raw mango juice, fulfilling the designated aim of the project.*

**Keywords:** fortification, fortificant, health foods, microgreens

## **Introduction**

Microgreens also known as “vegetable confetti” are young, tender edible crops harvested at the leaf stage along with the stem and cotyledons. An establishment of late 1990s into high-end culinary business with varied roles in combination to food items- commonly to enhance colour, texture, flavor of salads or to garnish a wide variety of main dishes. These microgreens are known to have superior nutritive value than their full grown counterparts. Microgreens are most commonly used as novel salad greens because of their unique appeal. In the market these greens are available among variety of novel salad greens because of their unique texture, varied colours (green, red, purple) and distinct flavours- sweet, mild, spicy,. There is an existence of 80-100 crops and crop variety used as microgreens- to name the most common ones- carrot, cress, arugula, basil, onion, chive, broccoli, fennel, lemongrass, buckwheat, spinach, sweet pea, and celery, cabbage, beet, kale, mustard, radish, amaranth, etc.,

Health foods are compelled to growing interests in health foods as they support good health and longevity. Thus, microgreens fall under the category of a health food that are dense in various nutrients- vitamins, minerals and antioxidants having a potential to prevent diseases and deficiencies on its consumption. There has been various researches proving the fact that minerals (iron, calcium, magnesium, zinc, selenium and manganese) and nitrate content, phytochemical content, antioxidant activity, ascorbic acid in microgreen varieties are

more than in mature leaves. In addition, microgreens have high levels of functional compounds and human bioactive compounds like- ascorbic acid, tocopherol, phylloquinone, phenolics, minerals and antioxidants more than the mature crop. Thus, microgreens are diminutive greens which has abundance of nutrients (minerals, vitamins, antioxidant, polyphenols) and adding to it is their attractive colours, flavours and crispness- allowing it to be a complete package of a superfood.

## **Methodology**

Materials: For the purpose of the project microgreens were grown at home level only with the use of regular vegetable seeds, coco beat, soil. The product development required raw mango, jiggery, regular spices

Reagents required: Bovine Serum Albumin (BSA), Biuret reagent, Anthrone reagent, petroleum ether, acetone, 2,6-dichloro indophenol dye, metaphosphoric acid, Folin-Ciocalteau reagent, DPPH (2,2-diphenyl-1-picrylhydrazyl) reagent, potassium ferrocyanide, trichloroacetic acid, phosphate buffer, iron (II) sulphate, thiobarbituric acid solution, calcium and iron estimation kits.

Product Development: Raw mango juice fortification was done for product development. Basic recipe (Table-1) along with variation 1 (Table-2) and variation 2 (Table-3) are presented in the tables below.

## Basic Recipe- Raw Mango Juice

Table 1: Basic recipe description

Ingredients	Amount (g/ml)
Raw mango	150g (without seed and peel)
Water	10ml

### Variation 1

Table 2: Variation 1 description of the products developed

Variations	Variation description
Basic	50 ml of raw mango juice
A.1)	50ml Basic recipe + 1ml Amaranth microgreen paste
A2)	50ml Basic recipe + 2ml Amaranth microgreen paste
A3)	5ml Basic recipe + 3ml Amaranth microgreen paste
M.1)	50ml Basic recipe + 1ml Mustard microgreen paste
M2)	50ml Basic recipe + 2ml Mustard microgreen paste
M3)	50ml Basic recipe + 3ml Mustard microgreen paste
C1)	50ml Basic recipe + 1ml Cilantro microgreen paste
C2)	50ml Basic recipe + 2ml Cilantro microgreen paste
C3)	50ml Basic recipe + 3ml Cilantro microgreen paste

Variation 2: From the above samples, one sample from each variation was chosen and to it addition of flavours and spices were done to make it more acceptable, appealing and tastier

Table 3: Variation 2 description of the products developed

Addition of ingredients to the beverage	Amount
Jiggery	5g
Red chilly powder	1 tsp
Salt	1tsp
Chaat masala	1 tsp

**Sensory Evaluation:** The standard product and all the variations was evaluated organoleptically for different quality attributes (colour, appearance, texture, taste, and odour) and overall acceptability by 25 panel members using 9 point hedonic scale.

**Chemical Analysis:** The standard and approved products as chosen by the panel members were

chemically analysed for their carbohydrate, protein, vitamin C, beta carotene, phenolic compounds, iron, calcium and DPPH radical scavenging activity, reducing power property, hydroxyl radical inhibitory potential.

**Carbohydrate Estimation (Anthrone method):** 100mg of glucose was measured and mixed with 100ml distilled water to form the stock standard solution and 10ml of it was diluted in 100ml distilled water to form the working standard.

100mg of sample was taken in a boiling tube and hydrolyzed by keeping it in a water bath for 3 hours with 5ml of 2.5N hydrochloric acid and cooled to room temperature with sodium carbonate it was neutralized until the effervescence seizes. The volume was made up to 100ml and centrifuged. The supernatant was collected and 1ml of aliquot was taken. The standards were made by taking 0, 0.1, 0.2, 0.4, 0.6, 0.8 and 1ml of working standard. The volume was made up to 1ml in all the test tubes by adding distilled water. 4ml of anthrone reagent was added to all the test tubes. It was heated for 8 minutes in a boiling water bath. Absorbance was checked at 630nm. A calibration curve was plotted to determine the concentration of the unknown. Further the calculation for the results was done using the calibration curve.

**Protein estimation (Biuret method):** BSA standard solution was prepared with a concentration of 10mg/ml. 0.2 to 0.8ml of standard protein solution was taken in five different test tubes and water was added to bring the volume to 1ml in each test tube and lastly 4ml of biuret's reagent was added and mixed. Simultaneously, a blank was prepared with 1ml of distilled water and 4ml of biuret's reagent and a test with 1 ml of test sample and 4 ml of biuret's agent was prepared. The test tubes were incubated for 30 minutes at room temperature and the optical density was measured in a spectrophotometer at 550nm. A calibration curve was plotted to determine the concentration of the unknown. Further the calculation for the results was done using the calibration curve.

**Iron estimation:** For the test the iron estimation kit was used following Ferrozine method. The obtained results were calculated as-

$$\text{Iron (mg/100ml)} = \text{abs. test} - (\text{abs. standard blank} + \text{abs. blank}) / \text{abs. standard} - \text{abs. blank} \times 100$$

**Calcium estimation:** For the calcium estimation calcium kit was used following OCPC method.

The obtained results were calculated as- Calcium (mg/100ml) =abs. test/abs. standard x 10

**Beta-carotene estimation:** For the estimation 5g of microgreen paste sample was taken and crushed into 10 ml of acetone with the help of motor and pestle and few crystals of anhydrous sodium sulphate. The solution was centrifuged at 3000 rpm for 3-4 minutes. The supernatant was transferred to a separating funnel. To it petroleum ether was added and mixed thoroughly. The two layers were allowed to stand and separate. The lower layer was discarded and upper layer was collected and OD was recorded at 452nm using petroleum ether as blank. The obtained results were calculated as-

Beta-carotene (mg/100ml)= O.D. of sample x 134 x  $10^3$  x 100/wt. of sample x 560 x 1000

**Estimation of Vitamin C:** The estimation of Vitamin C was done by standardizing 2,6- DCIP dye with vitamin C standard of known strength. Further 1ml of the juice with 1ml of metaphosphoric acid was taken in a test tube and titrated by 1ml of the dye till colourless. The obtained results were calculated as- V1 S1 x V2 S2

**Estimation of Total Phenolic content:** Folin-Ciocalteau method: The total phenolic content of microgreens leaf extract was determined using a spectrophotometer and Folin Ciocalteau's reagent. 1gm of sample was extracted in 5 ml of ethanol (24hrs extraction). To prepare a calibration curve 0, 1, 2, 3, 5 and 10ml of the Gallic acid solution is added into 100ml volumetric flasks and then diluted to volume with water. From each calibration solution, sample extract, or blank 0.5ml was taken and was mixed with 0.5ml of Folin Ciocalteau reagent (10% v/v dilution in distilled water). 4ml of anhydrous sodium carbonate (75%) is added to the solution which imparts blue colour. The solution was stirred for 15 seconds and incubated at 40°C for 30 minutes. The absorbance is measured at 765nm using UV- spectrophotometer using the Gallic acid as standard and against a blank. Further the calculation for the results was done using the calibration curve.

**Qualitative analysis of the phytochemical content of microgreen leaves:**

Chemical tests for the screening and identification of bioactive chemical constituents in the microgreens

were carried out with the extracts using the standard procedure as described. For each test, 1ml of each solvent extract was used for analysis, in exception for the saponin test in which 3ml solvent extract was used (Sagbo et.al., 2017).

1. **Test for alkaloids:** The leaf extracts of all microgreens were dissolved and filtered in dilute hydrochloric acid. Wagner's reagent was prepared by mixing 6gm of potassium iodide and 2gm of iodine in 100ml of distilled water, and then added to the previously obtained filtrate. The presence of alkaloids would be confirmed with the appearance of reddish-brown precipitate.
2. **Test for anthraquinones:** 0.2ml of microgreens leaf extracts were taken, to which 2ml of chloroform was added. The mixture was shaken and filtered, and was mixed with 10% ammonia solution. The presence of anthraquinones would be confirmed with the presence of bright pink precipitate.
3. **Test for flavonoids:** 0.5ml of microgreens leaf extracts were taken, to which few drops of 10% sodium hydroxide was added. The appearance of bright yellow colour, which disappeared with the addition of dilute acid, would confirm the presence of flavonoids.
4. **Test for phenols:** 0.5ml of microgreens leaf extracts were taken, to which few drops of 10% ferric chloride solution was added. The presence of phenol would be confirmed with the appearance of bluish black colour.
5. **Test for saponins:** The microgreens leaf extract was taken in a test tube and shaken vigorously. Formation of a stable foam would confirm the presence of saponins.
6. **Test for tannins:** 0.5ml of microgreens leaf extracts were taken, to which 10% sodium chloride solution containing 1% gelatin solution was added. The presence of tannins would be confirmed with the appearance of white precipitate.
7. **Test for triterpenes:** to microgreens leaf extracts, chloroform was added and filtered. To it, few drops of concentrated sulphuric acid was added, shaken and kept aside. The presence of triterpenes was would be confirmed with the appearance of golden yellow colour.

**Test for antioxidant (DPPH):** The scavenging activity of the rich microgreen fortified beverage was measured by using 2,2-diphenyl-1-picryl-hydrazone. The DPPH reaction mixture (3.5ml) was

made by adding ethanolic solution of DPPH, and of the beverage. The test tubes were incubated for 30 minutes in dark., and then absorbence was measured at 0.517 nm with ethanol as blank. For control, DPPH solution in ethanol was taken as control. Calculation of the percentage inhibition of DPPH was done by comparing the results of the test with the control by using the formula- DPPH inhibition(%) =  $([AC-AS]/AC) \times 100$

Where, AC- absorbance of control, AS- absorbance of the extract

Reducing power property: The reduction property of the product was assessed according to the method of Oyaizu. Different concentrations (0.2-1.0mg/ml) of fortified drink were added to 1ml of distilled water and then mixed with 2.5ml of 0.2ml phosphate buffer (pH 6.6) and 2.5ml of 1% potassium ferrocyanide. The mixture was incubated at 50°C for 20 minutes before addition of 2.5ml of trichloroacetic acid. The resulting mixture was centrifuged at 3000 rpm for 10 minutes. Thereafter, 2.5ml of the supernatant was mixed with an equal amount of distilled water and 0.5ml of 0.1%  $FeCl_3$ . The colour change of the resulting solution was taken at 700nm. The further estimation of results were done using the calibration curve.

Hydroxyl radical inhibitory potential: The ability of the microgreen fortified juice to stop  $Fe_2^+/H_2O_2$  induced decomposition of deoxyribose was assayed using the modified method of Oboh and Rocha. In brief, 40ml of the freshly prepared juice (0.2-1.0 mg/ml) was added to a 80ml of 0.1M phosphate buffer, 10ml of 500mm  $FeSO_4$ , and the volume was made upto 200ml with distilled water. The reaction mixture was initiated at 37°C for 30 minutes and stopped by adding 50ml of 2.8% TCA, followed by addition of 50ml of 0.6% thiobarbituric acid solution. The mixture was then incubated in boiling water for 20 minutes and absorbance was taken at 532nm. The results were further calculated using the calibration curve.

## Results and discussions

3.1-sensory evaluation-The results for the sensory evaluation of variation 1 and variation 2 was done by the panel members as shown in table 4. The products of variation 2 are those which were chosen by the panel members from the sensory evaluation of variation 1- B, A2 and M3. The best accepted were further modified to increase it's acceptability as shown in the table of variation 2.

Table 4: Mean $\pm$  S.D. of the ratings given to the different attributes of the sensory evaluation

Type of Variation	Appearance	Colour	Aroma	Texture	Taste	Overall Rating
<b>VARIATION - 1</b>						
Basic	7.6 $\pm$ 0.51	7.5 $\pm$ 0.52	7.7 $\pm$ 1.15	7.7 $\pm$ 0.67	7.5 $\pm$ 0.52	7.4 $\pm$ 0.69
A1	6.4 $\pm$ 0.69	6.8 $\pm$ 0.78	6.6 $\pm$ 1.42	7 $\pm$ 1.15	6.8 $\pm$ 0.78	6.7 $\pm$ 0.82
A2	6.9 $\pm$ 0.73	7 $\pm$ 1.24	7.2 $\pm$ 1.13	7 $\pm$ 0.81	7 $\pm$ 1.24	6.9 $\pm$ 1.28
A3	7 $\pm$ 0.81	6.9 $\pm$ 0.44	7.3 $\pm$ 0.82	6.9 $\pm$ 1.10	6.9 $\pm$ 0.44	6.8 $\pm$ 1.31
M1	6.6 $\pm$ 0.69	7.2 $\pm$ 1.03	6.6 $\pm$ 0.69	7.1 $\pm$ 0.99	7.2 $\pm$ 1.03	7.1 $\pm$ 0.73
M2	6.9 $\pm$ 1.19	6.8 $\pm$ 1.22	6.8 $\pm$ 0.91	6.4 $\pm$ 1.42	6.8 $\pm$ 1.22	6.8 $\pm$ 1.31
M3	7.3 $\pm$ 0.67	7.3 $\pm$ 1.05	7 $\pm$ 0.94	7 $\pm$ 1.05	7.3 $\pm$ 1.05	7.4 $\pm$ 0.69
C1	7.4 $\pm$ 0.69	7.2 $\pm$ 1.03	7.3 $\pm$ 0.82	7.9 $\pm$ 0.56	7.2 $\pm$ 1.03	7.9 $\pm$ 0.56
C2	7.3 $\pm$ 0.67	7.2 $\pm$ 1.03	7.5 $\pm$ 0.70	7.1 $\pm$ 0.99	7.2 $\pm$ 1.03	7.3 $\pm$ 1.05
C3	7.2 $\pm$ 0.63	7..1 $\pm$ 0.73	6.8 $\pm$ 1.03	6.6 $\pm$ 1.07	7..1 $\pm$ 0.73	7 $\pm$ 0.81
<b>VARIATION - 2*</b>						
B	8.1 $\pm$ 0.73	8. $\pm$ 0.73	8.2 $\pm$ 0.63	7.7 $\pm$ 0.67	8.7 $\pm$ 0.48	8 $\pm$ 0.47
A2(2)	8.9 $\pm$ 0.31	8.9 $\pm$ 0.31	8.8 $\pm$ 0.42	8.5 $\pm$ 0.52	7.7 $\pm$ 0.82	8.9 $\pm$ 0.31
M3(2)	8.2 $\pm$ 0.63	8.2 $\pm$ 0.63	8.2 $\pm$ 0.42	8.2 $\pm$ 0.42	8.9 $\pm$ 0.31	8.6 $\pm$ 0.51

\*post the evaluation of variation 1, the study of cilantro had to stopped due to its inability to grow owing to extreme heat conditions. B- basic recipe, A2(2)- basic recipe with 2 ml amaranth microgreen paste, M3(2)- basic recipe with 3ml mustard microgreen paste

## Nutritional Analysis

The results of the nutritional analysis are put down in the following tables, which were as follows. Macronutrient estimation- estimation of carbohydrate and protein.

Table 5: Results for estimation of macronutrients

Product Variation	Cho (G/100ml)	Protein (G/100ml)
B(2)	25.8	0.254
A2(2)	31.4	0.289
M3(2)	36.4	0.362

Table 5 represents the results for carbohydrate and protein estimation of the fortified drink. Carbohydrates are the main source of energy obtained from food, while proteins are the building blocks of life and both stand as the most important macronutrients. From the results we can see that the macronutrient content has been increased, and the prime reason possibly being the fortification of the basic recipe with microgreens. Addition of jaggery for the flavor enhancement also adds on to the reason behind increase in the carbohydrate content.

Table 6: Micronutrient estimation- estimation of iron and calcium.

Product Variation	Calcium (mg/100ml)	Iron (mg/100ml)
B(2)	10.932	0.250
A2(2)	14.44	0.359
M3(2)	13.24	0.422

Calcium and iron are vital minerals to perform important metabolic and regulatory roles of the human body. Shortage of these minerals could lead to serious health problems. Table 6 represents the results for calcium and iron value of the prepared products. The values shows the increase in the mineral content of the fortified drinks in comparison with the basic recipe, this could be due to addition of microgreens in the drink. Thus, fortification of the basic recipe showed positive results.

Table 7: Estimation of vitamins- Beta-carotene and vitamin C estimation

Product Variation	Beta-carotene (mg/100ml)	IRON (mg/100ml)
B(2)	12.4	0.250
A2(2)	21.5	0.359
M3(2)	16.8	0.422

Beta-carotene, an essential vitamin for a healthy vision, skin and tissues while vitamin C plays an important role in maintaining the immune system, cardiovascular care, skin health. Table 7 shows the results of vitamin content of the basic recipe and the fortified drink. The results showed the increased values of vitamins in the fortified juice than the basic juice, which could be due to the rich vitamin property of the microgreens.

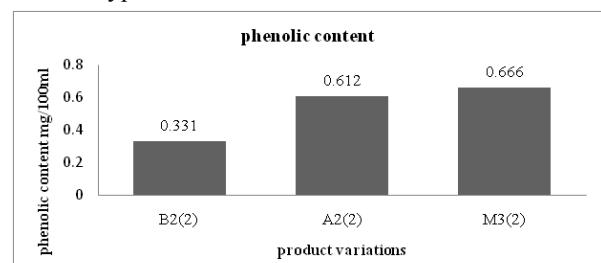
Qualitative analysis of the phytochemical content of microgreen fortified beverage

Table 8: Table showing the results for the qualitative analysis of microgreen fortified raw mango juice

Qualitative Analysis of phytochemical microgreen fortified raw mango juice			
Compound tested	Basic raw mango juice	Raw mango juice with mustard microgreen	Raw mango juice with amaranth microgreen
Alkaloids	-	-	-
Anthro-quinones	-	-	-
Flavonoids	+	++	++
Phenols	+	++	++
Saponins	-	-	-
Tannins	-	-	-
Triterpenes	+	++	++

The results obtained after performing the qualitative analysis of fortified raw mango juice were observed and tabulated as shown in table 8. From the given data, it can be observed that the prepared products are devoid of alkaloids, anthroquinones, saponins and tannins. It can also be observed that components like, flavonoids, phenols and triterpenes are present in comparatively good amounts in the beverage. These phenolic compounds pose anti-inflammatory, anti-carcinogenic and antioxidant and free radical scavenging properties.

Total Polyphenolic Content



Graph 1: graph depicting the total polyphenolic content of the product variations

Phenolic compounds are the secondary metabolites of our body, which benefit due to their antioxidant properties. The above graph 1 clearly proves that the phenolic content of the microgreen fortified drink was higher than that of the basic recipe.

Analysis of the antioxidant property- DPPH, reducing power property and hydroxyl activity inhibitory potential.

Table 9: table showing the results for the analysis of the antioxidant property

Product Variation	Anti-oxidant (%)	Reducing Power Property	Hydroxyl Activity Inhibitory Potential (ug/100ml)
B(2)	45.1	0.182	2.036
A2(2)	58.8	0.188	2.037
M3(2)	71.4	0.207	2.040

Antioxidants are substances that may protect our cells against the affects of the free radicals. Many antioxidant undergo electron-transfer upon exerting the antioxidant functions, therefore, the electrochemical assay of the reducing power has been employed to evaluate the activity of the antioxidant. Hydroxyl radical is the most reactive oxygen species and cause severe damage to the adjacent biomolecule. Thus, the test was aimed to investigate free radical scavenging activity. The table 9 shows the result for the antioxidant property analysis, which shows the increase in the values on fortification with microgreen, however, the range of difference in the values is minimal.

## Conclusion

The above tests showed positive and similar results which indicated the rise in the nutrient contents of the test performed on fortification with microgreens. The addition of flavours and spices could also have been a reason behind increase in the functional properties of the fortified drink in comparison to the basic recipe. Thus, we could conclude by saying the the results for the entire dissertation have been successful in all the areas. Few, difficulties were faced on executing the plan if action, however, all were achieved and the findings are known to be positive. Microgreen therefore are , nutrient sources which are easily, available, affordable, and producible. The 3-4 inches of crops are found to be rich in various vitamins, minerals having rich antioxidant property. These could be be a good source of consumption to combat various diseases

caused due to nutrient deficient conditions as they have therapeutic potential too. On the whole, the usage of microgreen should be highly promoted, as it could be consumed in variety of ways and not merely as toppings, garnishes and dressing in high-end food items. The vegetable confetti could bring about a huge difference if used in the correct manner to increase the nutritional status.

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# Nutritional and Functional Properties of Selected Edible Leaves

Tasnim Murtaza Zakir and Anindita Deb Pal

## ABSTRACT

This study was designed to document the nutritional and functional properties of raw, blanched and cooked Ceylon Spinach leaves, Mustard leaves and Pumpkin leaves by standard analytical measures. They were analyzed for the proximate composition, vitamin, mineral and phytochemical. The results of proximate analysis revealed remarkable ash, protein, carbohydrate, iron and vitamin C content of the leaf extracts. By using the standard qualitative phytochemical screening procedure, the raw leaves were seen to contain appreciable amount of phenol, alkaloids and flavonoids, which are responsible for the antioxidant and antimicrobial property, were observed to decrease on blanching and cooking. On blanching and cooking the leaves were still seen to retain an appreciable amount of the nutrients and phytochemicals. Thus, on the basis of the result, all three leaves can be said to be a good source of all the basic nutrients, natural antioxidant, antimicrobial and prebiotic which is needed for providing therapeutic effects in the body.

**Keywords:** Alkaloids, Antimicrobial, Antioxidant, Blanched, Cooked, Prebiotic, Phytochemical

## Introduction

Present word is over-dependent on just a few plant species for survival. Diversification in plant production and consumption habits of the people can include a broader range of plant species, especially those which are currently identified as under-utilized species. This would significantly contribute to improved health and nutrition, livelihoods of the population and ecological sustainability (Leonti, M. 2012).

Biochemical studies have demonstrated a significant positive correlation between the intake of natural food products and reduced rates of degenerative disease. Due to this study there is increase in the consumption of fruits and vegetables (Steimez, K. A. et. al., 1996). Many of the traditional food have shown benefit beyond their nutritive values because they contain many different plant secondary compounds also called as phytochemicals such as carotenoids, flavonoids, phenols, tannins, anthocyanin, etc. Many of these secondary compounds have proved useful for the management of different human diseases (Ebadi, M. 2007). Phytochemicals are anti-nutritional factors which are generally not essential for normal functioning of the human body but are needed for their antioxidant, antimicrobial, anti-carcinogenic, anti-inflammatory properties (Soetan, K. O. 2008).

Antioxidants are essential as they interfere with the production of free radicals and help to reduce oxidative stress. This further prevents the body

from oxidative damage or lifestyle diseases such as cancer, aging, vascular diseases, etc (Prakash, D. et. al., 2007). Plants are also observed to provide antimicrobial agent with potentially different mechanism of action and thus, it can be of a great significance in therapeutic treatment of infection, flu and many more (Nostro, A. et. al., 2000).

The aim of this paper is to document the nutritional, prebiotic, antioxidant and antimicrobial properties of selected edible leaf species which were traditionally used and to also check the retaining power after blanching and cooking of the leaves.

## Methodology

**Sample Collection and Sample Treatment:** The samples of *Cucurbita moschata duchesne*, *Basalle alba* and *Brassica juncea* used in this study were purchased from local vegetable market in North Kolkata. The leaves were separated from the stem, washed using tap water to remove sand and other impurities. They were divided into three parts: raw, blanched and cooked. After which they were air dried to remove the surface water. The dried leaves were then ground into fine powder using porcelain mortar, sieved and stored in zip-lock polythene bag. Leaf extract was prepared by soaking powdered sample in distilled water, after which the supernatant was collected and used for analysis.

**Proximate Analysis:** The moisture content of the fresh leave samples were determined by oven drying 5grams of the leaves at 130-133°C till constant

weight was achieved (AOAC). Ash content was determined by dry ashing the powdered sample in muffle furnace until grayish white ash was attained (Ceirwyn, S.J. 1995). Protein content was estimated by Biuret method (Wokes, F. et. al., 1942). Crude lipid of raw was quantified by using soxhlet apparatus and a solvent (AOAC). Carbohydrate was calculated by anthrone method (Ludwig, T. G. 1956). Crude fiber was determined by acid base digestion method which involves the use of 1.25%  $H_2SO_4$  and 1.25% NaOH solutions (Agarwal, K. G. et al., 2013).

**Phytochemical:** Total phenolic content of the leaf extract was determined using Folin-Ciocalteau micro method. Alkaloid, content was measured by the method described by (Unuofin, J.O. et al., 2017). **Antioxidant Quantification:** The free radical scavenging ability of the leaf extract against 1, 1-diphenyl-2-picrylhydrazyl (DPPH) was evaluated according to (Ursini et. al., (1994), with slight modification. The reducing property of the extracts were determined by the method described by Pulido et. al., (2000).

**Antimicrobial Activities and Prebiotic potential:** Antimicrobial activity of the leaf extracts were determined by well diffusion method described by Hugo and Russel, (2004). E.coli and B.subtilis were used as test organisms. The maximum zone was inhibition based on the extract concentration was calculated.

Prebiotic potential was obtained by comparing the growth curve of the negative control i.e., without the addition of leaf extract in the broth with the test sample.

**Statistical Analysis:** Results obtained were analyzed using Microsoft excel (2007) and p-value and standard error of mean were obtained by using GraphPad software.

## Result and discussion

**Proximate Composition:** The moisture contents of the raw Ceylon Spinach leaves was highest compared to the other two leaves Ash content for Pumpkin leaves was low (27.2%) when compared to 32 % and 51.75% recorded for Mustard leaves and Ceylon Spinach leaves respectively. Ash content is a measure of total mineral content of the plant, hence it was observed that Mustard leaves and Ceylon Spinach leaves are better mineral sources.

Protein content was high for raw compared to blanched and cooked sample. This is because protein is a organic molecules and hence breaks down on heating. Moreover, different amino acid has different thermo-stability and water solubility due to which the decrease in the content is seen. The crude fiber content in the leaf sample is moderate, which significantly contributes to dietary intakes since fiber is known to lowers the body cholesterol level, as well as dietary fiber are seen to have prebiotic potential.

Fat content for Mustard leaves was slightly high compared to the other two leaves. Carbohydrate on the other hand was seen to be low. On blanching and cooking, little loss was seen which may be due to the loss of low molecular weight substances which can easily get leached in water.

Iron and vitamin C content were present in appreciable amount in the raw sample. Vitamin C is needed for Iron absorption, as it helps to convert ferric ion to ferrous ion which the body can easily utilize. On blanching and cooking of the leaves, iron and vitamin C content were seen to decrease because Vitamin C is highly sensitive to heat and moreover, it is a water soluble vitamin, hence, it leaches out in water. Iron is a heat stable mineral. But when wet heat treatment is involved, it leaches out in water. Thus decreases the content in the leaves.

Qualitative phytochemical showed the presence of phenol, alkaloid, flavonoids, anthroquinone in the raw sample, blanched and cooked leave sample. Quantitative test showed that polyphenol content of Ceylon Spinach leaves was the highest compared to the other two leaf extract. Polyphenol in leaves have seen to possess antioxidant activity, which will further help to prevent any degenerative disease by the presence of free radical. Alkaloid content was maximum in Mustard leaves. Alkaloid content has been studied to have an antimicrobial effect in the body. Alkaloids are natural occurring chemical compounds derived from plants which are reported to inhibit ATP-dependent transport of compounds across the microbial cell membrane, which leads to cell death. Polyphenol and Alkaloid content both were seen to reduce on blanching and cooking because on wet heat treatment of the leaves, cell matrix modification takes place which further changes the intracellular structure and cell wall permeability and thus allows the secondary metabolites to leach out in water.

Phytochemical have shown to have antioxidant property, hence to observe the amount of inhibition DPPH free radical assay was conducted, which showed highest free radical inhibiting in Ceylon Spinach leaves and Mustard leaves followed by the pumpkin leaves. The blanched and cooked leave were observed to have slightly lower inhibition rate which may be the result of decreased phytochemical due to the effect of wet heat treatment of leaves.

Antioxidant property was further measured using hydrogen peroxide scavenging assay, which revealed that raw Mustard leaves have higher potential to scavenge hydrogen peroxide compared to the other leaf extracts. On the other hand, blanched and cooked leaves showed slightly lower antioxidant activity, this may be due to the loss of water soluble and heat sensitive phyto-chemicals which plays a major role in curbing the presence of hydrogen peroxide or free radical and thus preventing the body from undergoing oxidative stress.

The prebiotic potential of the leaf extract was assessed by the use of a prebiotic strain (*Lactobacillus sp*). The study showed positive growth in all leaf extracts compared to the negative control, though the growth rate were slightly lower in blanched which were further decreased in cooked leaf extract. This may be due to the conversion of starch to a gelatinized form on heat treating and thus the bacterium were unable to use it for energy production and thus led to a reduction in growth rate.

Secondary metabolites are also responsible for antimicrobial activity. 1.5ml of concentrated mustard leaf extract was seen to inhibit maximum growth of gram negative bacteria compared to the gram positive bacteria. This may be because of the difference in the cell wall structure as gram negative bacteria has a thin wall of peptidoglycan compared to the gram positive bacteria.

## Conclusion

Based on the nutritional and functional evaluation study of the edible plant it can be summarized that the leaves are a good source of macronutrients, micronutrients as well as the non nutritive compounds known as the phyto-chemicals which exhibits antioxidant and antimicrobial properties which prevents the body from several lifestyle diseases. It was seen that leaf were retaining an appreciable amount of the nutrients and the secondary compounds on blanching and cooking. Thus, awareness regarding these under-utilized

leaves are needed to get all the added advantage from it as well is to prevent shortage of food supply.

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# **Development of edible cutlery**

*Mehak Kaushal and Adrija Sarkar*

## **ABSTRACT**

*Protein energy malnutrition (PEM) is a major public health problem in India. Inpatients, especially patients in the ICU, suffer from protein-energy malnutrition (PEM), together with immune system dysfunction, leading to involuntary weight loss exceeding about 10% and become highly physiologically obtrusive when weight loss exceeds about 15%. About 30%-50% of anemia in children and other groups is caused by iron deficiency. Because 1.6 billion people are anemic, several hundred million manifest iron deficiency anemia. Due to the high prevalence of PEM and anemia edible cutlery, rich in protein and iron was made in order to facilitate in quicker recovery of the inpatients. According to experts at the All India Institute of Medical Sciences, celiac disease affects close to six to eight million people in India. Therefore, it was tailored for celiac patients also, to whom consumption of gluten may cause damage to their small intestines. Edible cutlery is also an eco-friendly alternative to disposable utensils prepared with plastic, wood and bamboo, such as bamboo chopsticks, thus, preventing various environmental problems such has reducing ground water table, landfills, risk of animals consuming harmful substances, etc. It was made using ingredients which formed a product which was not only rich in protein and iron, but also was strong enough to lift food into the mouth. The taste of the spoons was carefully considered so that it did not impart its own flavor while eating food but also was tasty enough to be consumed all on its own after the meal. It was designed to be nutritious, tasty and easily available throughout the year, for the people belonging to all the strata of the society.*

**Keywords:** Edible spoons, Gluten-free, Iron rich, Nutrient analysis, Protein rich, Shelf-life

## **Introduction**

With an increase in urbanization women folks are stepping out for jobs, they hardly have time for cooking and washing utensils. The demand for plastic containers is increasing over the past few decades. The use of which is harmful to human body because of presence of toxins and carcinogens. This is also a matter of great concern, now days that the environment impact caused by the excessive quantity of non-degradable waste materials discarded every day.

Edible cutlery is trending way to overcome all these problems. This edible cutlery is also known as ready to eat because these do not need any further preparation nor do they require any pre use steps. Edible cutlery can be used as utensils and can be used to serve solid, semi-solids in it. They do not lose texture quickly. These are environment friendly as they can easily discarded or be eaten by animals. They can be eaten without serving anything or may be eaten after food. Edible cutlery can be customized and can be used for therapeutic purposes.

Legumes are one of the easily available sources nutrients such as iron and protein. Legume flours like chickpea flours are cheap, nutrient dense, and easily available all around the year. Other flours such

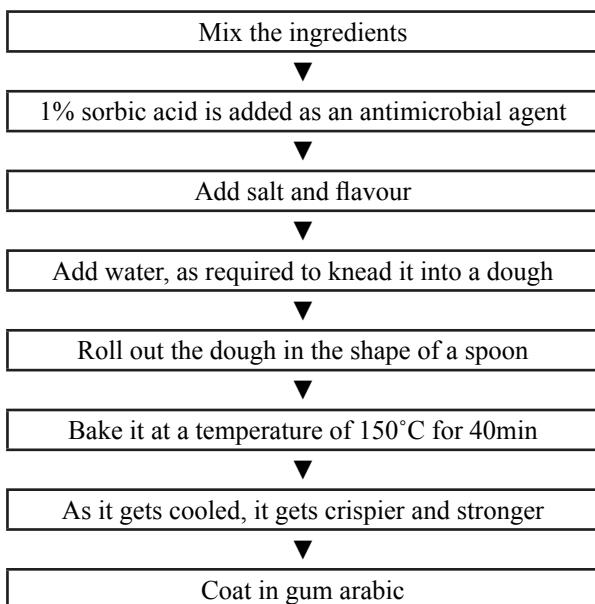
has soy flour are also rich in protein and are easily available at all time of the year.

## **Methodology**

The present study was conducted in the Department of Food Science and Nutrition Management, J.D. Birla Institute, Kolkata.

**Procurement of Samples:** Raw materials were inspected and sealed and branded materials (Soy flour, Chickpea flour, Whole wheat flour, Sunflower seeds, Sorbic acid, Kulekhara Leaves, Synthetic red food colour) were procured from local market of Kolkata.

**Processing:** Preliminary work was done to standardize the recipe for edible spoons by using different blends of a) soy flour, whole wheat flour and sunflower seeds b) chickpea flour and kulekhara leaves. These samples were further modified for celiac patients and were prepared without whole wheat flour. Chickpea flour and kulekhara leaves. The prepared samples were offered to panel members from J.D. Birla Institute to know best level of proportion of these blends. Unit operations that were used for the development of edible cutlery are explained below:



**Nutrient Analysis:** The final products were evaluated for physical as well nutritional constituents by using standard methods. The nutrients analyzed were- Protein content which was determined by the

Kjeldal Method. Iron content was determined using the Ferrozine method. Carbohydrate analysis was done by Anthrone method (Hedge, JE and Hofreiter, B T (1962). Fat analysis was done using Soxhlet (AOAC, 2000).

**Organoleptic Evaluation:** Edible spoons were evaluated for different sensory attributes by a panel of twenty five members of JD Birla Institute. Each panel members evaluated the products with respect to color, appearance, taste, texture and overall rating using a 9 point hedonic scale.

**Physical Estimation:** The edible spoons' physical capabilities to withstand different temperatures and not lose texture were measured. Shelf life was also tested under different conditions.

## Results & discussions

**Organoleptic Evaluation:** All the variations were scored by the panelists. The best variation in each of the four categories was then further analyzed for their nutritional content and physical analysis.

Table 1: Hedonic scores

Variations		Mean ±SD				
		Appearance	Color	Texture	Taste	Overall rating
NGP Basic	Natural	5.5±0.53	5±0	6.3±0.48	6.5±0.53	6.3±0.48
	Colored	7.4±0.7	9±0	7.6±0.52	6.5±0.53	6.7±0.48
NGP V.1	Natural	5.5±0.53	5±0	6±0.67	6.6±0.52	6.2±0.63
	Colored	7.4±0.7	9±0	7.5±0.53	6.6±0.52	6.4±0.84
NGP V.2	Natural	5.5±0.53	5±0	6.6±0.52	7.2±0.63	6.8±0.63
	Colored	7.4±0.7	9±0	7.8±0.42	7.2±0.63	7.1±0.99
NGP V.3	Natural	5.5±0.53	5±0	6.3±0.48	6.4±0.52	6.1±0.57
	Colored	7.4±0.7	9±0	7.6±0.52	6.4±0.52	6.4±0.84
NGP V.4	Natural	5.5±0.53	5±0	6.3±0.48	6.3±0.67	6.1±0.74
	Colored	7.4±0.7	9±0	7.6±0.52	6.3±0.67	6.3±0.95
NGF Basic	Natural	5.3±0.48	5±0	5.8±0.79	6.5±0.53	5.9±0.57
	Colored	7.5±0.53	9±0	7.4±0.52	6.5±0.53	6.1±0.57
NGF V.1	Natural	5.3±0.48	5±0	6.2±0.63	6.6±0.52	6.1±0.57
	Colored	7.5±0.53	9±0	7.5±0.53	6.6±0.52	6.4±0.7
NGF V.2	Natural	5.3±0.48	5±0	6.6±0.52	6.8±0.63	6.5±0.53
	Colored	7.5±0.53	9±0	7.7±0.48	6.8±0.63	6.7±0.95
NGF V.3	Natural	5.3±0.48	5±0	5.3±0.82	6.4±0.7	5.8±0.63
	Colored	7.5±0.53	9±0	7.3±0.67	6.4±0.7	6.1±0.57
NGF V.4	Natural	5.3±0.48	5±0	5.7±0.82	5.9±0.99	5.7±0.67
	Colored	7.5±0.53	9±0	7±0.67	5.9±0.99	6±0.67
GP Basic	Natural	6.7±0.48	5±0	7±0.82	6.6±0.7	6.6±0.7
	Colored	8±0	9±0	7.5±0.53	6.6±0.7	6.8±0.63

GP V.1	Natural	6.7±0.48	5±0	7±0.82	6.6±0.52	6.7±0.67
	Colored	8±0	9±0	7.6±0.52	6.6±0.52	6.9±0.57
GP V.2	Natural	6.7±0.48	5±0	7.1±0.74	7.3±0.48	7.2±0.92
	Colored	8±0	9±0	7.9±0.74	7.3±0.48	7.5±1.08
GP V.3	Natural	6.7±0.48	5±0	6.9±0.74	6.4±0.97	6.7±0.82
	Colored	8±0	9±0	7.7±0.67	6.4±0.97	7±0.94
GP V.4	Natural	6.7±0.48	5±0	7.4±0.7	6.1±0.88	6.4±0.84
	Colored	8±0	9±0	7.7±0.67	6.1±0.88	6.6±0.84
GF Basic	Natural	6.6±0.52	5±0	6.4±0.52	6.3±0.48	6.3±1.06
	Colored	7.9±0.32	9±0	7.2±0.42	6.3±0.48	6.5±1.18
GF V.1	Natural	6.6±0.52	5±0	6.4±0.52	6.4±0.52	6.3±0.82
	Colored	7.9±0.32	9±0	7.2±0.42	6.4±0.52	6.4±0.97
GF V.2	Natural	6.6±0.52	5±0	6.9±0.57	7.2±0.79	6.5±0.71
	Colored	7.9±0.32	9±0	7.6±0.7	7.2±0.79	6.8±1.23
GF V.3	Natural	6.6±0.52	5±0	5.4±0.74	6±0.67	6.2±0.42
	Colored	7.9±0.32	9±0	7±0.67	6±0.67	6.3±0.48
GF V.4	Natural	6.6±0.52	5±0	5.5±0.82	5.7±0.67	6±0.47
	Colored	7.9±0.32	9±0	6.6±0.52	5.7±0.67	6.1±0.32

The overall rating of a product is the score which the evaluator gives on a whole, by keeping in mind all the previously discussed attributes of the evaluation process. From table 1, it was observed that the colored variation of the GP V.2 was overall the most acceptable sample. Amongst each category, the colored samples of NGP V.2 in the non-gluten protein rich category, NGF V.2 in the non-gluten iron rich category, GP V.2 in the gluten protein rich category, GF V.2 in the gluten iron-rich category, were most liked. The non-colored variations of NGF V.3 and V.4 had obtained the lowest score. NGP V.4 had persistently scored low due to the bitter aftertaste because of ‘besan’, rough texture, thus had low overall rating and was not generally acceptable.

## Proximate Estimation

Table 2: Nutritional analysis of the samples

Variation	Protein (g/100g)	Fat (g/100g)	Carbo-hydrate (g/100g)	Iron (ug/dl)
Protein rich (non-gluten)	12.7	29.5	55	49.3
Protein rich (gluten)	12.67	18.7	51	32.40
Iron rich (non-gluten)	11.07	16.5	22	43.67
Iron rich (gluten)	10.45	13.4	22.9	30.98

From table 2 it can be observed that, the carbohydrate content of the protein rich (non-gluten) cutlery was the highest, this could be because the combination of sunflower seeds and soy flour contain high amount of carbohydrate and were used in the highest amount as compared to other variations. The carbohydrate content of iron rich (non-gluten) cutlery was the lowest. This could be because it contained soy flour and sunflower seeds in the least amount and had moderate amount of chickpea flour, which was low in carbohydrate content as compared to other cereals used in the product. All the samples had protein contents in the range of 10.45 to 12.70g. In the non-gluten variations of each category, i.e., protein rich and iron rich cutlery, the protein content was observed to be higher than the cutlery which did contain gluten. The reduced amount of protein in gluten containing products resulted from gliadin and gluten in interference with gluten formation by the presence of legume proteins. Thus, the legume protein disrupted the well-defined protein-starch complex. Thus, resulting in lowest amount of protein in iron rich (gluten) variation (Tsen et. al. 1971). Almost the same amount of protein was found in protein rich, non-gluten and gluten variations. This could be because the NGP variation contained high amount of soy flour, which is rich in protein and the GP variation that contains comparatively lower amount of soy flour, the amount of protein was compensated by whole wheat flours' gluten. Hence, they contained highest amount of protein amongst the other variations.

The NGP has the highest fat content, whereas, GF contained the lowest fat content. The high fat content could be attributed to the addition sunflower seeds used in the highest amount in NGP. The fat content of sunflower seeds is 50g/100g. It enriched the product with polyunsaturated fatty acids. The low amount of fat content was seen as GF contained high amount of 'kulekhara' leaves, thus, containing much lesser amount of sunflower seeds. 'Kulekhara' leaves contain negligible amount of fat, thus, the lowest fat content in GF.

## Physical Analysis

### Optimum temperature and durability of texture

Table 3: Durability of samples at different temperatures

Variation	Temperature			
	5°C	27°C	50°C	70 °C
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From the above data it was observed that the gluten and the non-gluten variations of the samples stayed durable for the longest time at 27°C for 45 minutes, without losing its texture or getting soggy. At 70°C the duration for which the samples could last the longest was for 27 minutes, by gluten variation. A general difference of 1-2 minutes was seen between the gluten and the non-gluten variations, wherein, the gluten variations lasted a little longer than their counterparts. This could be because of an error while noting the time for the NG variations.

NGF V.2 has the highest amount of iron content, this could be because it contained the highest amount of 'kulekhara' leaves as compared to the other variations. 'Kulekhara' leaves is the richest source of iron amongst green-leafy vegetables (Mukherjee, et.al. 2017). It also contained chickpea flour, which is a known source of iron. The least amount was found to be in NGP V.2, as its main ingredients were sunflower seeds and soy flour, which contain a low amount of iron content (Wood, 2007)

## Shelf Life

Table 4: Shelf life of samples under different conditions

Temperature	Condition	Shelf – life (tested for 3months)
Room temperature	Unsealed	1.5 months
Room temperature	Sealed in an airtight container	3 months
Refrigerated (4°C)	Unsealed	3 months
Refrigerated (4°C)	Sealed in an airtight container	3 months

From the data above it can be observed that if the samples are kept open, they have a lesser shelf-life of 1 1/2 months. This could be because they are in direct contact with moisture in the environment, which seeps into the sample, making it soggy. Thus, the sample had a low durability of texture when left

open. On the other hand, if the sample was kept in the refrigeration, without sealing, it had a minimum shelf life of 3 months. The increase in the shelf life upon changing the environmental conditions was seen due to a lowered temperature which controlled the growth of microbes on the sample and did not allow direct contact of air with the sample. When the samples were sealed properly in an air tight container, they were observed to have a minimum shelf life of 3 months, irrespective of their storage conditions, i.e., kept openly or refrigerated. This was because an airtight container provided the samples with a controlled atmosphere and minimum moisture contact to which they were being exposed.

**Costing:** The cost of ingredients costing of the final product was done by adding the cost of the ingredients, Labour cost (10%), overhead cost (20%), profit (20%). Cost of each type of cutlery was as following:

Table 5: Costing

	No-Coloured Cutlery (20g)	Coloured Cutlery (20g)
NGP V.2	Rs 4.7	Rs 4.8
GP V.2	Rs 3	Rs 3.1
NGF V.2	Rs 4.4	Rs 4.5
GF V.2	Rs 3.7	Rs 3.8

The cost the most expensive spoon, NGP V.2 (colored) is Rs 4.72 and the lowest is of GF V.2 (natural) Rs 2.6. The product targets the high income groups.

## Conclusion

The aim was to prepare and develop cutlery, rich in protein and iron, which was also modified for celiac patient. People prefer plastic cutlery for a number of reasons, e.g. it is cheap, ready to use, firm enough to lift food, food at all temperatures can be consumed using plastic cutlery and all types food, solid, liquid can be consumed with plastic cutlery. Therefore, for people to invest in edible cutlery, these properties of plastic cutlery had to be incorporated in it along with it being eco-friendly and cheaper. The ingredients that were used in order to prepare the cutlery were chosen such that they were easily available in the market, at all time of the year, along with being rich in essential nutrients. Therefore, edible cutlery was successfully prepared, fulfilling the aim and objectives.

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# Pathogenic Profile of Green Coloured Vegetables Using Different Washing Procedures

Beepsa Basu and Anindita Deb Pal

## ABSTRACT

*Green Vegetables and their Ready-To-Eat (RTE) salads are an important source of nutrients, but they can host a large microbial population, particularly bacteria. Fresh green vegetables carry the potential risk of microbiological contamination due to the poor handling practices, usage of untreated irrigation water or failure during harvesting, handling, processing and packaging anywhere from the farm to the fork. Appropriate washing can mitigate the risk of food borne illness consequent to vegetable consumption by reducing pathogen levels. Therefore, the study analyses the effectiveness of different domestic washing methods (hot water, salt water, tap water, and vinegar) in reducing microbial levels in RTE green vegetable samples. A combination of differential and selective agar mediums were utilized to characterize the microbes present as well as to assess the efficiency of various washing process in minimizing the microbial load. All samples were found to harbour a greater number of gram positive bacteria compared to gram negative bacteria. Results showed that washing with hot water (70°C) in combination with salt (8%) produced the maximum reduction in the number of microorganisms in all the vegetables studied. The Colony Forming Units present on the outer surface of the vegetables reduced to 49±0.4, 44±0.9, 33±0.5, 19±0.6, 29±0.7, and 49±0.9 in Capsicum, Cucumber, Broccoli, Coriander, Parsley and Lettuce respectively compared to 1838±1.8, 1780±0.8, 1885±0.7, 2000±1.6, 1498±1.2 and 1751±1.2 in the untreated samples. This present analysis attempts to increase awareness among consumers about health hazards of food as well as effective methods of sanitization which in turn could minimize the associated health risks.*

**Keywords:** Foodborne, Gram positive, microbes, vegetables, washing

## Introduction

Vegetables play an important role in human nutrition. They supply dietary fibre and are important sources of essential vitamins, minerals, and trace elements. Inclusion of vegetables in a balanced diet has been found to reduce incidences of several diseases including cancer, stroke, cardiovascular disease, gastrointestinal disorders and other chronic ailments. (Thunberg et. al., 2012). The USDA Dietary Guidelines recommends daily consumption of five to nine servings of fruit and vegetables, although the total amount consumed varies according to age and gender (Bertoia et. al., 2016). Green coloured vegetables are ideal for weight management as they are typically low in calories. Although less in their fat content, these vegetables are rich sources of dietary fibre, folic acid, Vitamin C, potassium and magnesium. Moreover, they host a range of phytochemicals such as lutein, beta-cryptoxanthin, zeaxanthin, and  $\beta$  carotene (Aldoori et. al., 2018). Lutein, zeaxanthin and  $\beta$  carotene are important in maintaining eye health and protect against incidences of macular degeneration and cataract. Additionally they have also been portrayed to prevent against cancers of breast, lungs and other tissues. (Christen et. al., 2015).

Since green vegetables are one of the most commonly consumed crop worldwide, it can be targeted as an easy carrier of pathogens due to inappropriate handling. This in turn questions on their safety aspect. A range of fresh vegetable products including lettuce, cauliflower, sprouts; mustard cress, endive and spinach have been implicated in *Salmonella* infection (Poppe et. al., 2014). *Escherichia coli* O157:H7 is commonly recovered from the faeces of ruminants. Livestock grazing in orchards may contaminate capsicum and broccoli florets culminating in proliferation of this bacterium in the vegetable tissues (Sagoo et. al., 2013). Indeed, *E. coli* has been associated with the outer skin of green vegetables (Janisiewicz et. al., 2017). Moreover, *Campylobacter* infection has been severely linked to consumption of contaminated leafy and non leafy greens. (Wang et. al., 2014). Furthermore, *Aeromonas* sp has been isolated from a wide range of fresh produce including sprouted seeds, asparagus, broccoli, cauliflower, carrot, celery and cucumber (Farvid et. al., 2016). Apart from gram negative coliforms, gram positive bacteria have been profoundly associated with green coloured vegetables. *Listeria* sp. is ubiquitous in the environment and can be isolated from soil, water, faecal matter and vegetation irrigated with contaminated water. The potential for environmental

Listeria to contaminate fresh produce and lead to enteric infection has long been recognized (Heaton et. al., 2013). Listeria monocytogenes grows at refrigeration temperatures and is hence likely to multiply during storage if present on fresh produce. It is capable of growing on lettuce when exposed to processing conditions. (Warriner et. al., 2016). Other gram positive isolates associated with green vegetables include *Brevibacillus laterosporus*, *Lactobacillus* sp, *Bacillus licheniformis*, *B latus* and *B cereus* (Godon et. al., 2015) Additionally, cultures of *Streptococcus faecalis*, *S liquefaciens* and *Staphylococcus aureus* have been reported in fresh green beans (Pzzuto et. al., 2016). Therefore direct consumption of raw vegetables without appropriate washing may increases the potential of food borne diseases.

Green salad vegetables have now become an attractive choice not only because of their nutritive values but also since most of them can be consumed either raw or with minimal processing. Green vegetables carry the potential risk of microbiological contamination due to the usage of untreated irrigation water, inappropriate organic fertilizers, wildlife or other sources that can occur anywhere from the farm to the fork such as failure during harvesting, handling, processing and packaging. Faecal material, soil and other inputs such as sewage overflow introduce pathogens directly to watercourses from which irrigation water may be extracted. Pathogens within soil may contaminate crops directly during heavy rain or irrigation. The present study enlightens the presence of pathogens on the outer skin of green vegetables that can be mostly eaten raw in the form of salads. Maintenance of proper hygiene and sanitation is principal towards preserving good health and limiting the development of diseases. Previous researches have reported chemicals like peracetic acid, percitric acid, sodium bicarbonate and sodium hypochlorite to reduce *Salmonella* and *Listeria* counts. (Valentin-Bon et.al., 2018) However these treatments were found to be effective only at high concentrations. This investigation therefore attempts to study the effectiveness of different washing procedures in controlling microbes using reagents available at the domestic scale. Moreover, care was taken to ensure maximum reduction of microbial numbers without compromising the vegetable quality. This study attempts to add on to the limited researches carried out on the safety assessment of green vegetables and provide valuable tools to limit food associated

disorders. Maintenance of appropriate hygienic practices including effectively washing vegetables prior to consumption may aid towards improved health and wellbeing of the population at large.

## Methodology

**Sample Preparation:** The green coloured vegetable samples used for microbial analysis (Table 1) were dissolved in peptone water (Peptone powder 15g, and distilled water 150ml). The media was sterilized using an autoclave. 5g of sample was grinded in a previously sterilized mortar pestle, until a uniform mixture was obtained and mixed in peptone solution for 48 hours followed by filtration through Whatman filter paper to obtain a clear extract. The extract was stored at 4°C until further use.

Table 1: Green coloured vegetable samples analyzed

Green vegetables	Sample Codes	No. of samples
Green Capsicum ( <i>Capsicum annuum</i> )	A	3
Cucumber ( <i>Cucumis sativus</i> )	B	3
Broccoli ( <i>Brassica oleracea var. italica</i> )	C	3
Coriander ( <i>Coriandrum sativum</i> )	D	3
Parseley ( <i>Petroselinum crispum</i> )	E	3
Lettuce ( <i>Lactuca sativa</i> )	F	3
	Total	18

**Microbial Analysis:** The media were prepared and then sterilized at a temperature of 121°C and a pressure of 15 psi for 15 minutes. A combination of selective and differential agars was selected for evaluating the presence of pathogens on outer surface of vegetables. Nutrient agar, MacConkey agar, Malachite Green agar and Mannitol Salt agar were used to enumerate and characterize microorganisms. While Nutrient agar is a general purpose, non selective media, MacConkey agar and Malachite Green agar was utilized for isolation of gram negative and positive bacteria respectively. Mannitol Salt agar was used to select for gram positive cocci. All samples were pour plated onto the respective agar medias and incubated for growth at 37°C for 48 hours.

**Washing procedures:** Several types of washing procedures were employed as follows:

**Tap water washing:** 5g of the samples was thoroughly rinsed under running tap water for 2 minutes at room temperature.

Hot water washing: 5 gm of sample was soaked in 100ml of hot water ( $70^{\circ}\text{C}$ ) for 2 minutes.

Vinegar washing: 5 gm of sample was soaked in vinegar (5%) for 2 minutes.

Salt water washing: 5 gm of sample was soaked for 2 minutes in table salt solution (2%, 4%, 6%, 8% and 10%).

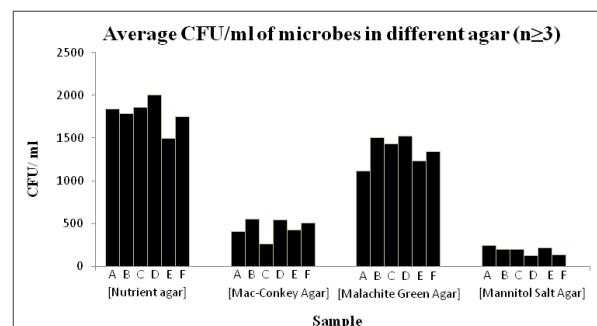
Commercial sanitizer: 5 gm of sample was soaked for 2 minutes in a solution prepared by adding 2 drops of the commercial formula (FSSAI approved; lic no. 11517034000917) in 100ml of water. This was taken as a positive control.

Statistical analysis: The data was represented as CFU/ml (mean  $\pm$  SEM) of  $N \geq 3$ . P value was evaluated using ANOVA Data analysis pack of Microsoft Excel (version 2007). data was analyzed at 95% Confidence interval and  $P \leq 0.01$  was considered as significant.

## Results and discussion

Microbial content of green coloured vegetables: Raw vegetables harbor huge numbers of microbial colonies which can host a range of pathological outcomes. Food borne pathogens can contaminate raw vegetables at any stage of their production process with a potential for human infection. The culture mediums were prepared followed by inoculation of samples into each agar. Nutrient Agar showed the growth of big circular red colonies in all the raw samples (Figure 1). The samples were inoculated on MacConkey Agar as it is specific for the growth of gram negative microbes especially Escherichia coli and other lactose fermenting Coliforms, revealing a characteristic red colour of the colonies. The crystal violet and bile salts present in its preparation are attributed for their selective action. Malachite Green Agar was utilized for the selective enrichment of gram positive microorganisms especially Bacillus, and Staphylococcus. A significant number of milky white colonies were observed in raw samples of the leafy and non leafy vegetables indicating improper handling of the vegetables. Cross contamination with the irrigated water and sewage accelerate the deterioration of the food quality whereas unhygienic practices, high moisture content and water activity generate favorable conditions for the growth of

bacteria. Moreover all vegetables displayed a higher content of gram positive microorganisms compared to their gram negative counterparts (Figure 1). The thick peptidoglycan layer may impart increased resistance and survivability in the former accounting for the above. Since the streaking on Malachite Green agar indicated the presence of coagulase-positive species, especially *Staphylococcus* sp., samples were plated onto Mannitol Salt Agar which facilitates the growth of *Staphylococcus* family, a major opportunistic foodborne pathogen. Results revealed the occurrence of *Staphylococcus* sp in the vegetables analysed.



## Tap Water Washing

Appropriate washing can reduce the risk of food borne illness consequent to vegetable consumption by minimizing pathogen levels. The six green vegetable samples were washed with tap water at room temperature for 2 minutes and plated on agar mediums to determine the effectiveness of this method in reducing microbial colonies. Untreated controls were designated as "U" and samples treated with tap water were indicated as "T". The reductions in the bacterial content indicated the detachment of microorganism from the outer skin of the vegetables due to the mechanical force of the running tap water treatment. The attachment of microorganisms to the vegetables seems to be governed by physical factors irrespective of the physiological state of the microorganisms. Thoroughly rinsing fresh produce vegetables under running water is an effective way to reduce the number of microorganisms. Therefore treatment of samples with running tap water reduced the microbial numbers compared to the untreated ones (Table 2). Samples treated with positive control showed negligible numbers of microbial colonies on these culture mediums (data not shown).

Table 2: Total Viable Count (TVC) of microbes after Tap Water washing

Sample	Nutrient Agar		Mac-Conkey's Agar		Malachite Green Agar		Mannitol Salt agar	
	U	T	U	T	U	T	U	T
A	1838± 1.8***	1246± 3.3**	403± 2.5***	149± 1.4**	1116± 2.5***	500 ± 3.4**	248± 2.3***	102± 1.2**
B	1780± 0.8***	1340± 0.8***	553± 4.1***	278± 2.4**	1500± 2.8**	349 ± 2.5**	202± 3.1**	101± 4.2**
C	1885± 0.7***	1253± 2.2***	266± 2.5**	223± 4.1**	1401± 1.3**	1005 ± 3.7**	200± 2.9**	91± 1.8**
D	2000± 1.6***	1050± 1.6***	546± 2.8**	174± 0.9**	1518± 2.1**	920 ± 3.2**	125± 3.7**	97± 0 .7**
E	1498± 1.2***	886± 2.4***	503± 4.1**	305± 2.4**	1233± 3.2**	1085 ± 2.1**	220± 4.2**	75± 2.1**
F	1751± 1.2***	1235± 0.8***	400± 2.6**	150± 2.9**	1343± 1.4**	886± 2.0**	138± 0.8**	94± 2.6**

#### Vinegar Water Washing

Treatments of the vegetable samples with vinegar decreased the bacterial numbers on the vegetables (Table 3). The acetic acid chemically interacts with proteins and other important biomolecules inside the bacterial cells causing them to lose their native structure resulting in increased control with respect to tap water washing (Table 2). However,

this treatment can only control the neutrophilic microorganism having little effect on the acidophilic ones. Moreover, the effectiveness of the washing method also depends on the growth phase of the cells, where logarithmic growth phase cells were more sensitive and easily killed than stationary phase cells.

Table 3: Total Viable Count (TVC) of microbes after vinegar washing

Sample	Nutrient Agar		Mac-Conkey's Agar		Malachite Green Agar		Mannitol Salt agar	
	U	T	U	T	U	T	U	T
A	1838± 1.8***	593± 6.4**	403± 2.5***	81± 0.6**	1116± 2.5***	263± 1.5**	248± 2.3***	93± 0.6**
B	1780± 0.8***	515± 0.7***	553± 4.1***	161± 1.7***	1500± 2.8**	220± 1.3***	202± 3.1**	72± 0.6***
C	1885± 0.7***	565± 0.8**	266± 2.5**	105± 2.2**	1401± 1.3**	901± 2.8**	200± 2.9**	65± 2.1**
D	2000± 1.6***	550± 0.8**	546± 2.8**	65± 0.8**	1518± 2.1**	506± 0.7**	125± 3.7**	50± 0.4**
E	1498± 1.2***	561± 1.1**	503± 4.1**	91± 0.6**	1233± 3.2**	761±3.6**	220± 4.2**	61± 1.6**
F	1751± 1.2***	681± 2.3**	400± 2.6**	141± 2.9**	1343± 1.4**	523±1.8**	138± 0.8**	71± 2.1**

**Hot Water Washing:** Washing with hot water (70°C for 2 minutes) lead to a significant reduction of the food borne pathogens from the outer skin of the vegetable samples analyzed. Moreover, the efficacy of this method was found to be higher in terms of decreasing the microbial load compared to tap water and vinegar washing. Since majority of the bacteria present on the surface of vegetables are mesophilic, the temperature of this treatment diminishes the rate of their multiplication and therefore survival.

The increased temperature of hot water may be causing inactivation of enzymes, degradation and as well denaturation of proteins and other cellular macromolecules accounting for a lower yield (Table 4). Moreover, the time for treatment was standardized such as to obtain maximum reduction without compromising the quality of the samples. Hot water washing displayed a marked reduction in all the agar mediums studied showing its efficacy against both gram positive and negative bacteria.

Table 4: Total Viable Count (TVC) of microbes after Hot Water washing

Sample	Nutrient Agar		Mac-Conkey's Agar		Malachite Green Agar		Mannitol Salt agar	
	U	T	U	T	U	T	U	T
A	1838±1.8***	113± 1.7**	403± 2.5***	24± 0.8 **	1116± 2.5***	155± 1.2**	248± 2.3***	50± 0.6**
B	1780±0.8***	1340± 0.8***	553± 4.1***	50± 0.7**	1500± 2.8**	133± 1.7**	202± 3.1**	52± 0.8**
C	1885±0.7***	1253± 2.2***	266± 2.5**	83± 2.51**	1401± 1.3**	184± 0.8**	200± 2.9**	59± 2.6**
D	2000±1.6***	1050± 1.6***	546± 2.8**	44± 0.9**	1518± 2.1**	385± 1.4**	125± 3.7**	42± 0.4**
E	1498±1.2***	886± 2.4***	503± 4.1**	60± 0.8**	1233± 3.2**	213± 2.8**	220± 4.2**	42± 0.4**
F	1751±1.2***	1235± 0.8***	400± 2.6**	53± 1.7**	1343± 1.4**	214±1.05**	138± 0.8**	48± 1.2**

Salt Water Washing: Salt water washing (4%) showed the best result with respect to reduction of microbial numbers compared to all other washing methods employed (Table 5). The salts may be responsible for control of microorganism through the process of dehydration and osmosis. High concentration of salt leads to loss of moisture from

the bacterial cells resulting in loss of cell structure and alteration in cell physiology and metabolism which may eventually lead to cell death. Salt water washing showed the maximum decrease in gram negative and gram positive microbes including *Staphylococcus* sp as tabulated in Table 5.

Table 5: Total Viable Count (TVC) of microbes after salt water washing

Sample	Nutrient Agar		Mac-Conkey's Agar		Malachite Green Agar		Mannitol Salt agar	
	U	T	U	T	U	T	U	T
A	1838±1.8***	113± 1.2***	403± 2.5***	14± 0.7***	1116± 2.5***	102± 0.7***	248± 2.3***	40± 0.5***
B	1780±0.8***	150± 0.5**	553± 4.1***	25± 0.8**	1500± 2.8**	129± 0.8**	202± 3.1**	47± 0.9**
C	1885±0.7***	189± 1.1***	266± 2.5**	66± 1.2***	1401± 1.3**	161±1.2***	200± 2.9**	42± 1.2***
D	2000±1.6***	170± 0.8**	546± 2.8**	25± 0.9**	1518± 2.1**	372± 1.9**	125± 3.7**	33± 1.9**
E	1498±1.2***	190± 0.7**	503± 4.1**	39± 1.2**	1233± 3.2**	202± 2.3**	220± 4.2**	39± 1.3**
F	1751±1.2***	248± 0.8**	400± 2.6**	71± 1.2**	1343± 1.4**	195± 2.2**	138± 0.8**	35± 1.4**

Hot water combined with salt washing: Since the above data clearly implicated hot water and salt water treatment to perform best in terms of reducing the microbial load, it was further evaluated whether combining the above could lead to a better control compared to the individual methods. Additionally, the efficacy of this treatment procedure was also checked across a range of salt concentrations in order to analyze the best combination bringing about maximum control. It was indeed observed that washing the vegetables with hot water

combined with salt resulted in an improved reduction of microorganism compared to either of the individual methods (Table 6). An increase in salt concentration increased the control efficiency of the above treatment. However, a further increase in salt concentration beyond 8% caused no further significant decrease in the microbial numbers (Table 6). Therefore, a salt concentration of 8% accompanied with hot water was found to bring about maximum control of bacterial numbers.

Table 6: Total Viable Count (TVC) of microbes after hot water combined with salt water washing

Sample	Untreated	Hot water (70°C)	Salt water (4%)	Hot water +Salt water (2%)	Hot water +Salt water (4%)	Hot water +Salt water (6%)	Hot water +Salt water (8%)	Hot water +Salt water (10%)
A	1838± 1.8***	113± 1.2***	102± 1.2***	98± 1.9*	81± 1.7*	72± 0.9**	49±0.4**	47± 0.5**
B	1780± 0.8***	150± 0.5**	127± 0.5***	120± 1.5**	80± 0.7**	67± 2.5**	44±0.9**	40± 1.4**
C	1885± 0.7***	189± 1.1***	101± 1.1***	96± 0.8**	87± 0.5**	75± 0.8**	33±0.5**	33± 0.3**
D	2000± 1.6***	170± 0.8**	123± 0.8**	94± 0.9**	60± 0.8**	49± 0.9**	19± 0.6*	18± 0.7*
E	1498± 1.2***	190± 0.7**	139± 0.7**	101± 1.8**	74± 1.2**	61± 0.8**	29±0.7**	26± 0.8*
F	1751± 1.2***	248± 0.8**	205± 0.8**	167± 2.1**	100± 1.8*	93± 0.5**	49±0.9**	47± 0.6**

## Conclusion

In India, recent food borne illness outbreaks have revealed links between some pathogens and some leafy green vegetables such as mostly lettuces, coriander and cucumber and their RTE salads since fresh leafy green vegetables carry the potential risk of microbiological contamination due to the usage of untreated irrigation water, inappropriate organic fertilizers, wildlife or other sources that can occur anywhere from the farm to the fork such as failure during harvesting, handling, processing and packaging. Considering this common salad items has been chosen and undergone lab analysis in defined manner which revealed the abounded growth of gram positive bacteria. Only appropriate washing can mitigate the risk of food borne illness in consequent to vegetable consumption by reducing pathogen levels. In this present work, four different washing methods, (Hot water, salt water, tap water, vinegar) were evaluated for their efficiency in reducing pathogenic levels. Results showed that washing with Hot water and salt water was the best and the most effective method in achieving the above. This highlights the importance of safe washing practices to circumvent vegetable contamination by food borne pathogens. This project summarizes current observations concerning the contaminated leafy green vegetables and their RTE salads as important vehicles for the transmission of some foodborne pathogens to humans.

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# **Formulation and Evaluation of Low Cost Value Added Product**

Banhishikha Roy and Manika Das

## **ABSTRACT**

*Malnutrition is a major health problem from decades in many developing countries due to insufficient affordability of food among low socio-economic people. Recent studies shows that worldwide three-quarters of children died of malnutrition related problems whereas about 1.3 billion tons of food is lost or wasted starting at the production stage and ending at the consumer domain in every year. In India Cauliflower, Turnip, Radish and Peas are widely used vegetables grown abundantly. But the leaves and pods of these vegetables are generally discarded. Research revealed that they are rich in proteins, vitamins, minerals and phenolic compounds which also have antioxidant properties. In this study, unused portion of vegetables (mainly leaves and pods) which are generally discarded in bins were used to develop a product, which can combat the nutritional deficiency of the low-socioeconomic population. Different variations of Aloo tikki and Savoury pancakes were prepared by using different unused leaf of cauliflower, turnip, radish and pea pods. Aloo tikkis were made by chopped and sautéed fresh leaves. Pancakes were made by using the sun dried leaves for 10- 12 days. Sensory evaluation was conducted by using 9 point hedonic rating scale by 20 panel members to evaluate the organoleptic properties (appearance, taste, texture, colour and overall rating). Biochemical analysis was performed to estimate the nutritive value of the best variant of product. The results showed that accepted variations of products were not only rich in macro nutrients such as protein, carbohydrate, and fat but also contain significant amount of micro nutrients such as calcium, iron, vitamin A, vitamin C and bioactive components. So it can be concluded that nutrients dense product can be used for the benefit of malnourished people among the low socio-economic group.*

**Keywords:** Food product, Malnutrition, unused portion of vegetables

## **Introduction**

In India more than half of the children (58%) are underweight, while Indian women between 15 to 49 years of age and 79% of children of age group between 6 to 35 months' age are anaemic (inadequate amount of haemoglobin in the blood). World Health Organization (WHO) defines malnutrition as "the cellular imbalance between the supply of nutrients and energy and the body's demand for them to ensure growth, maintenance, and specific functions". Malnutrition is a disease condition that occurs when the nutrients are not consumed in the correct proportion as required by the body and deficiency of macro and micro nutrients results. Inadequate and improper nourishment of children leads to under-nutrition and other micronutrient deficiencies in low socio-economic group.<sup>(1)</sup> Green leafy vegetables are cheapest as well as rich sources of vitamins such as carotene, ascorbic acid, riboflavin, folic acid and minerals such as iron, calcium, phosphorous and phenolic compounds, which include phenols, flavonoids, alkaloids, tannins, terpenoids, coumarins, and glucosinolates which can nourish the increasing population.<sup>(2)</sup> Nutritionists are encouraging both rural and urban sector people to consume green leafy vegetables in recipes to combat with these micronutrient deficiencies. The main reason for macro and micronutrient deficiency in

developing countries is food security while about 1.3 billion tons of food is lost or wasted starting at the production stage and ending at the consumer domain in every year.<sup>(3)</sup> Though more than one million tons of vegetable trimmings and unused portion of vegetables from the vegetable processing industry are produced and which can be used for value addition but there are many children, women and geriatric people, in low social status suffering from micro and macro deficiency because of poor diet and ill health. The unused portion of vegetables help in formation and inspiring the blood and prevent symptoms of anaemia and possess antioxidant, anti-bacterial activity and several bioactive components that enhance DNA repair, act as an estrogens antagonist, slowing the growth of cancer cells and detoxify the unwanted metals and impurities of our body, found in modern highly processed diet [4]. The aim of the study was to prepare a low cost food with good nutritional quality, seeking to reach the low-income population. The development of food products with functional activity is challenges that are becoming more attractive to scientific research. So the present study was carried out as there is very scanty literature available on the use of the unused portion of green leafy vegetables, especially cauliflower, radish, turnip and pea waste together in food production.

## Methodology

**Materials:** Sample collection: Vegetables were collected from the local market of Kolkata, India. The leaves and peels were finely chopped and they were sautéed.

**Reagents required:** Bovine Serum Albumin (BSA), Biuret reagent, Anthrone reagent, petroleum ether, 2,6-dichloro indophenols dye, metaphosphoric acid, Folin- Ciocalteau reagent, DPPH (2,2- diphenyl-1-picrylhydrazyl) reagent.

**Product Development:** Aloo Tikki was chosen for product development. Basic ingredients and recipe is presented in (Table 1). Different variations were tried by incorporating different peels and unused leaves of vegetables with varying amounts of 10 gram, 20 gram, and 30 gram individually which was incorporated in the standard recipe of Aloo Tikki. Other combinations were made with all the unused portion of leaves and peels 2 grams each and also with replacement of sattu. (Table 2).

Table 1: Basic Recipe/ Basic ingredients used for making Aloo Tikki

Ingredients	Amount (gm/ml)
Potato	100 gm
Red chilli powder	1.25 gm
Whole wheat flour	15 gm
Oil	2.5 ml
Salt	5 gm

Table 2: Different variation of Aloo Tikki (by addition or replacement of ingredients

Types of Variation	Variation Description
Variation 1.a)	Basic recipe + 10 gm cauliflower leaves.
Variation 1.b)	Basic recipe + 20 gm cauliflower leaves.
Variation 1.c)	Basic recipe + 30 gm cauliflower leaves
Variation 2.a)	Basic recipe + 10 gm radish leaves.
Variation 2.b)	Basic recipe + 20 gm radish leaves.
Variation 2.c)	Basic recipe + 30 gm radish leaves.
Variation 3.a)	Basic recipe + 10 gm turnip leaves
Variation 3.b)	Basic recipe + 20 gm turnip leaves
Variation 3.c)	Basic recipe + 30 gm turnip leaves

Variation 4.a)	Basic recipe + 10 gm pea pods.
Variation 4.b)	Basic recipe + 20 gm pea pods.
Variation 4.c)	Basic recipe + 30 gm pea pods.
Variation 5.a)	Basic recipe + 2 gm cauliflower leaves + 2 gm radish leaves+ 2 gm turnip leaves + 2 gm pea pods.
Variation 5.b)	Basic recipe + 4 gm cauliflower leaves+ 4 gm radish leaves+ 4 gm turnip leaves + 4 gm pea pods.
Variation 5.c)	Basic recipe + 6 gm cauliflower leaves + 6 gm radish leaves + 6 gm turnip leaves+ 6 gm pea pods.
Variation 6.a)	Basic recipe + sattu replaced with whole wheat flour + 2 gm cauliflower leaves + 2 gm radish leaves+ 2 gm turnip leaves+ 2 gm pea pods.
Variation 6.b)	Basic recipe + sattu replaced with whole wheat flour + 4 gm cauliflower leaves + 4 gm radish leaves+ 4 gm turnip leaves+ 4 gm pea pods.
Variation 6.c)	Basic recipe + sattu replaced with whole wheat flour + 6 gm cauliflower leaves + 6 gm radish leaves+ 6 gm turnip leaves+ 6 gm pea pods.

**Sensory Evaluation:** The standard product and all the variations was evaluated organoleptically for different quality attributes (colour, appearance, texture, taste, and odour) and overall acceptability by 20 panel members using 9 point hedonic scale.

**Chemical Analysis:** The standard and approved products as chosen by the panel members were chemically analysed for their Moisture Content, Ash Content, Protein, Fat, Carbohydrate, Iron, Calcium, Vitamin C, Beta Carotene, Phenolic Compounds, DPPH radical scavenging activity, reducing power property.

**Determination of moisture and ash content:** Moisture content of the products was determined by drying sample in a pre-weighed crucible in a hot air oven at 130-133°C for two hours. Then the weight was checked after 2 hours subsequently in every hour until the weight of the crucible becomes constant after intervals. Ash content of the products was determined by placing the measured amount of sample in a pre-weighed crucible in a muffle furnace at 600°C for 3 hours.

Determination of macronutrient content: Protein content of the products was estimated by Biuret method. 0.2 to 0.8ml of standard protein solution was taken in five different test tubes and water was added to bring the volume to 1ml in each test tube and lastly 4ml of biuret's reagent was added and mixed. Simultaneously, a blank was prepared with 1ml of distilled water and 4ml of biuret's reagent and test samples were prepared with 1 ml of test sample and 4ml of biuret's agent was prepared. The test tubes were incubated for 30 mins at room temperature and the optical density was measured in a spectrophotometer at 550nm.<sup>(5)</sup>

Fat content of the products was measured by using Soxhlet method. The sample was thoroughly powdered and 5gm was weighed. The sample was placed in the middle part of the Soxhlet apparatus. 150ml of ether was poured in the bottom flask (previously weighed with a glass chip inside) and heat was applied with an electrically controlled mantle heater. The volatile ether vapour ascends through the inlet tube and after condensation in the condenser falls drop by drop into the sample placed in the middle part. When the condensing liquid has reached a certain height it falls back into the flask through the outlet tube carrying the dissolving oil from the material. The loss of ether is minimum if the condensation temperature is sufficiently low. After extraction the ether was transferred to a heater and the flask was cooled thoroughly with successive portion of little fresh ether. The bottom flask with the residue was dried. It was cooled and weighed.<sup>(6)</sup>

Total carbohydrate of the products was estimated by the Anthrone method. The taste samples were prepared by dissolving 1 gram of sample in 10ml of water. The standards were made by taking 0, 0.1, 0.2, 0.4, 0.6, 0.8 and 1ml of working standard. The volume was made up to 1ml in all the test tubes by adding distilled water. 4ml of anthrone reagent was added to all the test tubes. It was heated for 8 minutes in a boiling water bath. Absorbance was checked at 630nm. A calibration curve was plotted to determine the concentration of the unknown.<sup>(7)</sup>

Estimation of Calcium: The samples of each verity of the product were taken as experimental solutions. Observations have been taken in triplicate for each sample. Estimation of Iron content was done by OCPC method for determination of Calcium.

Estimation of Iron content: The samples of each verity of the product were taken as experimental

solutions. Observations have been taken in triplicate for each sample. Estimation of Iron content was done by Ferrozine method used for determination of Iron and Total Iron binding capacity.

Determination of ascorbic acid content: The ascorbic acid content of the products was measured by indophenol dye method. In a conical flask, equal amount of metaphosphoric acid and standard ascorbic acid was filtered through cotton. In a test tube, 1 ml of 2, 6-dichlorophenol indophenol dye was taken which was titrated with the filtered solution of metaphosphoric-ascorbic acid until colourless. The readings were noted in triplicates. Similarly, test samples were prepared by filtration of equal amounts of metaphosphoric acid-sample solution which was used to titrate the dye until colourless and the readings were noted in triplicates. The concentration of the ascorbic acid in the test samples was calculated.<sup>(8)</sup>

Determination of beta-carotene content: Five gram of sample was taken, crushed in 10-15ml of acetone with the help of pestle and mortar and few crystals of anhydrous sodium sulphate were added. The solution was centrifuged at 3000 rpm for 3-4 minutes. The supernatant was transferred to a separating funnel; 10-15ml of petroleum ether was added and mixed thoroughly. Two layers separated out on standing. The lower layer was discarded and upper layer was collected in 100ml volumetric flask. The volume was made to 100ml with petroleum ether and optical density was recorded at 452nm using petroleum ether as blank.<sup>(9)</sup>

Determination of Total Phenolic content: Total phenolic content was measured by Folin-Ciocalteau's method. Firstly, 0.1mL of extract was made up to 5 mL with distilled water in a 10-mL volumetric flask, followed by addition of 0.5mL 2 N Folin-Ciocalteau's phenol reagent. About 1mL of saturated (35% w/v) sodium carbonate solution was added into the mixture after three minutes. The mixture was made up to 10 mL with water. After 1 hour, the mixture was measured spectrophotometrically at 725 nm against the reagent blank. Gallic acid within the concentration range of 0-400 µg/mL assay solution was used as the standard curve for the total phenolic acids content. The reaction between the Folin-Ciocalteu reagent and phenolic compounds in alkaline medium results in the formation of a blue chromophore constituted by a phosphotungstic /phosphomolybdenum complex that absorbs radiation and allows quantification. Results were

expressed as mg gallic acid equivalents (GAE)/100 g of fresh weight.<sup>(10)</sup>

**Estimation of antioxidants activity: DPPH radical scavenging assay**

Antiradical activity assay is based on the reduction of 1, 1-diphenyl-2- picrylhydrazyl (DPPH). Due to the presence of an odd electron it gives a strong absorption maximum at 517 nm. As this electron becomes paired off in the presence of a hydrogen donor, i.e. a free radical scavenging antioxidant, the absorption strength is decreased and the resulting decolorization is stoichiometric with respect to the number of electrons captured. The dilution of different variations of Aloo tikkis aqueous extract (0.1mg/ml) was prepared. The absorbance of the resulting solution was measured spectrophotometrically at 517 nm.<sup>(11)</sup> The scavenging activity of each extract on DPPH radical was calculated using the following equation:

$$\text{Scavenging activity (\%)} = \frac{1 - \text{Absorbance of Sample}}{\text{Absorbance of Control}} \times 100$$

**Reducing power property: Oyaizu method:** The reduction property of the extracts was assessed according to the method of Oyaizu. Different concentrations (0.2–1.0mg/mL) of S. Montana extracts were added to 1 mL of distilled water and then mixed with 2.5mL of 0.2 mphosphate buffer

(pH 6.6) and 2.5mL of 1% potassium ferrocyanide. The mixture was incubated at 50°C for 20 min. before the addition of 2.5mL of trichloroacetic acid. The resulting mixture was centrifuged at 3000 rpm for 10 min. After this, 2.5 mL of the supernatant was mixed with an equal amount of distilled water and 0.5 mL of 0.1% FeCl<sub>3</sub>. The colour change of the resulting solution was then taken at 700 nm.

## Results and Discussion

The results of chemical analysis were expressed as mean ± standard deviation of triplicate analyses while mean of sensory scores for each attribute was based on twenty judgements.

The standard and approved products as chosen by the panel members were chemically analysed for their moisture content, total ash, protein, fat, total carbohydrate, vitamin C, beta carotene, phenolic compounds, and DPPH radical scavenging activity.

**Sensory Evaluation:** Acceptability of variation product/ recipe including basic were evaluated from the ratings obtained through the score card using 9 point hedonic scale during the sensory evaluation and comparative study between the products was done (Table 3) and chemical analysis were performed.

Table 3: Representing the Mean±S.D. of the ratings given to the different attributes of the sensory evaluation

Type of Variation	Appearance	Colour	Aroma	Texture	Taste	Overall Rating
Basic Recipe	8.9± 0.37	8.9± 0.37	8.7± 0.47	8.6± 0.50	8.8± 0.44	8.8± 0.44
Variation 1.a)	8.9±0.37	8.9± 0.37	8.9± 0.37	8.9± 0.37	8.9± 0.37	8.9±0.37
Variation 1.b)	8.7±0.49	8.7±0.49	8.6± 0.51	8.6±0.51	8.4± 0.49	8.4±0.49
Variation 1.c)	8.4±0.49	8.5±0.51	8.4± 0.49	8.3± 0.47	8.4± 0.49	8.2±0.41
Variation 2.a)	8.4±0.49	8.8±0.41	8.3± 0.47	8.6± 0.51	8.3± 0.47	8.3±0.44
Variation 2.b)	8.5±0.51	8.9±0.31	8.6± 0.51	8.3± 0.47	8.7± 0.47	8.5±0.51
Variation 2.c)	8.5±0.51	8.5±0.51	8.5± 0.51	8.6± 0.50	8.6± 0.51	8.7±0.49
Variation 3.a)	8.9±0.37	8.9±0.37	8.8± 0.41	8.5± 0.69	8.9± 0.37	8.7±0.49
Variation 3.b)	8.9±0.37	8.8±0.41	8.6± 0.50	8.2± 0.52	8.6± 0.50	8.7±0.49
Variation 3.c)	8.6±0.51	8.6±0.60	8.5± 0.61	8.5± 0.69	8.5± 0.69	8.5±0.61
Variation 4.a)	8.5±0.51	8.5±0.51	8.1± 0.85	8.2± 0.52	8.2±0.37	8.4±0.50
Variation 4.b)	8.5±0.51	8.5±0.51	8.3± 0.64	8.5± 0.51	8.4± 0.60	8.2±0.59
Variation 4.c)	7.9±0.59	8.1±0.31	7.7± 0.93	7.3± 0.47	7.3± 0.73	7.7±0.49
Variation 5.a)	8.9±0.31	8.9±0.31	8.8±0.41	8.8± 0.41	8.8± 0.44	8.7±0.49
Variation 5.b)	8.4±0.60	8.5±0.51	8.3±0.57	8.6± 0.50	8.6± 0.50	8.6±0.51
Variation 5.c)	8.2±0.37	8.2±0.37	8.4± 0.68	8.2± 0.62	8.2± 0.62	7.8±0.41
Variation 6.a)	8.9±0.37	8.9±0.37	8.9±0.37	8.8± 0.41	8.8± 0.41	8.9±0.31
Variation 6.b)	8.3±0.47	8.3±0.47	8.6±0.50	8.6± 0.50	8.7± 0.47	8.7±0.47
Variation 6.c)	8.2±0.49	8.2±0.41	8.1±0.55	8.1± 0.55	8.3± 0.47	8.4±0.49

## Chemical analysis

Total moisture and ash content: Total moisture content and ash of the products were estimated. Moisture content and ash content of the standard product and the variations is more than the standard. Ash content was more in Variation 3.a) which has the highest percentages of ash content (8.5%) while the lowest ash content (5%) is present in Basic recipe.

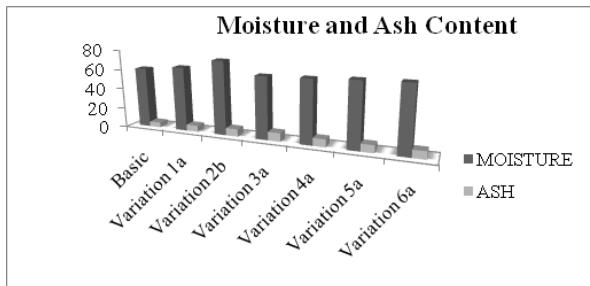


Fig 1: Bar graph representing the Moisture and Ash content of the samples

Total Macronutrient content: Protein, carbohydrate and fat content of the standard and variations of acceptable products were estimated. It was found that the protein, carbohydrate and fat content of the standard and most acceptable product showed changes. Most of the variations having relatively similar carbohydrate content as these variations contain only refined wheat flour. Variation 6.a contains 17.89 gram/ 100 gram of carbohydrate which is lowest. The stand recipe contains lowest amount of protein but it has increased in the acceptable variations. Fat content remained same in almost all the variations but it has increased in Variation 2.b as it contains (20 grams) of leaves so more amount of oil was absorbed. Protein, carbohydrate and fat content (gm) per 100 gm of products were represented in the graphs.

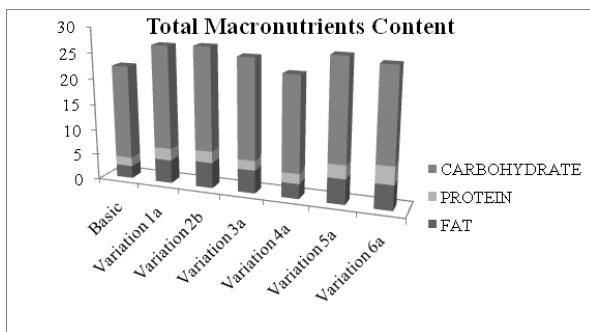


Fig 2: Bar graph representing the total micronutrients content of the samples

Beta-carotene content: Beta- carotene content of the acceptable variations was higher compared to standard. Variation 6.a) has the highest percentages of  $\beta$ - Carotene content (1.13 mg) while the lowest content is found in the Basic Recipe has the lowest percentages of  $\beta$ - Carotene content (0.13 mg).

Vitamin C Content: Vitamin C content of the acceptable variations was higher compared to standard. Variation 6.a) has the highest percentages of Vitamin C content (2.8 mg/) while the lowest content is found in the Basic Recipe (1.47 mg).

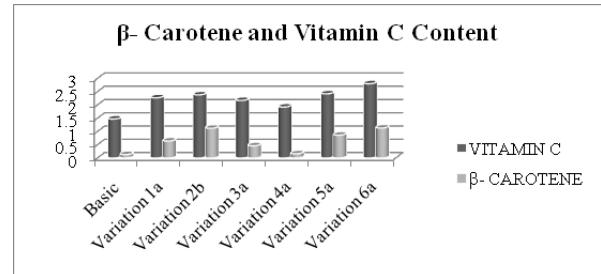


Fig 3: Bar graph representing the  $\beta$ - Carotene and Vitamin C content of the samples

Iron Content: Iron and Calcium content of the standard and variations of acceptable products were estimated. It was found that the iron and calcium content of the standard and most acceptable product showed changes. Variation 6.a) has the highest percentages of iron content (5.38 mg) while the lowest content is found in the Basic Recipe has the lowest percentages of iron content (1.6 mg).

Calcium content: Calcium content of the acceptable variations was higher compared to standard. Variation 3.a) has the highest percentages of calcium content (84.89 mg) while the lowest content is found in the Basic Recipe has the lowest percentages of calcium content (10.66 mg).

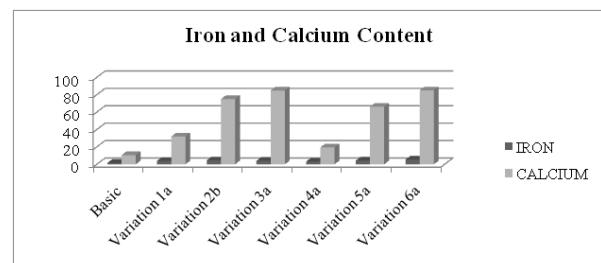


Fig 4: Bar graph representing the Iron and Calcium content of the samples

Total Polyphenol Content: Total Polyphenol content of the standard and variations of acceptable products were estimated. It was found that the polyphenol content of the most acceptable product showed changes than standard. Total polyphenol content was found to be high in Variations 6.a) (125 mg/100gram) and lowest in the basic recipe (83 mg/100gram).

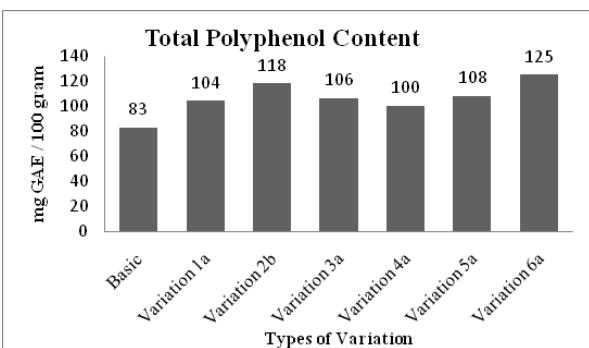


Fig 5: Bar graph representing the total polyphenol content of the samples

**Antioxidant content:** It was found that the antioxidant content of the most acceptable products showed better result than standard. Antioxidant activity was found to be high among Variation 6. a) (64.1 %) has the highest antioxidant activities, followed by Variation 5. a) and Variation 2.b) while the lowest % was found in the Basic recipe (29.74 %).

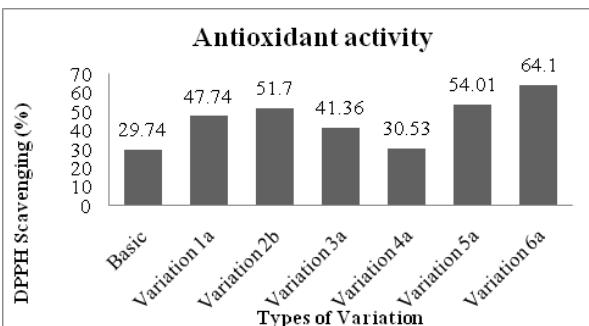


Fig 6: Bar graph representing the Antioxidant content of the samples

Table 4: Representing the Mean $\pm$  S.D. of the ratings given to the different attributes of the sensory evaluation

Type of Variation	Appearance	Colour	Aroma	Texture	Taste	Overall Rating
Basic Recipe	6.5 $\pm$ 0.5	6.6 $\pm$ 0.49	6.2 $\pm$ 0.43	7 $\pm$ 0.71	6.5 $\pm$ 0.5	6.5 $\pm$ 0.5
Variation 1.a)	8.5 $\pm$ 0.5	7.2 $\pm$ 0.4	7.7 $\pm$ 0.83	8 $\pm$ 0.71	8.5 $\pm$ 0.5	8 $\pm$ 0.71
Variation 2.b)	7.5 $\pm$ 0.5	7.8 $\pm$ 0.4	6.5 $\pm$ 0.5	7.7 $\pm$ 0.43	6.5 $\pm$ 0.5	7.2 $\pm$ 0.40
Variation 3.a)	7.5 $\pm$ 0.5	7.8 $\pm$ 0.8	6.2 $\pm$ 0.43	7.5 $\pm$ 0.5	6.5 $\pm$ 0.49	7.5 $\pm$ 0.5
Variation 4.a)	8 $\pm$ 0.71	7.7 $\pm$ 0.43	6.5 $\pm$ 0.5	7.5 $\pm$ 0.5	6.5 $\pm$ 0.5	7.2 $\pm$ 0.40
Variation 5.a)	7.5 $\pm$ 0.5	7.6 $\pm$ 0.49	6.5 $\pm$ 0.5	7.7 $\pm$ 0.43	6.2 $\pm$ 0.43	7.5 $\pm$ 0.5
Variation 6.a)	8.7 $\pm$ 0.47	8.9 $\pm$ 0.20	8 $\pm$ 0.71	8.8 $\pm$ 0.4	8.9 $\pm$ 0.20	8.8 $\pm$ 0.37

## Conclusion

Finally to conclude, malnutrition is alarmingly increasing in developing countries which is the root cause behind many other diseases. It is not only important to treat malnutrition pharmacologically but also through dietary interventions. This research was conducted to eliminate malnutrition in low- socio-economic people by using the unused

**Reducing Power Assay:** The most acceptable products showed the best result. The Variation 6.a) displaced the highest reducing power (11.48 mg/ gram), while the Basic recipe showed the lowest potentiality (10 mg/ gram). Total Scavenging activity of citrus peel supplemented acceptable products was much higher compared to the standard product.

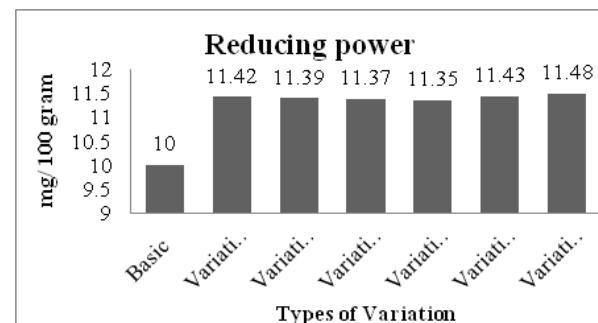


Fig 7: Bar graph representing the reducing power of the samples

## Alternative use

### Sensory Evaluation

Acceptability of variation product/ recipe including basic were evaluated from the ratings obtained through the score card using 9 point hedonic scale during the sensory evaluation and comparative study between the products was done (Table 4) and chemical analysis were performed.

portion of vegetables. Though vegetables in the form of pomace, peels, and seeds are rich in several nutrients and antioxidants which play a significant role in preventing many micronutrient deficiency diseases, are being wasted. Hence, it is beneficial to incorporate all these nutrient dense wastes in our diet to have a healthy life.

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# **Increasing Stain Removal Efficiency by Using Activated Charcoal**

*Shramana Mallick and Richa Chauhan*

## **ABSTRACT**

*Clean clothes in good repair are necessary for a person to present a well groomed, well organized appearance. Every consumer is occasionally plagued by a spot or a stain on a garment or household article. Stains on fabrics arise from various sources and they reduce the consumer appeal resulting in avoidance of its use or sometimes making it unserviceable forever. Stain removal is a necessary part of clothing care. For the investigation, ten most frequently occurring stains were selected based on the survey and to remove those stains, four different agents were selected- Sodium hypochlorite, hot borax solution, detergent and activated charcoal mixed with detergent. The stain removal efficacy was evaluated using spectrophotometer.*

**Keywords:** stain, efficiency, activated charcoal, stain removal

## **Introduction**

Articles of clothing show an inseparable bit of the human body. Through clothing, a person makes a first step in non-verbal communication to the world. It is commonly said that “The first impression is the last impression”. Subsequently the individual appearance is of incredible appearance. Stain is a spot or a mark of discoloration left on the fabrics by the contact and absorption of a foreign substance. Stains can be defined as a spot or a mark of discoloration left on the fabrics by the contact and absorption of a foreign substance. Staining can destroy the appealing looks of the fabrics by acting on its properties. Exposure of stain to air, water and heat can lead to setting of stains which makes its removal a more difficult task leading to wastage of time and money. So to make this task all the more speedy, prudent and more secure, adequate information is fundamental. Stain evacuation is a vital piece of apparel care. Brisk and wary stain evacuation keeps garments in wearable condition longer and lessens apparel costs. Stain expulsion is an expertise which calls for long understanding and needs extraordinary consideration.

## **Methodology**

The present investigation is planned with objectives like to study the consumer behavior on stain and its removal, to find the stain removal efficiency of fresh and set stains by adding activated charcoal with the regular detergent. For the investigation, ten most frequently occurring stains were selected based on the survey; regular detergent and activated charcoal mixed with detergent are used as stain removal agents. The stain removal efficacy was evaluated using spectrophotometer. During the process of stain removal, certain properties of fabrics are affected which were tested.

**Materials Used:** A pilot survey was done prior to start the research work. The idea of the survey was to identify the common stains encountered by the respondents and also their preference on colours, fabrics, stain removers etc. On the basis of respondent's preference, the fabric was chosen and it was found to be Cotton keeping in mind the demographics. The respondents feel that the white is the color that is mostly affected by the stains.

The collected data were scrutinized, coded, quantified, tabulated and compiled systematically, to commensurate with the objectives of the study. Appropriate statistical tools and tests were applied to draw inferences. The samples washed with different agents to remove the stains were tested to see the impact or changes occurred in the properties of the fabrics like weight loss, tensile strength and change in color. The change of color was assessed using a spectrophotometer. It will help to find the efficiency of reagents in stain removal. The impact of stain removal on physical characteristic of fabric needs to be measured using different apparatus and machines.

Tests	Testing Standard
Weight Loss	IS:1964(1970)
Colour Change	AATCC Evaluation Procedure 2/ ISO 105-A03
Tensile Strength	ASTMD5034
Thickness	ASTM D1777

## **Results and Discussion**

The most frequently stains were selected to check the stain removal efficiency using the mentioned two agents. The selection of the stains were done keeping in mind the demographics and psychographics of the consumers of the selected city. The most frequently

occurring stains and their efficiency of removal was analysed from the respondents are shown in the following graph.

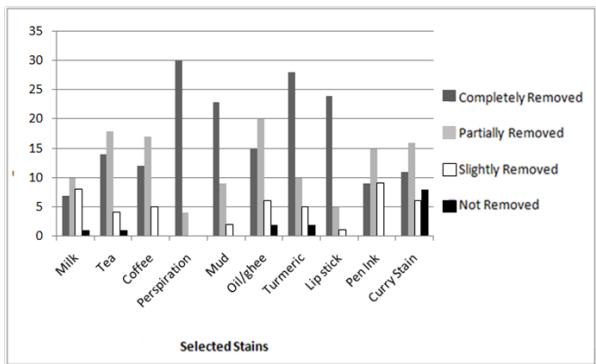


Figure 1: Response of Respondents about Stain Removal using detergents

It was noticed that that a lot of stains were partially removed using only detergent. This was the reason for carrying out the experiment to increase the stain removal efficiency.

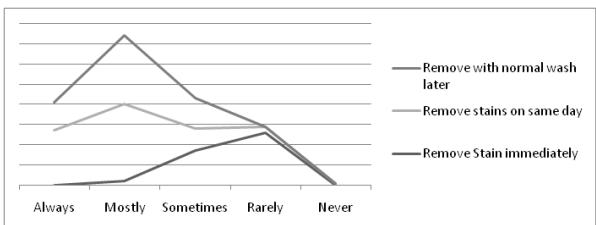


Figure 2: Trend of removal of stains among respondents

From the spectrophotometric evaluation it was found that detergent+ activated charcoal was effective on a wide variety of stains. A study was done on the trend in stain removal activity by the respondents. The response of the candidates using the activated charcoal + detergent was recorded and the following graph shows the same.

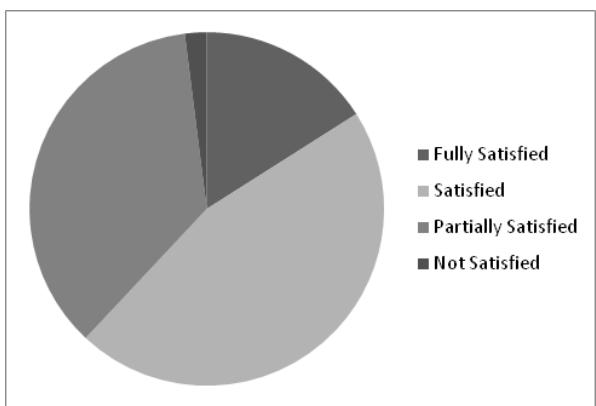


Figure 3: Satisfaction Level of Customers using Activated charcoal+detergent

The comparison between the satisfaction level of the consumers were also recorded. The following graph shows it.

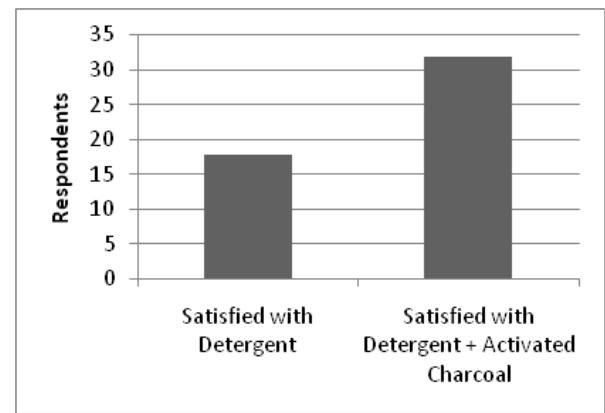


Figure 4: Graphical representation of Response of Respondents after using both agents for stain removal

After the process of stain removal, the comparison for the weight loss occurred after laundering with different agents was done as this would be helpful to determine the efficiency of the stain removing agents.

The overall weight loss after stain removal process, the detergent + activated charcoal shows the least loss in strength.

The conclusion drawn from this study is that the innovative approach of using activated charcoal in detergent is useful as it is effective on a wide range of stains from different sources as well as cause less adverse impact on fabric properties.

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# Dyeing Potash Alum and Chitosan pre-mordanted Silk fabric using Black Walnut Hull

Malvika Binani and Richa Chauhan

## ABSTRACT

*There has been a growing interest in the application of natural dyes on natural fibers due to worldwide environmental consciousness of the consumers. Black walnut is currently under pressure from the thousand cankers disease that is causing decline of walnuts in some areas. Black walnut is also allelopathic, which means that it releases chemicals from roots and other tissues that harm some other organisms and give the tree a competitive advantage; this is often undesirable as it can harm garden plants and grasses. The hull of Juglans Nigra, i.e. black walnut has been used as a source for dye extraction. The outer husk of the nut is the source of dye. The colorant is juglone. It is a direct dye, which means that no mordant is necessary when used with a protein fiber. Application of chitosan as a biomordant has been done to improve the dyeability and dye coverage. To make the experiment eco-friendly, the application of potash alum along with chitosan as a biomordant as well as dyeing has been done at room temperature using padding mangle followed by drying and curing. Extraction is done with variations in pH and FLR. Pre-mordanting using potash alum has been done at different mordant concentrations at room temperature. Biomordanting of silk fabric has been done using chitosan and citric acid as the cross-linking agent with different concentrations and the recipe was optimized with respect to crease recovery, tensile strength, flexural rigidity and bending length of the treated silk fabric.*

**Key words:** Black Walnut Hull, Chitosan, Potash Alum, Silk

## Introduction

Natural dyes comprise those colourants (dyes and pigments) that are obtained from animal or vegetable matter without chemical processing (Gulrajani & Gupta, 1992).

The word ‘natural dye’ covers all the dyes derived from the natural sources like plants, animal and minerals. Natural dyes are mostly non-substantive and must be applied on textiles by the help of mordants, usually a metallic salt, having an affinity for both the colouring matter and the fibre. Transition metal ions usually have strong coordinating power and/or capable of forming weak to medium attraction/interaction forces and thus can act as bridging material to create substantivity of natural dyes when a textile material being impregnated with such metallic salt (i.e. Mordanted) is subjected to dyeing with different natural dyes, usually having some mordantable groups facilitating fixation of such dye. These metallic mordants after combining with dye in the fibre, forms an insoluble precipitate or lake and thus both the dye and mordant get fixed to become washing fast to a reasonable level (Samanta and Konar, 2011). (Vadwala, 2015)

Walnut trees grow throughout the temperate regions of the Northern Hemisphere as well as in South America. In the United States, walnut trees are grown for lumber, with the state of Missouri being the leading producer. The fruit of the walnut

is commonly harvested and is comprised of the nutmeat, or kernel, the shell, and the husk. Black walnut trees mature slowly, but are resistant to infestation by insects. The walnut grows best in well drained, neutral soils and are commonly found on hillsides and rich mesic bottomlands. Due to the walnut husks' high phenolic content, the husks have promising antioxidant potential and possibility for valorization. Walnut husk extracts have demonstrated antimicrobial effects against grampositive bacteria. Walnut husk extracts can also inhibit xanthine oxidase, an enzyme which forms xanthine which causes hyperuricemia, a metabolic disorder causing inflammation and gout. Walnut husks are also high in naphthoquinones, which have a variety of potential uses. Black walnuts can also be used as a bio-herbicide. (Wenzel et. al., 2017)

The mordant is a sort of bridge between the fibre and the dyestuffs that are extracted from the plants or animals (Bohmer, 2002). Chitin is a most abundant naturally occurring polysaccharide after cellulose. It is a white, hard, inelastic, and nitrogenous compound primarily present, in varying amounts, in the exoskeletons of crustaceans (such as crab, shrimp, lobster etc.) and also in various insects, worms, fungi and mushrooms (Hafdani et al., 2011). Chitosan polymer is known to be odourless, non-toxic, biocompatible in animal tissues and enzymatically biodegradable. They have superior physical properties such as high surface

area, porosity, tensile strength and conductivity. In addition, they can be easily molded into different shapes and forms (films, fibers, sponges, beads, powder, gel and solutions) (Cheung et al., 2015) and are biodegradable.

## Methodology

The hulls were washed and dried in sun. They were then powdered in a grinding machine. The colouring matter was then extracted for 60 minutes with a temperature of 80°C, dye concentration 1:10 and pH 8 using 500ml liquor. Then the solution was extracted at variable dye concentrations (1:5, 1:10, 1:15) and pH (5, 6, 8).

Black walnut hulls were used to extract the colouring matter. The Black Walnut hulls were dried and then crushed to powder in a grinding machine. Degummed, undyed and plain woven 100% silk fabric with 8 tex silk yarn as warp and 5 tex silk yarn as weft was chosen to be used in the present work. Degummed silk fabric was pre-mordanted before carrying out the dyeing process.

Pre-mordanting of the fabric was done at different mordant concentrations and were assessed on the basis of fabric stiffness, crease recovery and breaking tenacity. During the process of optimization of the pre-mordanting recipe, mordant concentration was varied, while keeping temperature, time and FLR constant. The fabric was then dried at 90°C for 5 minutes.

Fabric samples were treated with 7% citric acid, 6% sodium hypophosphite and 1.5% chitosan having FLR 1:20. The chitosan (0.5%, 1%, 1.5%, 2%) and citric acid (3%, 5%, 7%, 9%) concentration was varied while keeping the concentration for sodium hypophosphite and FLR constant. Acetic acid was used to dissolve chitosan. Again, samples were dried at 85°C for 5 minutes and followed by curing at 190°C for 3 min.

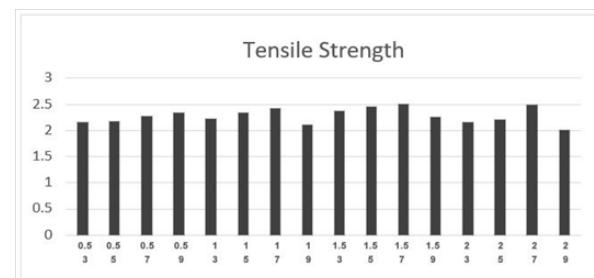
Pre-mordanted silk was dyed with the extracted solutions of Black Walnut hull. Parameters like dye concentration (1:5, 1:10, 1:15) and pH (5, 6, 8) were varied while keeping the time and temperature constant. The dyed samples were then dried at 90°C for 3 minutes and cured at 150°C for 5 minutes. After dyeing, the fabric was washed using 1g/l soaping agent. The samples were assessed on the basis of surface colour strength, colour interaction parameters, light fastness, wash fastness and rubbing fastness.

## Results and Discussion

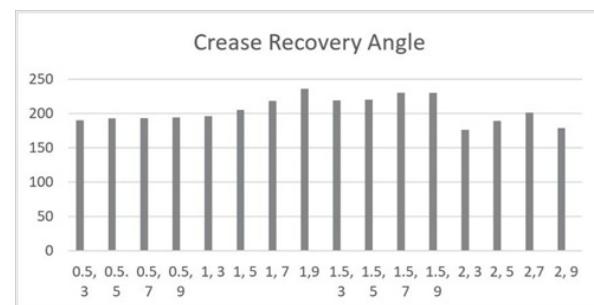
Pre-mordanting of the fabric was done at different mordant concentrations and was assessed on the basis of fabric stiffness, crease recovery and breaking tenacity.

**Tensile Strength:** On the basis of observation, it is seen that the tensile strength of the degummed silk fabric is the highest (2.51./cm<sup>2</sup>) when treated with 1.5% chitosan and 7% citric acid concentration. The highest values of tensile strength are observed when degummed silk fabric is treated with 1.5% chitosan and the lowest values were observed when degummed silk fabric is treated with 2% chitosan concentration.

**Crease Recovery Angle:** Crease recovery angle of silk fabric bio mordanted with chitosan was highest when the fabric was treated with 1.5% chitosan and 7% & 9% citric acid concentration. (2300). The highest values in crease recovery were observed when the silk fabric was treated with 1.5% chitosan while the lowest values were observed when it was treated with 2% chitosan.



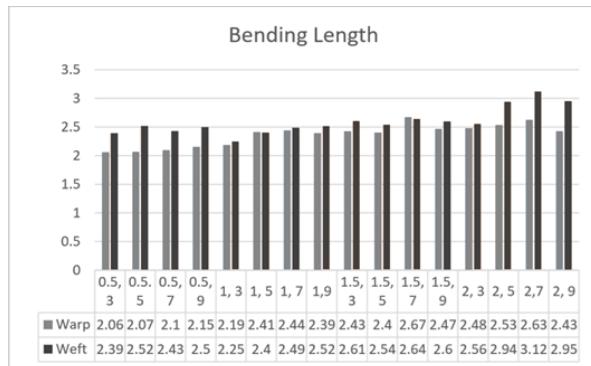
Graph 1: Tensile strength. Chitosan content (0.5, 1, 1.5, 2) and Citric Acid content (3, 5, 7, 9)



Graph 2: Crease Recovery Angle. Chitosan content (0.5, 1, 1.5, 2) and Citric Acid content (3, 5, 7, 9)

**Bending Length:** The bending length of degummed chitosan biomordanted silk fabric was highest weft-way (3.12 cm) when treated with 2% chitosan and 7% citric acid while the warp-way was 2.625 cm. Highest warp-way bending length observed was (2.67 cm) when treated with 1.5% chitosan and 7% citric acid while the weft-way was 2.642 cm. It was

observed that the highest bending length was seen when the fabric had been treated with 2% chitosan and the lowest was observed when the fabric was treated with 0.5% chitosan.



Graph 3: Bending Length. Chitosan content (0.5, 1, 1.5, 2) and Citric Acid content (3, 5, 7, 9)

Effect of samples dyed at different concentrations on Colour Fastness Dry Rubbing

pH 8: The best results are obtained with dye concentration 1:10.

Dye concentration	Potash alum concentration	Dry rubbing
1:10	30	4
1:10	20	3-4
1:10	10	4

pH 5: The best results are obtained with dye concentration 1:10.

Dye concentration	Potash alum concentration	Dry rubbing
1:10	30	4
1:10	20	4
1:10	10	3-4

pH 6: The best results are obtained with dye concentration 1:10.

Dye concentration	Potash alum concentration	Dry rubbing
1:10	30	4
1:10	20	4
1:10	10	4

Wet Rubbing

pH 8: The best results are obtained with dye concentration 1:10.

Dye concentration	Potash alum concentration	Dry rubbing
1:10	30	4-5
1:10	20	4-5
1:10	10	4-5

pH 5: The best results are obtained with dye concentration 1:10.

Dye concentration	Potash alum concentration	Dry rubbing
1:10	30	4-5
1:10	20	4
1:10	10	5

pH 6: The best results are obtained with dye concentration 1:10.

Dye concentration	Potash alum concentration	Dry rubbing
1:10	30	4-5
1:10	20	5
1:10	10	4-5

Wash Fastness

pH 8: The best results are obtained with dye concentration 1:10.

Dye concentration	Potash alum concentration	Fading	Staining	
			Cotton	Silk
1:10	30	3-4	5	5
1:10	20	3	4-5	5
1:10	10	3-4	4-5	4-5

pH 5: The best results are obtained with dye concentration 1:10.

Dye concentration	Potash alum concentration	Fading	Staining	
			Cotton	Silk
1:10	30	3	4-5	4-5
1:10	20	3	4	4-5
1:10	10	3-4	5	5

pH 6: The best results are obtained with dye concentration 1:10.

Dye concentration	Potash alum concentration	Fading	Staining	
			Cotton	Silk
1:10	30	3	4-5	5
1:10	20	3-4	4-5	4-5
1:10	10	3	4-5	4-5

#### Light Fastness

pH 8: The highest light fastness values are observed with dye concentration 1:10.

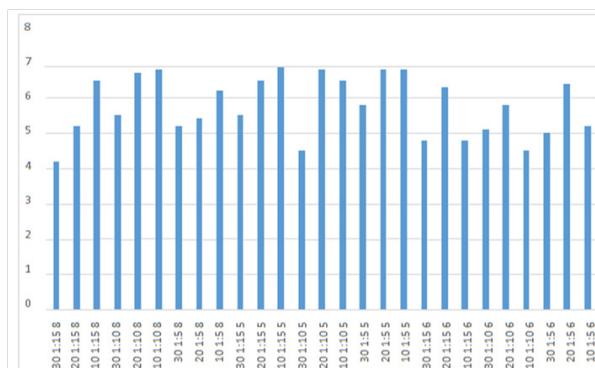
Dye concentration	Potash alum concentration	Dry rubbing
1:10	30	5.5
1:10	20	6.7
1:10	10	6.8

pH 5: The highest light fastness values are observed with dye concentration 1:5.

Dye concentration	Potash alum concentration	Dry rubbing
1:5	30	5.8
1:5	20	6.8
1:5	10	6.8

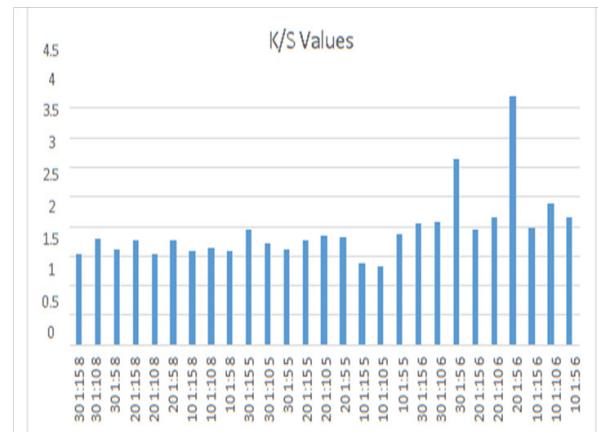
pH 6: The highest light fastness values are observed with dye concentration 1:5.

Dye concentration	Potash alum concentration	Dry rubbing
1:5	30	5.0
1:5	20	6.4
1:5	10	5.2



Graph 4: Light Fastness (0.5, 1, 1.5, 2) and Citric Acid content (3, 5, 7, 9)

Colour Change  
K/S at  $\lambda_{max}$ : 400 nm



Graph 5: k/s values (0.5, 1, 1.5, 2) and Citric Acid content (3, 5, 7, 9)

In case of pH 8, the K/S value was recorded highest (1.793) when the dye concentration was 1:10 and concentration of potash alum was 30 gpl. In case of pH 5, the K/S value was recorded highest (1.952) when the dye concentration was 1:15 and concentration of potash alum was 30 gpl. In case of pH 6, the K/S value was recorded highest (4.212) when the dye concentration was 1:5 and concentration of potash alum was 20 gpl.

$\Delta L$ ,  $\Delta a$ , and  $\Delta b$  indicate further implication of the colour difference in terms of lightness / darkness ( $\Delta L$ ), redness / greenness ( $\Delta a$ ) and blueness / yellowness ( $\Delta b$ ) respectively. Analysis for lightness/darkness shows that when dye concentration is 1:5 having pH 6 and potash alum concentration of 20 gpl, the value recorded for darkness is highest (-32.208), the value for redness is highest (15.341), the value for yellowness is highest (9.222) and the value for brightness is highest (12.790).

Changes in hue ( $\Delta H$ ) for all the cases are found to be negative, indicating that there is no major change in predominating hue, except showing some shift in the tonal variation. The highest value recorded (-12.522) is when dye concentration is 1:5 having pH 6 and potash alum concentration of 20 gpl.

#### Conclusion

The present study concluded that:  
On the basis of tensile strength, crease recovery and bending length, the recipe for chitosan pre-treatment was: 1.5% chitosan, 7% citric acid, having constants 6% sodium hypophosphite, drying at 85°C and curing at 190°C.

The fastness properties increased significantly with the combined use of potash alum and chitosan.

The colour strength, redness, yellowness, darkness and brightness levels varied with different concentrations and was highest seen in the sample having dye concentration is 1:5, pH 6 and potash alum concentration of 20 gpl\s

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# A Study on Union Fabrics Developed with Soyabean Protein Fibre and Other Fibres from Natural Sources

Rishika Didwania and Samita Gupta

## ABSTRACT

Soya protein fibre (SPF) is made from the waste products of the Soya bean industry. It is a soft fibre with good performance and appeals to the environmental issues. Present study was planned to explore the possibility of constructing and evaluating the properties of union fabrics using Soya yarns with wool, silk, linen, modal and cotton yarns. Soya yarn was acquired from Gogreen products, Chennai while the wool, silk, linen, modal and cotton yarns were obtained from Fulia, West Bengal. Fabrics were woven at Jayita Handloom, Fulia. To construct soyabean union fabric, the soyabean yarn was used as warp with cotton, linen, modal, silk and wool as weft. In this study, the fabric was prepared with two different weaves, that is plain and twill weave. Fabric testing was done to find out the weight, thickness, abrasion, drape, strength, and shrinkage. Costing of all the woven fabrics was done. A comparative subjective evaluation was done based on fabric quality by the panel of 50 respondents who were having textile background. Based on the fabric testing, aesthetic properties such as handle, appearance, texture and luster and considering the cost of the fabrics; these developed fabrics were found suitable for various textile applications. One way ANOVA was done to suggest that all woven samples were equally acceptable in terms of Fabric structure, handle, durability and aesthetic properties. Thus, the newly designed SPF union fabrics are unique and can develop into a new venture for the textile industry.

**Keywords:** Soyabean Protein Fibre, Twill structure, Union fabrics

## Introduction

Soyabean fibre is the healthy and comfortable fibre of the 21st century. At present, only industrialized countries have invested heavily in developing new fibres for the new century (Mahapatra, 2017). Soybean protein fibres (SPF) are manufactured fibres, produced from regenerated soya Glycine Max soybean proteins in combination with synthetic polymer (polyvinyl alcohol) as a predominant component. According to textile fibre labelling textiles from SPF can be marked as azlons from soybean. Azlons are manufactured fibres in which the fibre forming substance is composed of regenerated naturally occurring proteins (FTC, 2011).

China is the first country to achieve the industrial production of the soyabean protein fibre in the world. This technical achievement fills the vacancy of original and innovative Chinese technology in the field of chemical synthetic fibre, and also influences the research of development of new fibres in the 21st century (Yi-You, 2004). First researches for developing fibres from soyabean proteins were made by the Japanese. In the year 1940 the first US patent was granted to Japanese Toshiji Kajita and Ryohei Inoue. In 1939 the American Ford Motor Company produced soyabean protein fibres for their car's upholstery and seat fillings. Soyabean protein fibres were also produced in Japan under the name Silkool. The production of the mid twentieth soyabean protein fibres was ceased at the end of the World War II. After ten years of intensive researches

the Chinese scientists with Guanqi Li succeeded in producing high tenacity soyabean protein fibres from soyabean protein and polyvinyl alcohol (Rijavec et al., 2011). The Soyabean fibres are of low strength, and are sensitive to moisture to the extent of losing sixty nine percent of their tenacity when wet. It has better fineness, low specific gravity, high tensile elongation, and good acidic and alkali resistance. It is similar to natural fibres such as wool, silk, etc. this new fibre is considerably cheaper than real silk (around one third of the cost of silk) and can partially replace silk. Its moisture absorption performance is equivalent to cotton, and its permeability is greatly better than cotton, ensuring better comfort. The Soyabean protein fibre (SPF) has good affinity to human skin. The natural colour of Soyabean fibre is light yellow, like the colour of silk. With good fastness to light and perspiration, it also has good dyeing brilliance and dyeing fastness in comparison with real silk products. Fabric from pure soyabean protein fibre (SPF) has got natural colour and pure with abundant fluff on the surface without pilling, excellent hand and drape and softness (Mahapatra, 2017). The development of textile process makes the soyabean fibre able to be blended with any other fibres at any proportion, without problems in production. It can be easily blended with cashmere wool, mercerized cotton, silk, combed cotton, elastomeric fibres and synthetic fibres.

At present, some key enterprises are undertaking development and production task in yarn, fabric

or garments using innovations. Hence keeping the above points in mind this study on Developing Union Fabrics using Soya has been formulated with the following objectives: to construct union fabrics using yarns of SPF and yarns from other fibres such as wool, silk, cotton, linen and modal using different weaves, to study the physical properties of the woven fabrics, and to take preferences on general appearance and suitability of developed woven fabrics.

### Methodology

The union fabric used in this experiment is made from yarns of soya, cotton, linen, modal, silk and wool. The soya yarns are used in the warp direction. In the weft direction other yarns such as soya, cotton, linen, modal, wool and silk are used respectively. The experimental procedure comprised of following steps:

**Selection of Raw Materials for Weaving a Union Fabric:** The spun soya yarns of 120s count were collected from Gogreen Products, Chennai, in the form of cones. The 60s cotton and 70s spun mulberry silk yarns were collected from the local market of Madhan Mohan Textile, Fulia, West Bengal. The

60s linen, 60s spun modal and 48s wool was also collected from the local market of Fulia. The soya union fabric was hand woven in Jayita Handloom, Fulia in two basic weaves.

**Constructional Details of Soya Union Fabrics:** The Soyabean union fabric was hand woven in Jayita Handloom, Fulia in two basic weaves that is plain weave 1/1 and twill weave 2/2. The warp yarns are soya yarns (120s) and the weft yarns are cotton (60s), linen (60s), modal (60s), wool (48s) and silk (70s).

**Conditioning of the Samples:** Prior to the testing, all the yarn and fabric samples were conditioned according to the moisture equilibrium in standard atmosphere at 65 +/- 2 percent relative humidity and 27 +/- 2oC temperature in a conditioning temperature.

**Yarn Testing:** The yarns were tested in Kolkata base Prod Control India Pvt. Ltd. All the yarn samples, i.e., soya, linen, cotton, silk, wool and modal were tested. The standard method of tests was followed to determine the count, yarn weight and twist per inch.

Table 1: Constructional Details of Woven Fabrics

S. No.	Union Fabric	Weave Type	Code	Yarn Details		Yarn Count	Direction
Control Sample							
1	Soya x Soya	Plain Weave	SP	Soya	120s	Warp	
				Soya	120s	Weft	
2	Soya x Soya	Twill Weave	ST	Soya	120s	Warp	
				Soya	120s	Weft	
Test Samples							
3	Soya x Cotton	Plain Weave	SCP	Soya	120s	Warp	
				Cotton	60s	Weft	
4	Soya x Cotton	Twill Weave	SCT	Soya	120s	Warp	
				Cotton	60s	Weft	
5	Soya x Linen	Plain Weave	SLP	Soya	120s	Warp	
				Linen	60s	Weft	
6	Soya x Linen	Twill Weave	SLT	Soya	120s	Warp	
				Linen	60s	Weft	
7	Soya x Modal	Plain Weave	SMP	Soya	120s	Warp	
				Modal	60s	Weft	
8	Soya x Modal	Twill Weave	SMT	Soya	120s	Warp	
				Modal	60s	Weft	
9	Soya x Wool	Plain Weave	SWP	Soya	120s	Warp	
				Wool	48s	Weft	
10	Soya x Wool	Twill Weave	SWT	Soya	120s	Warp	
				Wool	48s	Weft	
11	Soya x Silk	Plain Weave	SSP	Soya	120s	Warp	
				Silk	70s	Weft	
12	Soya x Silk	Twill Weave	SST	Soya	120s	Warp	
				Silk	70s	Weft	

**Fabric Testing:** The union fabrics were tested for some important fabric properties such as properties related to fabric structure (Fabric Weight, Fabric Thickness and Thread Count), properties related to fabric handle (Bending Length, Crease Recovery and Drape Coefficient) and properties related to fabric durability (Abrasion Resistance, Tearing Strength, Tensile Strength and Shrinkage Resistance) using the standard methods mentioned in Table 2.

Table 2: Standard Method of the Fabric Testing

Properties	Standard Method	Instrument Used
GSM of the Fabric	IS: 1964-2001	Electric Weighing Balance
Fabric Thickness	IS: 7702-1975	Thickness Gauge
Thread Count	IS: 1963-1981	Pick Glass
Bending Length	IS: 2502-1963	Shirley Stiffness Tester
Crease Recovery	IS: 2313-1972	Shirley Crease Recovery Tester
Drape Coefficient	IS: 8357-1977	Fabric Drape Tester
Tearing Strength	SSEN ISO 13937 (2)-2000	MAG MecTear
Tensile Strength	SSEN ISO 13937 (2)-2000	MAG UniStretch
Abrasion Resistance	IS: 12673-1989	Martindale Abrasion Tester
Shrinkage Resistance	ASTM D2259	Shrinkage Glass Tester

Table 3: Physical Properties of the Yarns

Sl. No.	Yarn Testing	Soya Spun Yarn	Modal Spun Yarns	Cotton Yarns	Spun Silk Yarns	Wool Yarns	Linen Yarns
1	Yarn count	120	60	80	70	48	60
2	Twist Per Inch	16	13	16	19	20	24
3	Yarn Weight in grams per metre	0.4	0.55	0.52	0.57	0.75	0.86

### 3.2 Properties Related to Fabric Structure

A. **Fabric Weight - Soya x Linen** union fabrics were found to be the heaviest and Soya x Silk fabrics the lightest. When compared to the control samples in terms of fabric weight, Soya x Silk, Soya x Cotton and Soya x Modal produced lighter

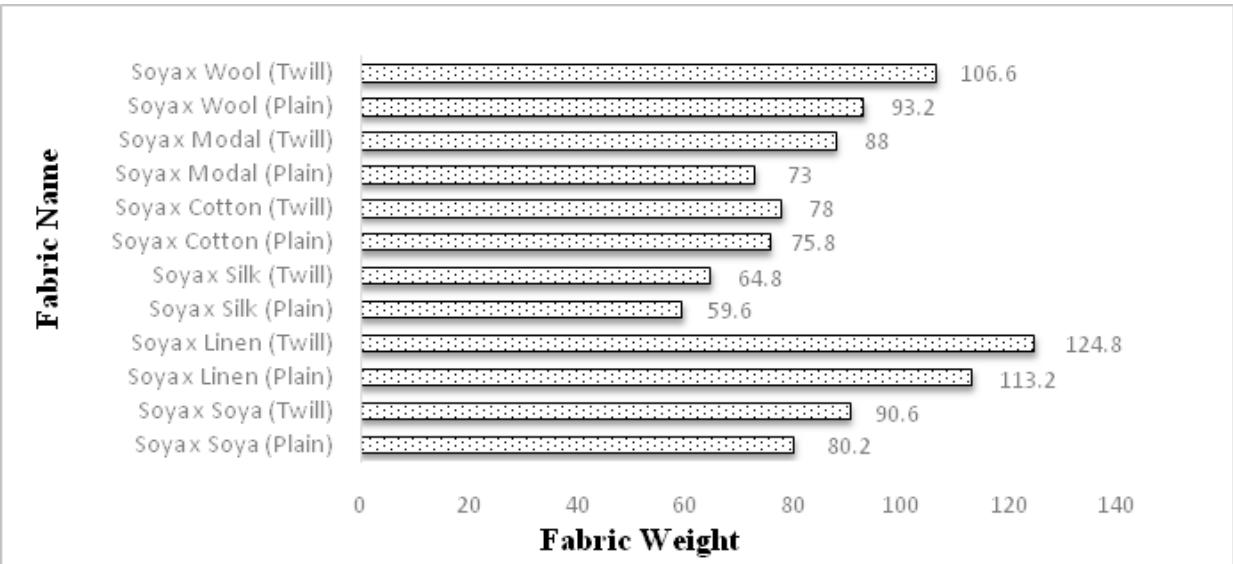
**2.6 Costing of the Woven Fabric:** The cost of each prepared sample was calculated separately on the basis of raw material, weaving execution charges, finishing and profit margin. A total of twenty per cent profit margin was added in the calculated cost for getting sale price.

**2.7 Subjective Evaluation of the Woven Samples:** A closed ended questionnaire was framed to gather information. Fifty respondents with knowledge of textiles (textile students, teachers, designers) were taken for the survey as a purposive sample for assessment. Assessment of aesthetic and handle properties of Soya union fabrics were performed by assessing fifty respondents with knowledge of textiles was selected. Some important properties, such as handle (Rating scale: 1- Stiff, 2- Crisp and 3- Soft) (Sular et al, 1996), appearance (Rating scale: 1- Poor, 2- Fair and 3- Good), texture (Rating scale: 1- Rough, 2- Moderately smooth and 3- Smooth) and luster (Rating scale: 1- Dull, 2- Matt and 3- Lustrous) (Gundola et al, 1996) were assessed by the respondents with the help of closed ended questionnaire. Assessment of the constructed woven fabric was done for its properties such as handle, appearance, texture, luster and price. Statistical analysis of data was done using one-way ANOVA factor and Correlation Matrix.

## Result and Discussion

**3.1 Yarn Testing:** Yarns were tested for the physical properties like yarn count, twist per inch and yarn weight using standard methods. The physical properties of the yarns are reported in Table 3.

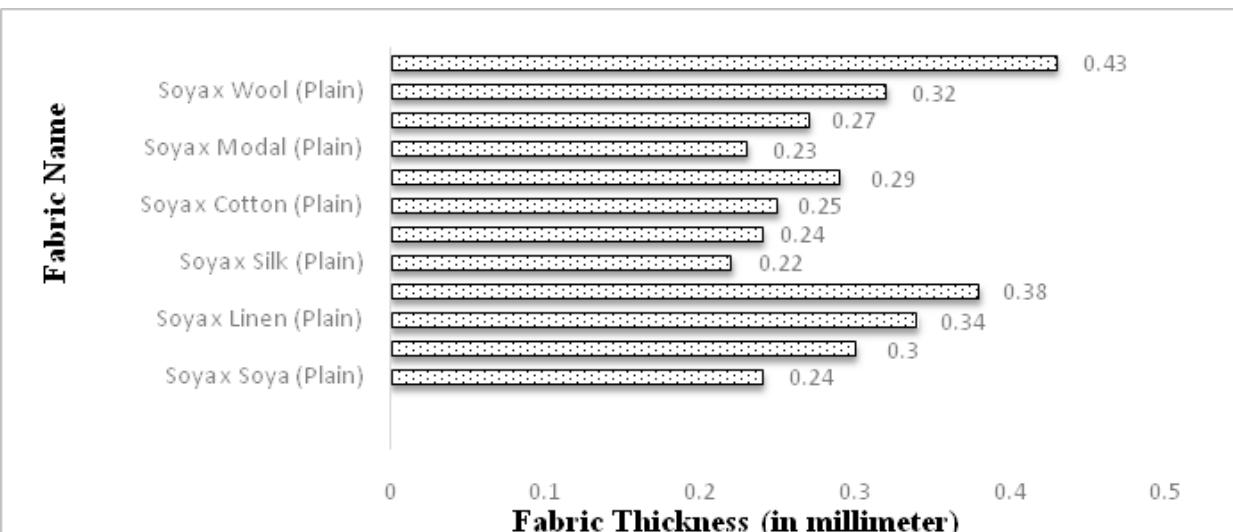
fabrics in spite of lower density of Soya fibre in comparison to density of cotton, silk and viscose (Swicofil, 2011). This variation in fabric weight may be due to the difference in fibre composition, yarn properties as well as density of the fabric (Boruah et al, 2018).



Graph 1: Fabric Weight of the Woven Samples

B. Fabric Thickness - It could be elicited that Soya x Silk union fabric in plain weave and Soya x modal union fabric in plain weave had minimum thickness compared with other union fabrics. Soya x Wool in twill weave had maximum fabric thickness, thus probably giving higher thermal insulation. When

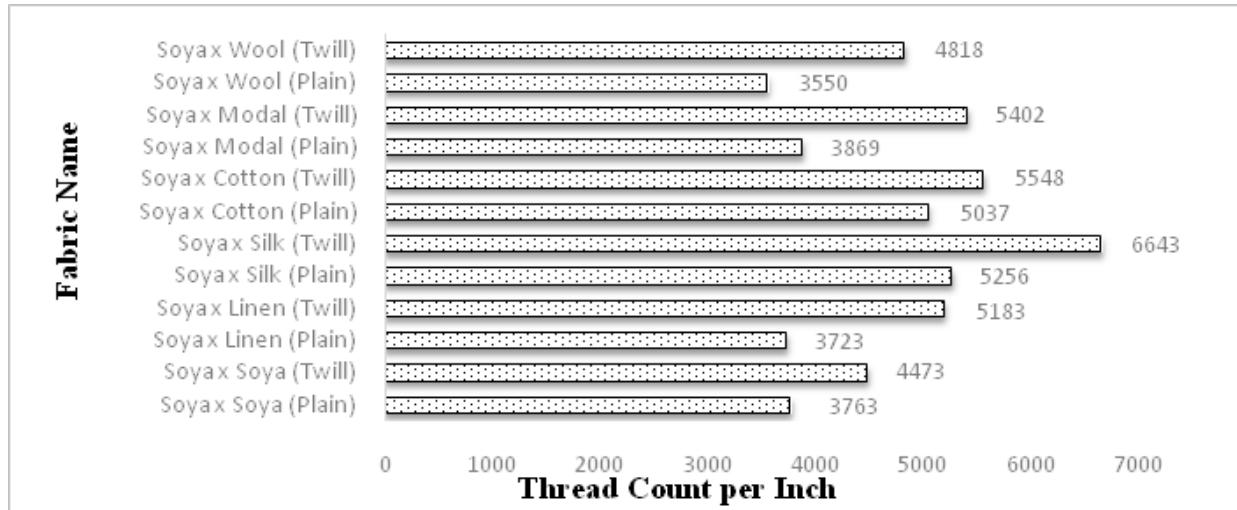
compared to the control samples in terms of fabric thickness, Soya x Silk, Soya x Cotton and Soya x Modal produced finer fabrics. The difference in thickness may be due to the fibre types, yarn twist and fabric structure.



Graph 2: Fabric Thickness of the Woven Samples

C. Thread Count-Highest value of Soya x Silk union fabrics in terms of thread count could be due to the fineness of the silk yarns. The thread count in warp direction was almost same due to the fact that similar warp threads were used for weaving of all

the samples. The difference was found in the thread count of weft direction, which might be due to the reason that different types of yarns with different counts were used in weft direction, according to their suitability with Soya warp yarns.



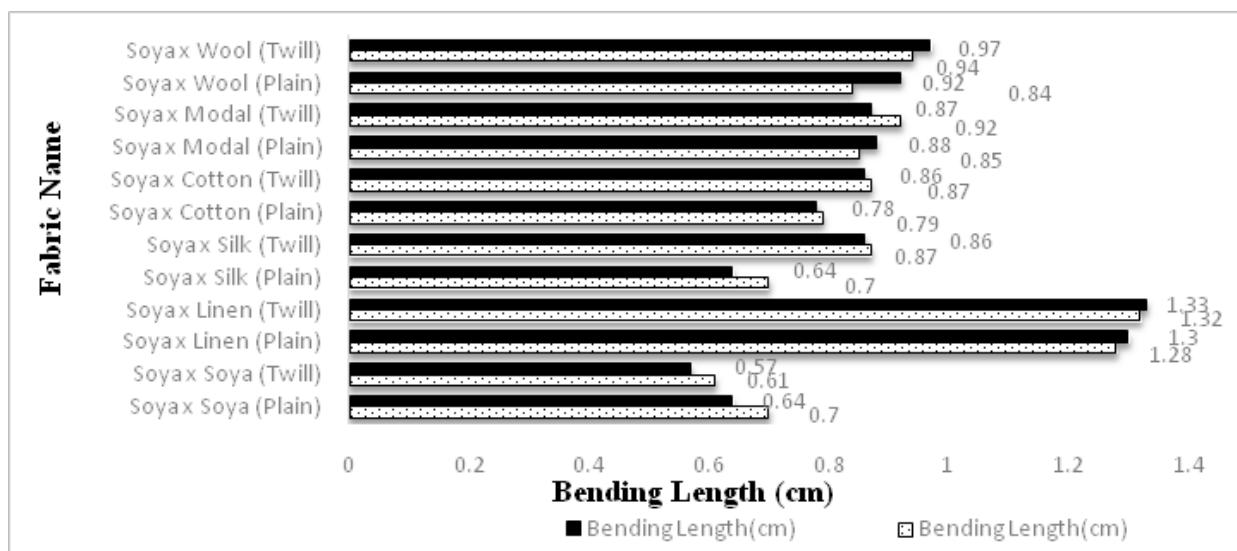
Graph 3: Thread Count of the Woven Samples

In order to check whether fabric structure properties (fabric thickness, fabric weight and thread count) of all the union fabrics was equally acceptable or not, one-way ANOVA test was done which showed that all the union fabric used for fabric structure properties had same level of acceptability. All fabrics were equally liked in terms of fabric structure properties.

### 3.2 Properties Related to Fabric Handle

A. Bending Length - The Soya x Linen sample has a greater value than other fabric may be due to its

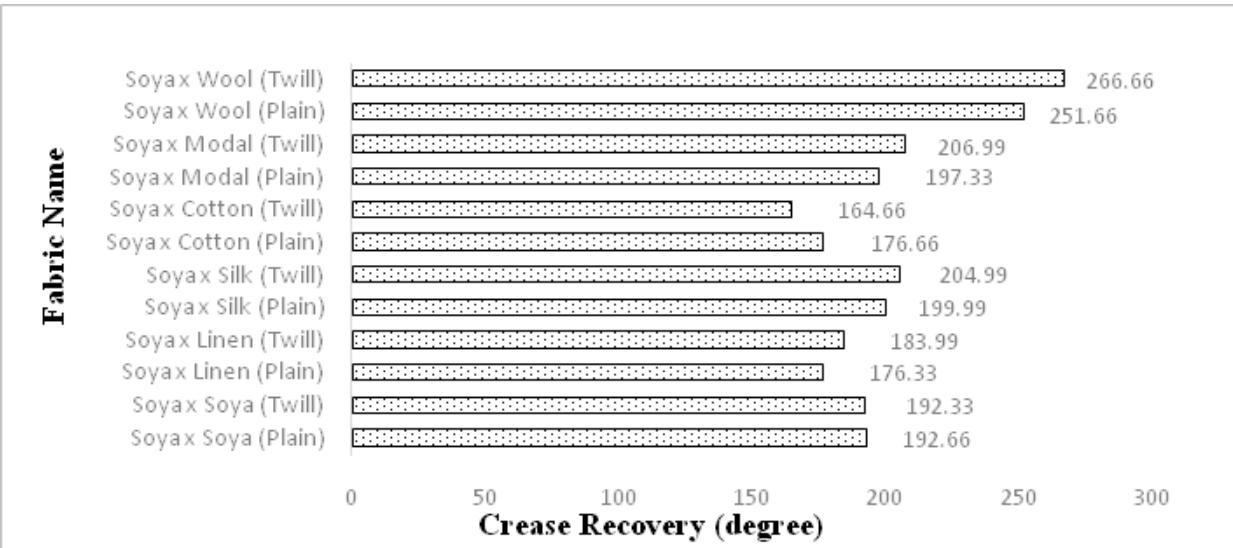
fibre characteristics, yarn structure, yarn count, cloth thickness and fabric weight which indicates that the Soya x Linen sample fabric is rougher and stiffer compared to other fabrics. Also, linen inherently is stiff and has less flexibility. Control samples woven in Soya x Soya showed lowest bending length value indicating that soya yarns are flexible and produce soft and supple fabrics. Soya x silk woven samples also had similar bending length values as the control samples. It may be due to weave which have direct effect on bending rigidity of the fabrics.



Graph 4:Bending Length of the Woven Samples

B. Crease Recovery- The crease recovery of all the woven samples were assessed and observed that the crease recovery of Soya x wool was the highest. Crease recovery of soya x wool, soya x silk and soya

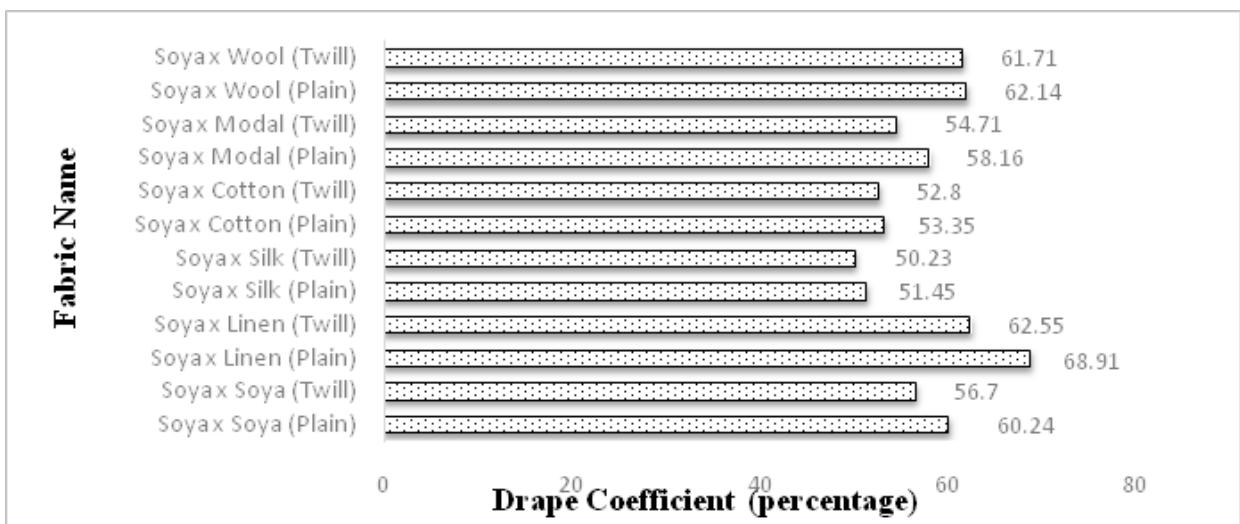
x modal are higher than control samples. Therefore, combining two different types of yarns in production of union fabrics enhanced various fabric properties.



Graph 5: Crease Recovery of the Woven Samples

C. Drape Coefficient - Drape coefficient of all fabrics woven in twill weave was lower than the plain weave samples of the same composition, which means that all twill weave fabrics had higher drapability than plain weave fabrics. Lowest drape coefficient was found in Soya x Silk union

fabrics, indicating that they have the highest drapability. Drape of Soya x Silk, Soya x Cotton and Soya x Modal was found to be better than that of the control samples. Therefore, combining two different types of yarns in production of union fabrics enhanced various fabric properties.

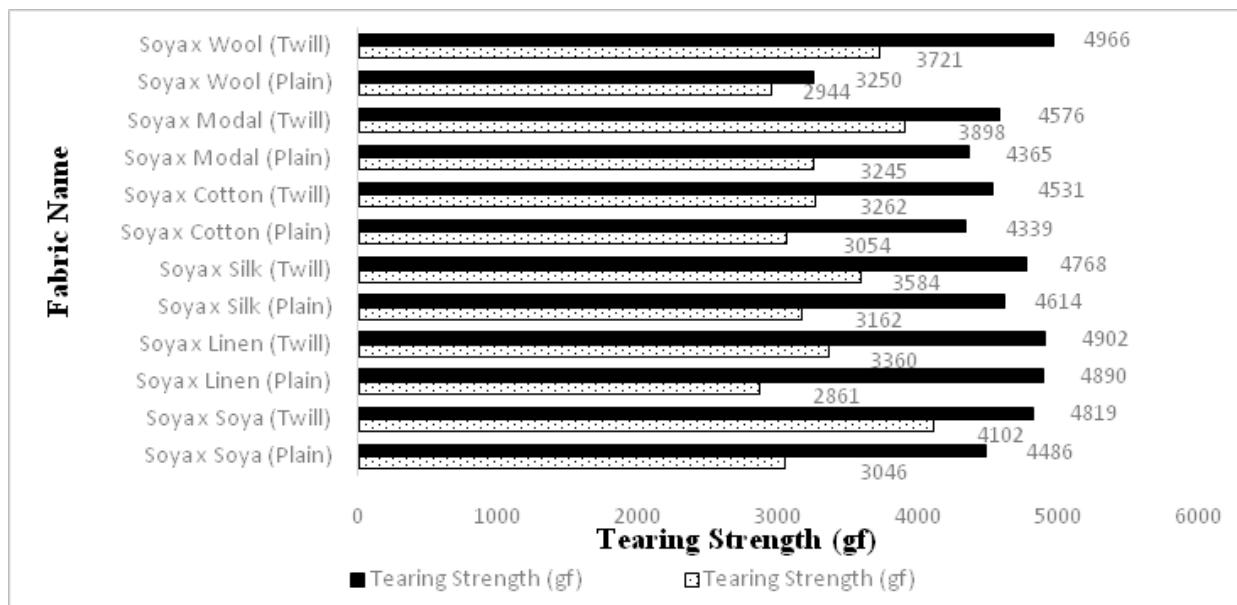


Graph 6: Drape Coefficient of the Woven Samples

In order to check whether handle properties (bending length, crease recovery and drape coefficient) of all the union fabrics was equally acceptable or not, one-way ANOVA test was done which showed that all the union fabric used for handle properties had same level of acceptability. All fabrics were equally liked in terms of handle properties.

### 3.3 Properties Related to Fabric Durability

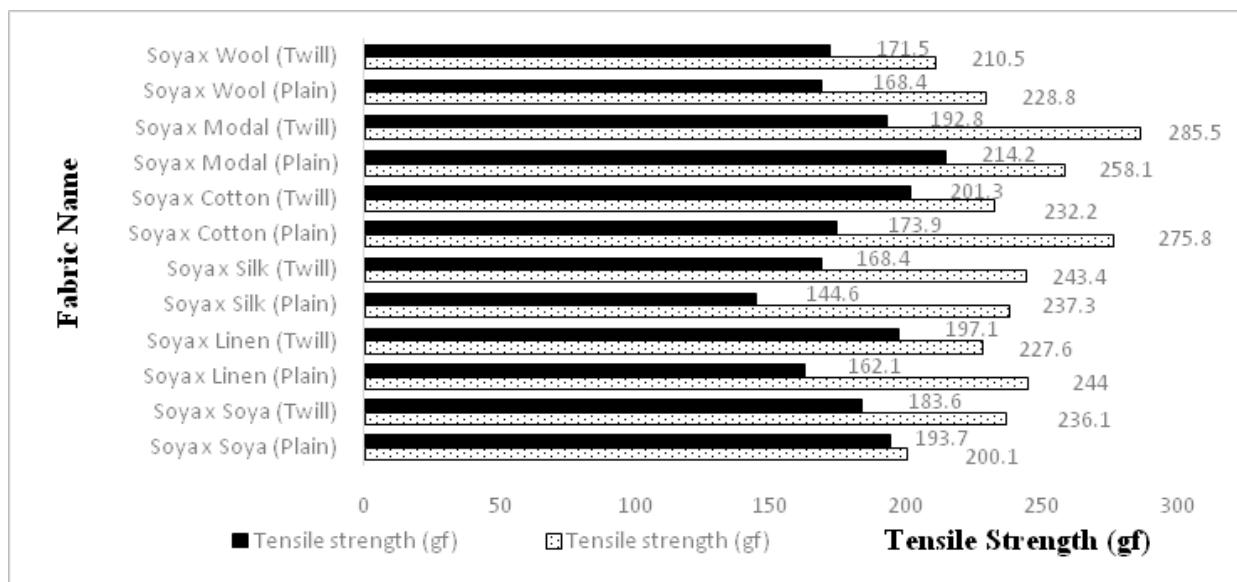
A. Tearing Strength-Excepting soya x wool plain weave fabric, all other fabrics have higher tearing strength than the control samples, which signifies that combining different yarns enhances various fabric properties and can have varied end use applications accordingly.



Graph 7: Tearing Strength of the Woven Samples

B. Tensile Strength-Excepting soya x linen fabric, all other fabrics have lower tensile strength than the control samples. Tensile strength of a yarn or

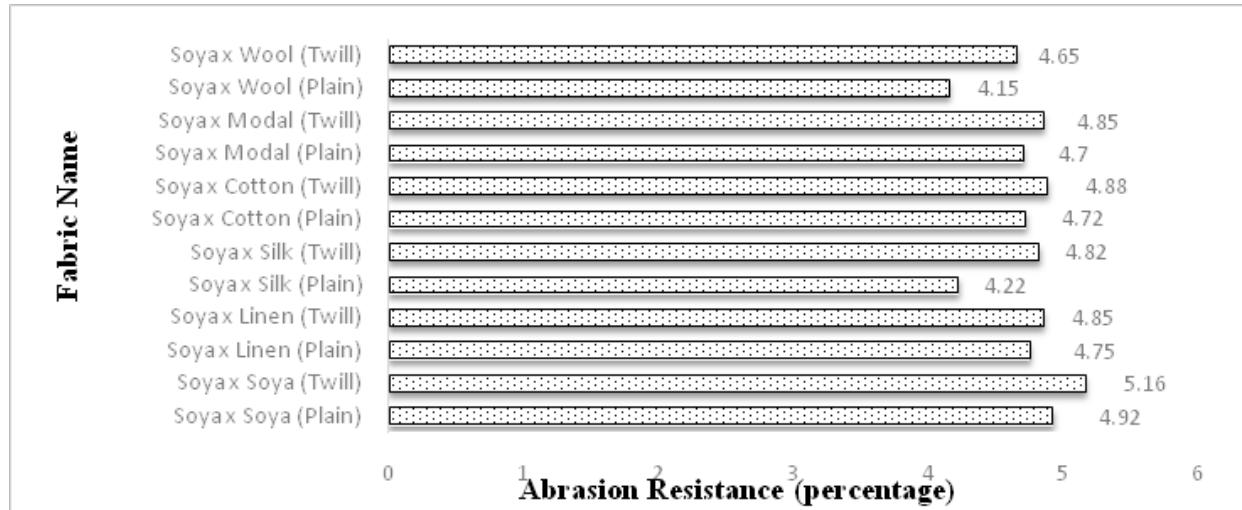
fabric is defined as a maximum load that it will endure without breaking when subjected to uniaxial tensile loading.



Graph 8: Tensile Strength of the Woven Samples

C. Abrasion Resistance-The data revealed that maximum percent weight loss was found in Soya x Soya twill weave sample. Regenerated protein fibres have poor resistance to abrasion as studied by Elder and Fergusan in a research. Natural fibres

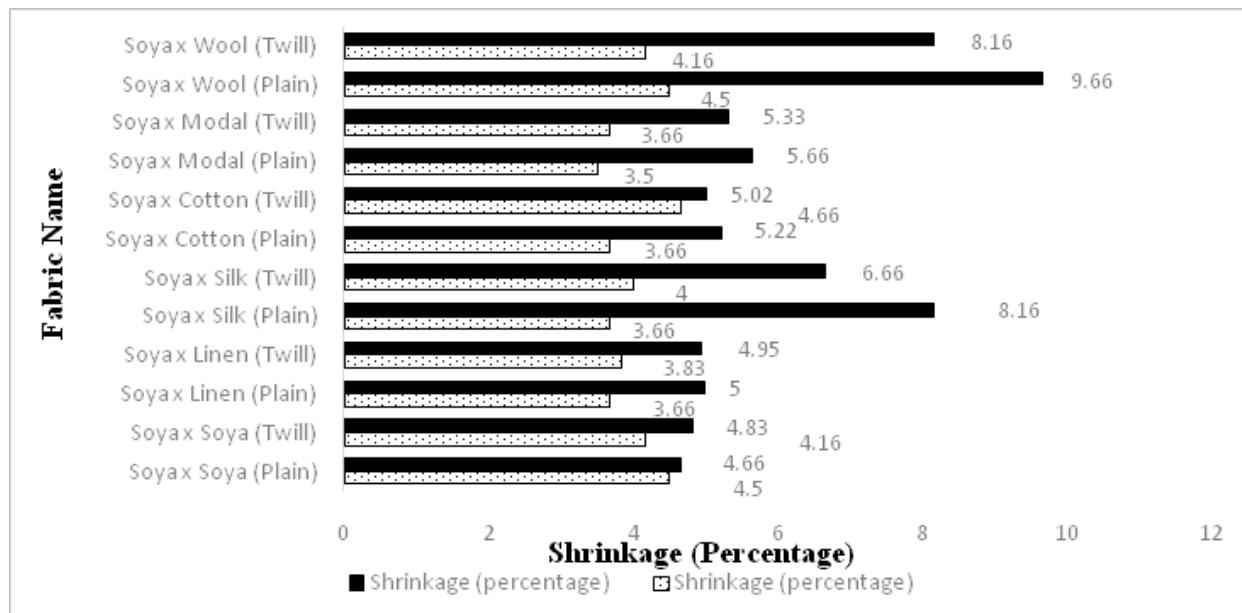
have moderate to low abrasion resistance which is shown by almost similar percent weight loss values. However, mixing soya with other materials has significantly improved the abrasion resistance properties.



Graph 9: Abrasion Resistance of the Woven Samples

D. Shrinkage Resistance-Weft shrinkage is highest in soya x wool, followed by soya x silk, soya x modal, soya x cotton and then soya x linen, probably

due to inherent fibre composition. Control samples have low shrinkage in comparison to other samples except soya x linen.



Graph 10: Shrinkage Resistance of the Woven Samples

A. Response towards Fabric Handle- A survey was conducted to see the response towards the fabric handle of the soya union fabrics. A three-point scoring Performa was used for this purpose. The samples were scored as 1, 2 and 3 corresponding to stiff, crisp and soft respectively against various

attributes. Majority of the respondents like the fabric handle of the soya x cotton plain and twill weave fabric. This probably could be because the respondents felt that the fabric was soft than the other union fabrics.

Table 4: Distribution of Respondents on the Basis of their Preference towards the Fabric Handle

Sample No.	Fabric Composition	Weave	Weighted Score	$\bar{X}$	Rank
SP	Soya x Soya	Plain Weave	147	2.94	III
ST	Soya x Soya	Twill Weave	148	2.96	II
SCP	Soya x Cotton	Plain Weave	149	2.98	I
SCT	Soya x Cotton	Twill Weave	149	2.98	I
SLP	Soya x Linen	Plain Weave	52	1.04	VIII
SLT	Soya x Linen	Twill Weave	52	1.04	VIII
SSP	Soya x Silk	Plain Weave	130	2.60	V
SST	Soya x Silk	Twill Weave	135	2.70	IV
SWP	Soya x Wool	Plain Weave	115	2.30	VI
SWT	Soya x Wool	Twill Weave	110	2.20	VII
SMP	Soya x Modal	Plain Weave	147	2.94	III
SMT	Soya x Modal	Twill Weave	148	2.96	II

In order to check whether fabric handle of all the union fabrics was equally acceptable or not, one-way ANOVA test was done which showed that all the union fabric used for fabric handle had same level of acceptability. All fabrics were equally liked by the respondents in terms of fabric handle.

B. Response towards Fabric Appearance-A survey was conducted to see the response towards the

fabric appearance of the soya union fabrics. A three-point scoring Performa was used for this purpose. The samples were scored as 1, 2 and 3 corresponding to poor, fair and good respectively against various attributes. With respects to fabric appearance majority of the respondents like the soya x soya plain weave fabric appearance followed by soya x cotton plain and soya x modal plain weave.

Table 5: Distribution of Respondents on the Basis of their Preference towards Fabric Appearance

Sample No.	Fabric Composition	Weave	Weighted Score	$\bar{X}$	Rank
SP	Soya x Soya	Plain Weave	149	2.98	I
ST	Soya x Soya	Twill Weave	144	2.88	V
SCP	Soya x Cotton	Plain Weave	148	2.96	II
SCT	Soya x Cotton	Twill Weave	146	2.92	III
SLP	Soya x Linen	Plain Weave	105	2.10	X
SLT	Soya x Linen	Twill Weave	102	2.04	XI
SSP	Soya x Silk	Plain Weave	109	2.18	IX
SST	Soya x Silk	Twill Weave	110	2.20	VIII
SWP	Soya x Wool	Plain Weave	115	2.30	VI
SWT	Soya x Wool	Twill Weave	113	2.26	VII
SMP	Soya x Modal	Plain Weave	148	2.96	II
SMT	Soya x Modal	Twill Weave	145	2.90	IV

In order to check whether all the union fabric appearance was equally acceptable or not, one-way ANOVA test was done which showed that in terms of fabric appearance, all the union fabric had equal levels of acceptability.

C. Response towards Fabric Texture-A survey was conducted to see the response towards the fabric texture of the soya union fabrics. A three-point

scoring Performa was used for this purpose. The samples were scored as 1, 2 and 3 corresponding to rough, moderately smooth and smooth respectively against various attributes. With respects to fabric texture, majority of the respondents like the soya x modal plain weave fabric texture. This probably could be because the respondents felt that the fabric texture was smoother than the other union fabric followed by soya x modal twill weave.

Table 6: Distribution of Respondents on the Basis of their Preference towards Fabric Texture

Sample No.	Fabric Composition	Weave	Weighted Score	$\bar{X}$	Rank
SP	Soya x Soya	Plain Weave	135	2.70	VI
ST	Soya x Soya	Twill Weave	138	2.76	V
SCP	Soya x Cotton	Plain Weave	142	2.84	IV
SCT	Soya x Cotton	Twill Weave	145	2.90	III
SLP	Soya x Linen	Plain Weave	50	1.00	XII
SLT	Soya x Linen	Twill Weave	50	1.00	XI
SSP	Soya x Silk	Plain Weave	126	2.52	VII
SST	Soya x Silk	Twill Weave	125	2.50	VIII
SWP	Soya x Wool	Plain Weave	116	2.32	X
SWT	Soya x Wool	Twill Weave	115	2.30	IX
SMP	Soya x Modal	Plain Weave	150	3.00	I
SMT	Soya x Modal	Twill Weave	149	2.98	II

In order to check whether all the union fabric texture was equally acceptable or not, one-way ANOVA test was done which showed that fabric texture of all the union fabrics developed had equal levels of acceptability.

D. Response towards Fabric Luster- A survey was conducted to see the response towards the fabric luster of the soya union fabrics. A three-point scoring Performa was used for this purpose. The samples were scored as 1, 2 and 3 corresponding to dull, matt and lustrous respectively against various

attributes. With respect to fabric luster majority of the respondents like the soya x modal plain and twill weave fabric texture. This probably could be because the respondents felt that the fabric appearance would be high than the other union fabric followed by soya x cotton twill weave.

In order to check whether all the union fabric luster was equally acceptable or not, one-way ANOVA test was done which showed that in terms of fabric luster, all the union fabrics had equal levels of acceptability.

Table 7: Distribution of Respondents on the Basis of their Preference towards Fabric Luster

Sample No.	Fabric Composition	Weave	Weighted Score	$\bar{X}$	Rank
SP	Soya x Soya	Plain Weave	138	2.76	IV
ST	Soya x Soya	Twill Weave	136	2.72	V
SCP	Soya x Cotton	Plain Weave	145	2.90	III
SCT	Soya x Cotton	Twill Weave	148	2.96	II
SLP	Soya x Linen	Plain Weave	85	1.70	XI
SLT	Soya x Linen	Twill Weave	90	1.80	X
SSP	Soya x Silk	Plain Weave	130	2.60	VI
SST	Soya x Silk	Twill Weave	125	2.50	VII
SWP	Soya x Wool	Plain Weave	110	2.20	IX
SWT	Soya x Wool	Twill Weave	115	2.30	VIII
SMP	Soya x Modal	Plain Weave	150	3.00	I
SMT	Soya x Modal	Twill Weave	150	3.00	I

E. Response towards Fabric Price-A survey was conducted to see the response towards the fabric price of the soya union fabrics. A three-point scoring Performa was used for this purpose. The samples were scored as 1, 2 and 3 corresponding to will not buy, might buy and will buy respectively

against various attributes. With respects to fabric price majority of the respondents like the soya x modal twill weave fabric. This probably could be because the respondents felt that the fabric price is less than the other union fabrics and the quality and the feel of the fabric was good.

Table 8 : Distribution of Respondents on the Basis of their Response towards Fabric Selling Price

Sample No.	Fabric Composition	Weave	Fabric Price/ mt in Rs.	Weighted Score	$\bar{X}$	Rank
SP	Soya x Soya	Plain Weave	505	131	2.62	VI
ST	Soya x Soya	Twill Weave	530	136	2.72	V
SCP	Soya x Cotton	Plain Weave	400	145	2.90	IV
SCT	Soya x Cotton	Twill Weave	410	146	2.92	III
SLP	Soya x Linen	Plain Weave	520	100	2.00	IX
SLT	Soya x Linen	Twill Weave	535	102	2.04	VIII
SSP	Soya x Silk	Plain Weave	495	110	2.20	VII
SST	Soya x Silk	Twill Weave	510	100	2.00	IX
SWP	Soya x Wool	Plain Weave	485	100	2.00	IX
SWT	Soya x Wool	Twill Weave	520	110	2.20	VII
SMP	Soya x Modal	Plain Weave	390	149	2.98	II
SMT	Soya x Modal	Twill Weave	395	150	3.00	I

In order to check whether all the union fabric price was equally acceptable or not related to fabric handle, fabric appearance, fabric lustre and fabric texture correlation matrix test was done which showed that if the fabric price increase then the fabric appearance will also increase and its shows that fabric appearance plays a major role determining the acceptability in fabric price.

## Conclusion

Majority of the respondents liked the woven soya union fabrics. With respect to fabric handle majority of the respondents like the fabric handle of the soya x cotton plain and twill weave fabric. With respect to fabric appearance, majority of the respondents liked the soya x soya plain weave followed by soya x cotton plain weave and soya x modal plain weave. With respect to fabric texture, majority of the respondents liked the soya x modal plain weave fabric texture. This probably could be because the respondents felt that the fabric texture was smoother than the other union fabric followed by soya x modal twill weave. With respect to fabric lustre majority of the respondents liked the soya x modal plain and twill weave fabric texture. With respects to fabric price majority of the respondents like the soya x modal twill weave and soya x modal twill weave fabric.

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# A Study on evaluation of the antibacterial activity of selected herbal plants on non-wovens

Rachita Mandhana and V. Sujitha

## ABSTRACT

*Healthcare is a serious business which is not only influenced by practicing medical professionals. Good hygiene is an aid to health, comfort and social interactions. With the increasing threat from new strains of bacteria and viruses growing problems. Textiles being vulnerable to microorganisms attack would cause many cross infections and allergic reactions. The number of bio-functional textiles with an antimicrobial activity has increased considerably over the last few years. Antimicrobial finish on fabrics can minimize the transfer of microorganisms onto the wearer by creating a physical barrier. Considering the fact this research is taken to study the three herbal plants such as: Lavendula angustifolia mill. (lavender), Matricaria chamomilla L. (Chamomile), Rosmarinus officinalis l. (Rosemary). The medicinal plants were synthesized and processed to optimize under various conditions for extraction and finishing. The optimized conditions of selected herbal extracts was applied on spunlace non-wovens - polyester, bamboo and viscose fabric using a padding mangle. The antibacterial activity assessed in herbal treated and untreated samples against medically important human pathogenic bacteria such as Staphylococcus aureus and Escherichia coli. From the results, it is concluded that the fabrics treated with these three natural sources has remarkable antibacterial activity.*

**Key words:** Anti-microbial finishing, natural plants, extraction, sustainability

## Introduction

The growing consciousness on personal hygiene and the need for cleanliness and freshness has increased over the years. Swachh Bharat and other health care initiatives have given impetus to new thoughts among common people. As a result, the demand for a safe, sustainable, environmentally friendly has increased manifold. Hygiene is derived from "Hygeia" - the goddess of health in Greek mythology. It is defined as the science of health and embraces all factors which contribute to healthful living. Personal hygiene includes bathing, clothing, washing hands after toilet, care of nails, feet and teeth. The aim of personal hygiene is to promote standards of personal cleanliness within the setting of the condition where people live (Pal, 2017).

Sanitation, hygiene, and cleanliness are the hallmarks of a civilized society. Sanitation is critical for health and sustainable socio-economic development. There is an increasing tendency for communities in rural hinterlands to defecate in the open much to the annoyance of officials who are working overtime to deal with different aspects of sanitation with individuals, families and the nation at large. NGOs and the staff and line agencies in the government see this as a crucial aspect for development, as this seems to be the biggest challenge for the governance of development in the 21st century. Cleanliness and hygiene are important from not only the public health point of view, but also socio and economic

development of the family. There is no doubt to say in this era sanitation dictates the human life. India is just above Afghanistan and Pakistan in sanitation indices among developing countries in the world. Even Bangladesh is above India in this crucial social index.

The wearing of clothing is exclusively a human characteristic and is a feature of most human societies. It is used as protection from cold, heat and rain especially as humans migrated to new climates; clothing and textiles have been important in human history and reflect the materials available to a civilization as well as technologies that it has mastered. The social significance of the finished product reflected their culture; sentiments and moods. Its texture, pattern and style, as the order of social rank and as a matter of social discrimination, symbolize the cultural and ritual manifestation that is featured in scriptures, sculptures, literatures, ventures and history and became a very important item during festivals and family functions (Sara, 1991).

The expression 'antimicrobial' suggests a wide variety of products and technologies that give different degrees of defense for textile materials against germs and microorganisms. Antimicrobials products vary in their actions, chemical properties, impact on environment and people, durability, regulatory compliance, handling characteristics,

costs and their interaction with microorganisms. Textile materials inherently do not have any antimicrobial properties. The inherent properties of textile fibers provide room for the growth of microorganisms. Humid and warm environment still aggravate the problem. Many prominent textile brands and manufacture use antimicrobials to value add to textiles and their consumers. (Ahmed, 2014).

Herbs are abundantly available in nature, non-toxic and are cheap. Extracts from plant parts such as roots, leaves, flowers and seeds exhibit antibacterial properties. Due to their eco-friendly nature herbal finishes are gaining significant momentum. These antibacterial extracts can be used as textile finishing agents in solvent form or microcapsules to enhance the durability and controlled release of the extracts. This finish is applied in such a way that appearance and feel of the fabric is not changed and no chemical odour remains. These are applied to textile materials for two purposes as to protect the wearer and the cotton fabric itself. The finish extracts from different parts of plants like flowers, leaves etc. exhibits anti-bacterial properties. Herbs like neem leaves, tulsi leaves, turmeric, pomegranate rind are taken and the finish is extracted from them by using methanol solution. It is applied on to the substrate by using micro-encapsulation and pad-dry-cure method. After the application the assessment of anti-bacterial activity is done by using agar diffusion and suspension method.

Nonwoven fabrics demonstrate specific characteristics such as strength, stretch, resilience, absorbency, liquid repellency, softness, flame-retardancy, cushioning, wash ability, filtering, bacterial barrier and sterility. Nonwoven fabrics can be used in a wide variety of applications, which may be limited life, single-use fabrics as disposable materials or durable fabrics for automotive and civil engineering applications. This increasing market share will be driven by the strong growth in many key disposable markets such as adult incontinence products, filters and protective apparel, and key non-disposable markets such as geotextiles and battery separators. Disposable markets were the majority of nonwoven demand, which accounted for a 64 per cent share (Rajanna, 2017).

## Methodology

*Matricaria chamomilla*, *Lavandula angustifolia*, *Rosmarinus officinalis* were three medicinal plants which were chosen for the research known for their pharmacological properties. *Rosmarinus officinalis* extract is important for its medicinal uses and its powerful antibacterial, cytotoxic, anti-mutagenic, antioxidant, anti-phlogistic and chemo-preventive properties. The extracts of lavender (*L. angustifolia*) has antibacterial activity at doses of 4.0-9.0 mg/ml. Traditionally, chamomile has been used for centuries as an anti-inflammatory, antioxidant, mild astringent and healing medicine. The properties of these plants make it suitable for the study and were collected from Aum Freeze, Vadodara.

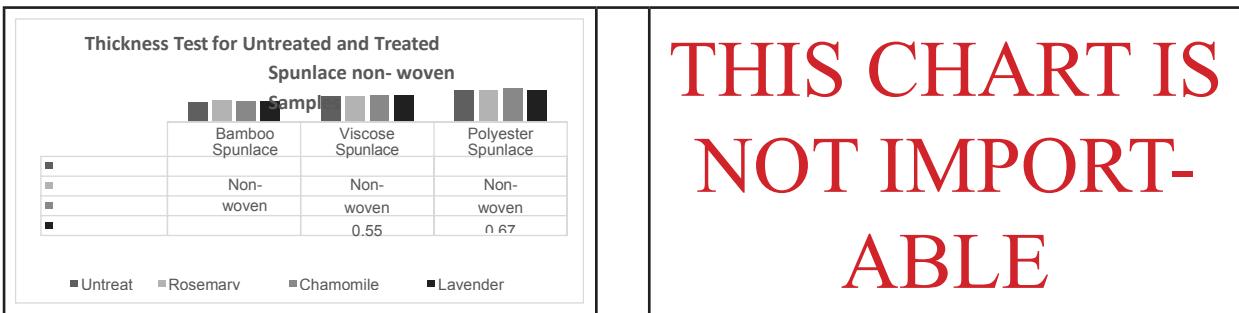
Spunlaced Bamboo (100 GSM), Viscose (80 GSM), Polyester (80 GSM) were also chosen for the study due to the properties of spunlace non-wovens. These non-wovens were collected from SITRA, Tamil Nadu.

The plant source was suspended with required amount of ethanol to make a concentration of 5%, 10%, 15% at 60°C for 6 hours using Shaker Incubator technique at rpm of 120. 15% extract was later chosen due to best antimicrobial zone of inhibition. For finishing extract 1%, citric acid 5% and the selected nonwoven fabric was soaked in the for 5 mins with continuous stirring for even dispersal of extracted solution onto the fabric. The padding mangle was set at 80% expression and the process was finally carried out following 2 dip and 2 nip process. After the padding process the finished fabric was placed in a baking dish, then dried in the hot air oven at 80°C for 5 mins and then cured at 120°C for 5 mins. The finished samples were assessed for physical properties like Thickness, Stiffness, Absorbency and functional property like antimicrobial resistance (AATCC 147).

## Results and Discussion

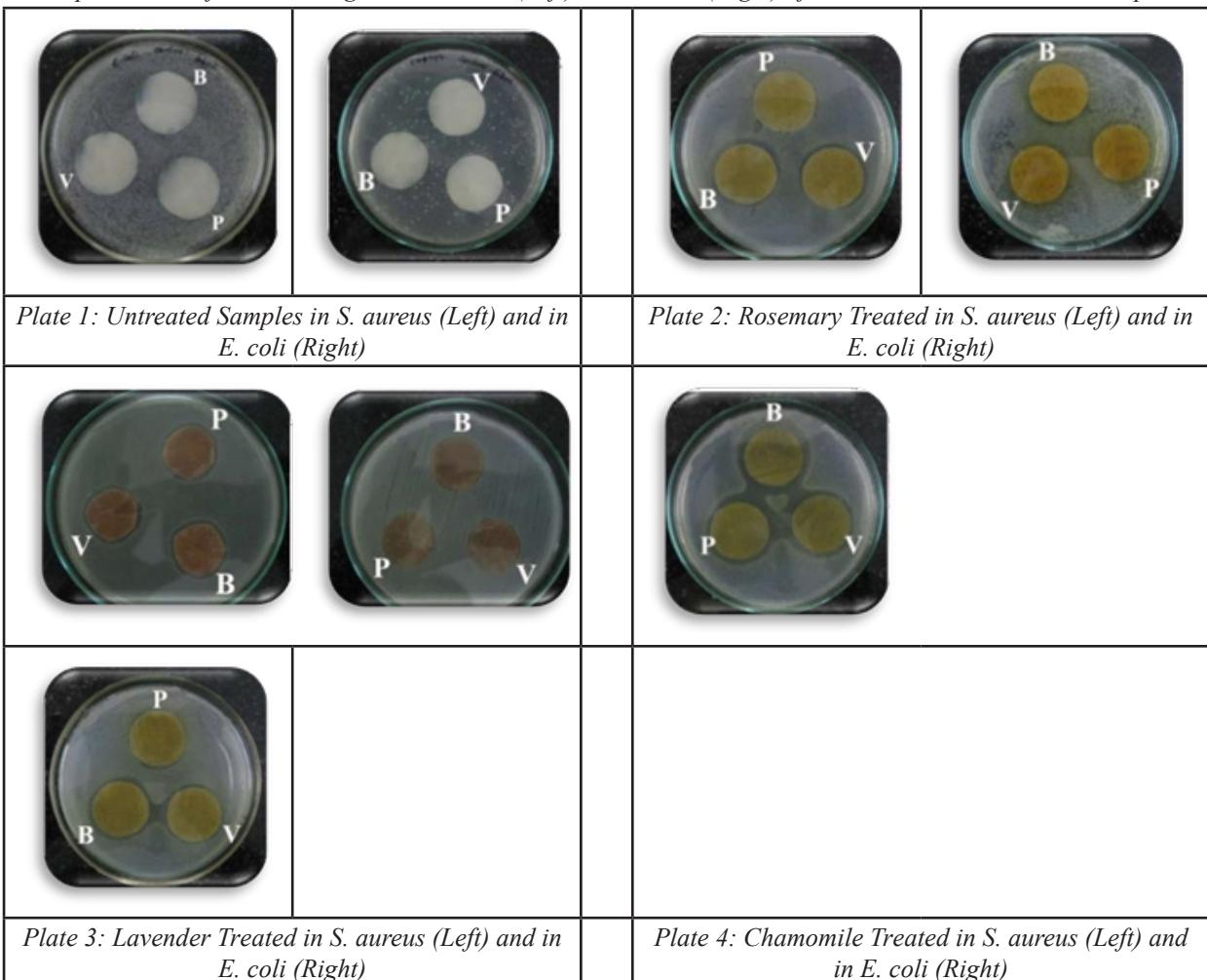
The finished samples were tested for functional antimicrobial property and physical tests like Thickness, Stiffness and Absorbency.

**Functional Antimicrobial Property Assessment:** All the finished samples and unfinished samples were tested for antimicrobial properties by Agar diffusion Test method (AATCC 147) and accordingly results were discussed:



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Graph 1: Zone of Inhibition against *S. aureus* (Left) and *E. coli* (Right) of all Untreated and Treated Samples



As Illustrated in the (Plate 2, 3 & 4) and the table it is revealed that the Bamboo sample(B) showed more activity of zone formation against *Staphylococcus aureus* than the other samples viscose and polyester against *E-Coli*. This is also because Bamboo Fabric possess inbuilt antibacterial properties. After Bamboo Fabric(B), Viscose Fabric(V) shows best activity zone of formation against *Staphylococcus aureus* than Polyester sample(P).

From the above table 1, it is seen that the natural plant extract has better effect on the bacterial strains which is exhibited by showing zone formation by inhibiting its growth around the test samples. The control sample seemed to have no effect on the

test organisms whereas the herbal finished samples exhibited better zone of inhibition than the unfinished group. Sample bamboo treated with chamomile extract has exhibited the maximum zone formation of 1 mm and 0.7 mm against *S. aureus* and *E. coli*. Minimum zone formation was noticed in the sample polyester with 0 and 0.1 mm against *S. aureus* and *E. coli* compared to the plant finished samples. This may be due to the smaller size of the particles which is coated and also possess controlled and sustained release of the finished antibacterial agent.

## Physical Property Assessment

**Thickness:** All the untreated and treated fabric was assessed for thickness using a Thickness Gauge and

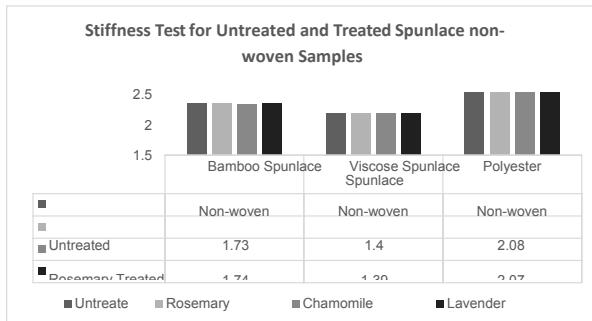
results were discussed: With reference to the below illustrated and graph (2), the mean value of spun lace fabric thickness of bamboo varies from 0.43-0.45 mm, polyester ranges between 0.68-0.7 1mm and viscose varies from 0.55-0.58 mm.

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*Graph 2: Graph for Thickness Test Readings for Untreated and Treated Spunlace non-woven Samples*

The Rosemary, Chamomile and Lavender treated samples such as bamboo, viscose and polyester remarked an increase in thickness of 0.1- 0.3 mm which may be due to the nature of finishing to form a thin film like coating on the fibre surface thus altering the soft fabric to a stiffer and coarser one thereby increasing the fabric thickness.

**Stiffness:** All the untreated and treated fabric was assessed for Stiffness using a Shirley's Stiffness Tester and results were discussed: From Graph (3), it is evident that the stiffness of the plant extract finished samples have reduced. The stiffness of the treated spunlace samples decreased by 1-3% when compared to the original untreated sample. The decrease in stiffness is very minimal, there is no difference but it may increase the comfort properties of the all spunlace fabrics and this may be because the finishing treatment has softened the treated fabric.



*Graph 3: Graph for Stiffness Test Readings for Untreated and Treated Spunlace non-woven Samples*

**Absorbency:** All the untreated and treated fabric was assessed for Absorbency using a Spray Tester and results were discussed. From the evaluation bamboo spun lace non-woven fabric has the highest absorbency rate in all three treated sources in this

study whereas the least absorbency rate possessed by polyester spun lace in non-woven fabrics. Viscose spun lace non-woven has the moderate absorbency rate. Bamboo fabrics need less plant extracts than cotton, modal or viscose due to the higher rate of absorption. It seems that the absorption of plant extracts is remarkably better. Bamboo absorbs the plant extracts faster and shows the purpose of finishing better.

### Conclusion

Traditionally, complementary and alternative medicines are widely used and are rapidly growing health systems, including Chinese medicine, Indian ayurveda, and Arabic medicine, which use plant material, animal parts, and/or minerals. Among them, the potential health-promoting effects of plants can be traced back to the earliest recorded history. The use of herbs includes herbal materials, herbal preparations, and finished herbal products that contain active ingredients, the parts of plants, other plant materials, or their combinations. The essential aim of the present study was the exploration of anti-microbial properties of Chamomile, Rosemary and Lavender extracts on spun lace non-woven fabrics such as bamboo, polyester and viscose to advent a new technology in consumer needs. These selected plants were extracted and study was carried for individual plant extracts. The selected spunlace non-woven fabrics were treated with selected plant extracts using pad-dry-cure method where less amount of water is used for the entire finishing process. The treated fabrics were found to be very hygienic by evaluation of anti-bacterial activity. Then the treated samples were subjected to physical testing where the results found to be improved than untreated ones. Thus the results of this study evidenced the ancient remedies with modern technology which promotes hygiene in a more efficient way.

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# A Study on The Properties of Unconventional Fibres For the Fabrication of Textile Composites

Princy Jain and V. Sujitha

## ABSTRACT

Nowadays, due to environmental concerns and financial problems of synthetic fibres, natural fibres or bio-fibres are interesting to be used as reinforcement fibres in polymer composites for structural elements and construction materials. Chemical surface modification method is a well-known method to increase the interfacial bonding strength between fibres and polymer matrix. The alkaline treatment not only affects the surface but also the texture of fibre resulting in the variation of the mechanical and physical properties. The present work focuses on extraction of Betel nut (*Areca catechu*) leaf fibre and Sunnhemp fibre (*Crotalaria juncea*) with alkali treatment process by using 6% of sodium hydroxide solution, composite preparation and determination of mechanical properties of composite. Various fibre tests were performed on the untreated fibres. The treated fibres were converted to mat by interlacing of the fibre bundles. 3 kinds of mats were made Sunnhemp fibre, Betel nut fibre and a hybrid of both Sunnhemp and Betel nut fibre. Various samples of composites were made by varying the number of mat layers using polyester resin as a matrix. The investigation of mechanical and morphological properties of the treated Betel nut fibre and Sunnhemp fibre reinforced composites was done against Polyester composite by following Indian standard procedures.

**Key words:** Sunnhemp fibre, Betel nut fibre, fibre testing, alkaline treatment, surface modification, fibre reinforced composites, mechanical and morphological properties

## Introduction

Natural fibres are currently attracting a lot of attention for reinforcement. Fibre reinforced composites consists of fibre as reinforcement and a polymer as a matrix. Natural fiber polymer composites (NFPC) are a composite material consisting of a polymer matrix embedded with high-strength natural fibers. Natural fibres used as reinforcement can be classified into many categories, i.e. bast, seed, fruit, straw fibre, leaf, and grass fibres. There is a wide selection of natural fibre used as reinforcement in polymer composites such as kenaf, hemp, jute, and coir. Their special advantage is their low cost, low density, good mechanical properties, biodegradability, etc. The advantage of natural fibre composites includes lack of health hazards and non-abrasive nature. Natural fibres provide stiffness and strength to the composite and are easily recyclable. These fibres exhibit good reinforcing properties in polymer composites; they have low density and are cost effective. They are less hazardous to humans during fabrication and handling as compared to synthetic fibre; hence it is a good option to employ natural fibre as reinforcement in polymer composites (Väisänen et. al., 2017).

Agricultural crop by-products are a good source of natural fibre. Most of the developing countries are very rich in agricultural fiber production and a large part of agricultural waste is being used as fuel. India produces more than 400 million tons of

agricultural waste, such as bagasse, maize cobs, peanut shells and other wastes. Agricultural residues are excellent potential alternative waste materials to substitute plastic products, due to their availability. Apart from their abundance and renewability, the utilization of agricultural residues is advantageous to the economy, environment, and technology, due to their low density, low manufacturing energy demand, low CO<sub>2</sub> emission, and high level of biodegradability, when compared to thermoplastic polymer composites reinforced by inorganic fillers (Obi et al., 2016).

Industrial uses of natural fibers increasingly gain attention from various manufacturing sectors. Natural fibers reinforced composites are emerging very rapidly as the potential substitute to the metal or ceramic based materials in applications that also include automotive, aerospace, marine, sporting goods and electronic industries. Natural fiber composites exhibit good specific properties, but there is high variability in their properties. Many automotive components are already produced with natural composites, mainly based on polyester or Polypropylene and fibers like flax, hemp, or sisal. The adoption of natural fiber composites in this industry is led by motives of price, weight reduction, and marketing rather than technical demands. Germany is a leader in the use of natural fiber composites. The German auto-manufacturers, Mercedes, BMW, Audi and Volkswagen have taken

the initiative to introduce natural fiber composites for interior and exterior applications. In structural applications and infrastructure applications, natural fiber composites have been used to develop load-bearing elements such as beam, roof, multipurpose panel, water tanks and pedestrian bridge (Sanjay et. al., 2016).

The major downside of utilizing natural fibres in polymer composites is the incompatibility between the hydrophilic nature of natural fibre and hydrophobic properties of polymer matrix, which generally leads to poor fibre-matrix interfacial adhesion. Poor interfacial adhesion between fibre and matrix affects the mechanical properties of the composites due to interruption of good stress transfer at the fibre-matrix interface. Many methods have been investigated to alter the natural fibre surface in order to improve the compatibility of natural fibre with most types of polymer matrix. Common surface treatments for natural fibres are alkali and silane treatment, acetylation, grafting methods, and uses of chemical agents to improve the fibre-matrix bonding. Among these treatments, alkali treatment is often chosen to improve the adhesion properties of natural fibre, as it is considered more economical compared to other types of chemical treatment (Kabir et. al., 2012).

Sunnhemp (*Crotalaria juncea* L.) is one of the important textiles fibres extracted from outer bark of the stem is considered oldest fibre yielding crop of India. It ranks second to jute among bast fibres and is more durable, lighter in colour and fairly resistant to moisture, mildew and micro-organisms. The fibre has high cellulose content, low lignin and negligible ash. The properties of the fibre make it ideal for making specialty paper fibre, high quality tissue paper, cigarette paper and paper for currency. The bast fibres are used for cot stringing, unsized twine, fishing nets, matting, sacking, marine cordage, coarse canvas, bags, rope and maybe mixed with jute fibres. It is a long, soft, shiny vegetable fibre that can be spun into coarse, strong threads. Sunnhemp is an attractive natural fibre for use as reinforcement in composite because of its low cost, renewable nature and much lower energy requirement for processing (Bhatt et. al., 2014).

Arecanut (*Areca catechu*) fiber possesses a very good fiber surface roughness, this will intern help in achieving better interfacial bonding between fiber and matrix, which will lead to high mechanical properties for the composites. In present days,

these areca husks being widely used as fuel in the processing of areca nut. The unmanaged green areca husk left in the plantation causes terrible odor and other decay-related problems. Therefore, an extensive planning for the disposal of husk is necessary. Thus, the use of this unmanaged and under-utilized husk as reinforcement to structural material has been thought and some amount work has been done (Sanjay, 2016).

### Methodology

Arecanut (*Areca catechu*) and sunnhemp (*Crotalaria juncea* L.) were the two plants chosen for fiber extraction. Arecanut fruit husk and sunnhemp stem were the source for extraction of fibres. The Arecanut fruit was collected from the local markets of Kolkata and the sunnhemp stems were collected from Vruksha composites and services, Chennai.

Water retting process of extraction was chosen for extraction of fibers. Arecanut fruits were soaked in water at room temperature for 5 days to loosen the fiber. The Arecanut fibers were separated manually from the nut part by hand stripping method and washed thoroughly with distilled water before drying in oven at 70°C for 24 h. The stems of sunnhemp plant were left as such until complete microbial degradation of fleshy pulp of the stems occurs. The loosened fibres were washed thoroughly with plain water and dried in sunlight for about 2 days. Dry retted fibres are washed with detergent solution, and cleaning the fibres.

Then both the extracted fibers went under alkaline treatment for surface modification of the fibers. Both the fiber was treated with 6 % NaOH (sodium hydroxide) to the total volume of solution. Arecanut fibres were treated for 1 hour at room temperature and Sunnhemp fibre were treated for 3 hours at room temperature, it was thoroughly washed in running water to remove all the chemical traces. After the extraction of fibers, a fiber woven mesh was made by combing and cutting the fibers of appropriate length. A mould of 100 mm x 100 mm and 15 mm in depth was made out of thermocol for the preparation of the composite. Polyester resin- BCC53 and its corresponding resin were mixed in a ratio of 10:1. The mixture was poured and then the woven mesh was placed dried and cured at room temperature. Arecanut, sunnhemp and Arecanut and sunnhemp combined reinforced composites were achieved.

The extracted fibers were assessed for its Chemical Composition, Mechanical Property like strength and

elongation, Physical Properties like length, density, fineness, moisture content, Fibre Characterization (SEM analysis). For the composites, Mechanical Properties like Tensile Properties, Impact Test, Flexural test and Morphological Study (SEM analysis) was carried. The testing was done at Prodcontrol (India) Pvt. Ltd.

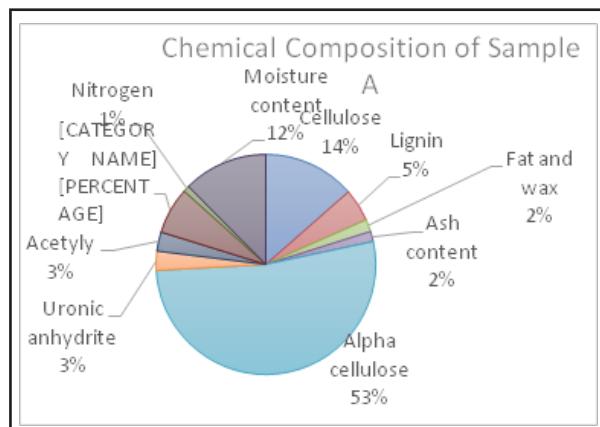
## Results and Discussion

The extracted fibers were assessed for its Chemical Composition, Mechanical Property like strength and

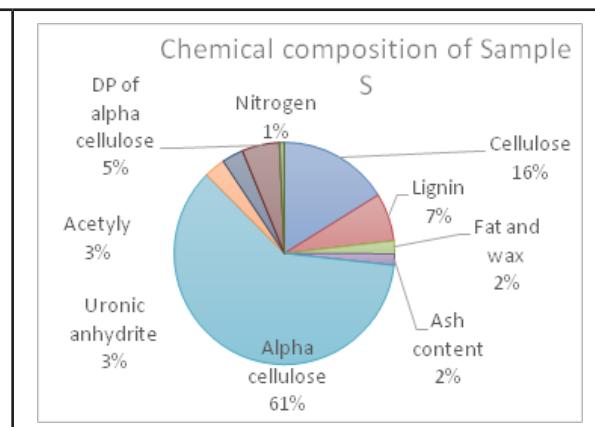
elongation, Physical Properties like length, density, fineness, moisture content, Fibre Characterization (SEM analysis). For the composites, Mechanical Properties like Tensile Properties, Impact Test, Flexural test and Morphological Study (SEM analysis) was carried.

### Fiber testing

**Chemical composition:** The chemical composition for fibres was examined by chemical testing where the samples are subjected to dissolve.



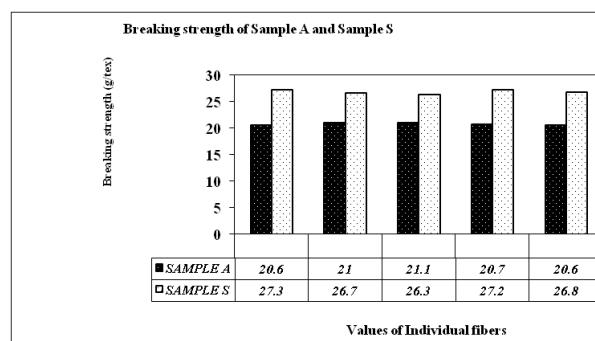
Graph 1: Chemical composition of Sample A



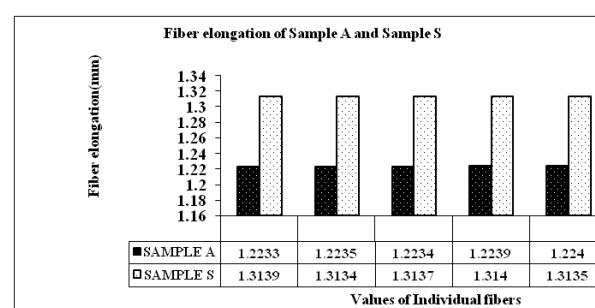
Graph 2: Chemical composition of Sample S

As illustrated in graph 1 and 2, both the fibers have high cellulose content which makes them pliable, absorbent and strong. Lignin amounts of 6.3 per cent for sample S and 4.8 per cent for sample A which is mainly responsible for the fibre stiffness. Both the extracted S and A fibres have a high cellulose with low lignin, wax and ash contents. Hence it was suitable to be used as a textile fibre for various applications.

**Breaking Strength and Elongation:** The extracted fibers were tested for breaking strength and elongation using ASTM D638 standard.



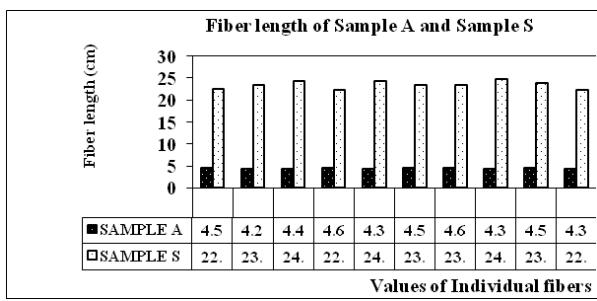
Graph 3: Breaking strength of Sample A and Sample S



Graph 4: Fiber elongation of Sample A and Sample S

Breaking strength donated in graph 4 shows the maximum tension the fiber is able to withstand before breaking. Among the tested samples, Sample A shows the good tensile. From graph 4 it can be seen that among the tested samples, Sample A shows the good elongation which is a good property while selecting a fiber for composite.

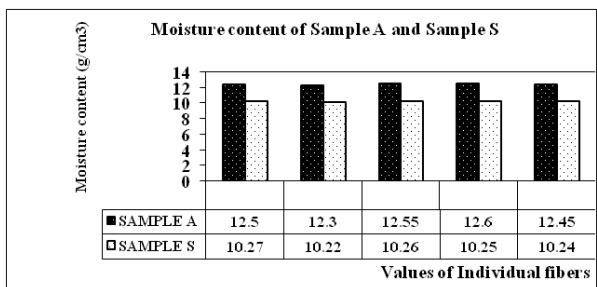
**Length:** The fibre length of Sunnhemp and Areca nut fibres were measured by straightening the fibres one by one over a calibrated metal scale directly.



Graph 5: Fiber length of Sample A and Sample S

From graph 5 it can be observed that the fiber length varies for both the sample. Sample A is extracted from the fruit of Areca nut whereas Sample S is extracted from the stem of sunnhemp plant.

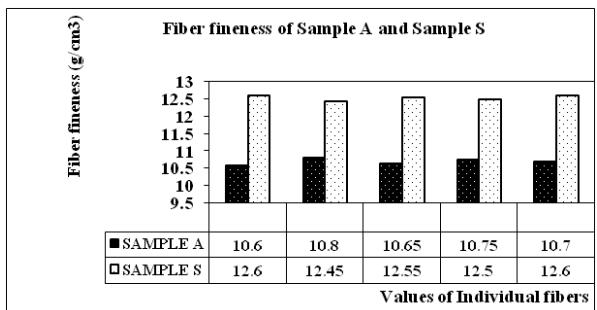
Moisture content: Moisture content of both the fibres were determined as per ASTM D 629-1999 and BIS - 2000 method.



Graph 6: Moisture content of Sample A and Sample S

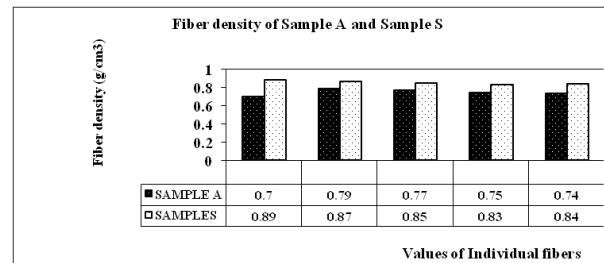
The cellulose content in Sample S higher than Sample A leading to higher moisture absorbency. The presence of hollow structure in the fiber attracts the water molecule leading to higher moisture content. Sample A as compared to Sample S has no free space to trap in moisture leading to comparatively less moisture content.

Fineness: Fineness or linear density of cut staple fibre was determined by following the procedure recommended by Committee D-13, A.S.T.M.



Graph 7: Fiber fineness of Sample A and Sample S

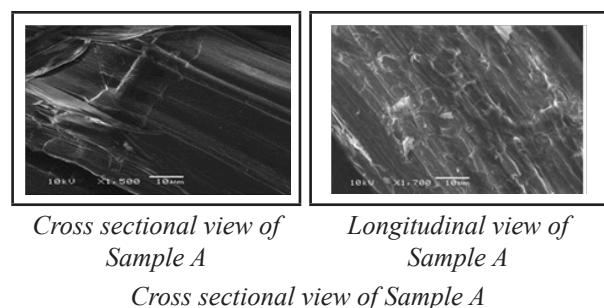
Fineness determines how many fibers are present in the cross section of the fiber which not only provides extra strength, but also better distribution in the yarn. Sample S seems to be finer by having a value of 12.5 tex when compared to sample A which has fineness of 10.7 tex. Sample S is more finer resulting in better strength and elongation. Density: The density measurement of the both fibres was carried out using standard procedure.



Graph 8: Fiber density of Sample A and Sample S

Sample S has the density of 0.86 g/cc and sample A has the density of 0.74 g/cc which was less when compared to other cellulosic fibres. Due to the presence of hollow space the density of Sample S increases. Sample S and A being cellulosic in nature have negligible variation in its physical properties. But the strength of the fibre seems to have much difference. Hence both the fibres were selected for this study.

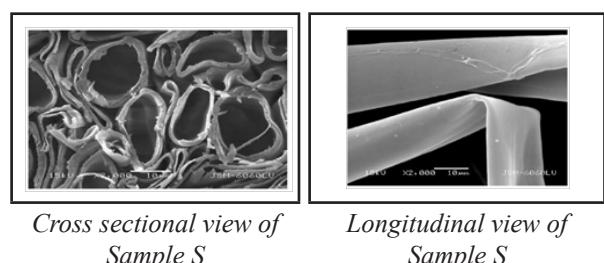
Fibre Characterization: SEM analysis was performed by using a JEOL - MODEL 6390 electron microscope.



Cross sectional view of  
Sample A

Longitudinal view of  
Sample A

Cross sectional view of Sample A



Cross sectional view of  
Sample S

Longitudinal view of  
Sample S

Plate 1: SEM image of Sample A and Sample S

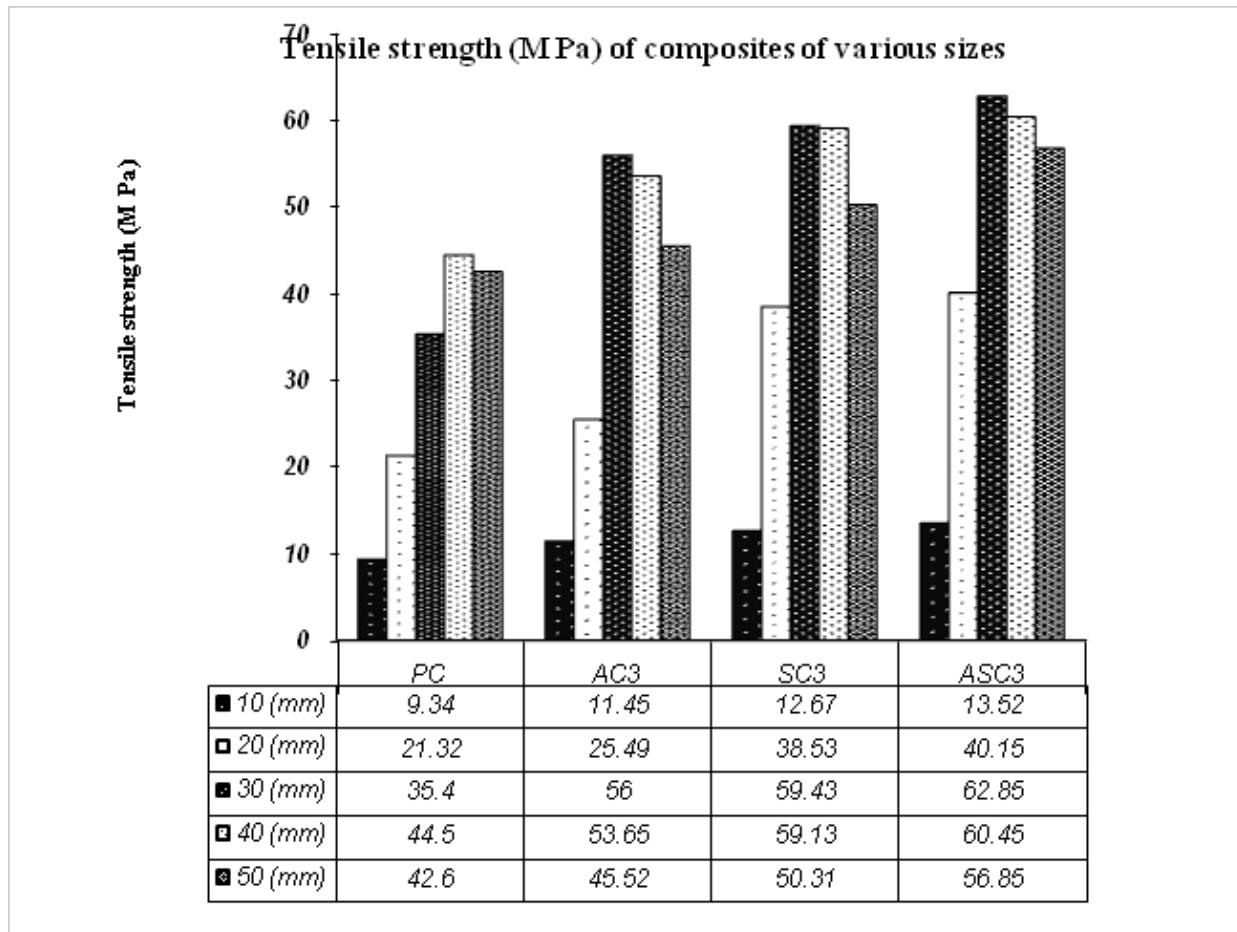
Both Sample A and S was magnified up to  $10\mu\text{m}$  for its cross sectional and longitudinal view. Sample A has a mesh like a structure having no boundaries which may result in less strength and may leading easy breaking of the fiber. The cross-sectional view of sample A shows large empty spaces which are irregular in shape. The longitudinal section shows that the fibrils are arranged in a cylindrical manner. Sample S has small empty spaces called voids or lumen which was clearly visible along cross-

sectional view. Hollow cylindrical rod like structure having very fewer protruding ends. It has irregular structure which may possibly lead to providing greater strength to the fiber.

#### Fiber reinforced composite testing

Tensile Test (ASTM D3039), Flexural Test (ASTM D4812-99) and Impact Test (ASTM D790) and SEM analysis were studied for the composite samples. They are discussed as follows.

**Tensile test:** The testing of the prepared composites was done for various sizes for all the samples. The observation are as follows:

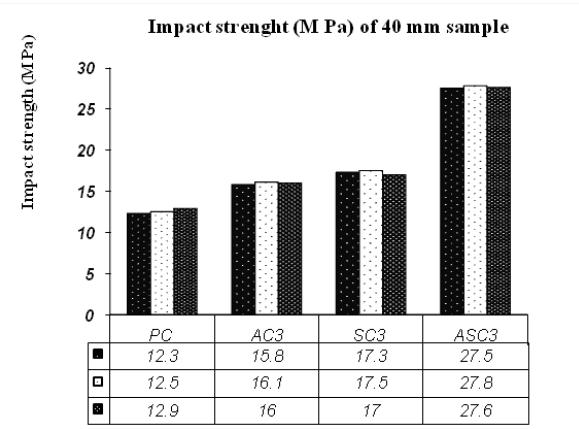


Graph 9: Tensile strength of PC, AC3, SC3, ASC3 samples in various sizes

From the graph 9 it can be evidently seen that Sample ASC3 showed the maximum tensile strength of 62.85 M Pa followed by the sample SC3 of 59.43 M Pa followed by sample AC3 of 56 MPa and least by sample PC OF 21.32 M Pa. It showed a drastic change in the strength for different sizes well as for different composition of samples. Size wise the strength of the composite firstly increases and then decreased. Hence it could be concluded that the

tensile strength of the sample AC3, SC3 had better tensile strength as compared to sample PC because of the reinforced fibers but when the 2 fibers were combined sample ASC3 had greater strength than the sample AC3, SC3 and PC.

**Impact strength:** The testing of the prepared composites was done for 40 mm sample size for all the samples. The observation are as follows:

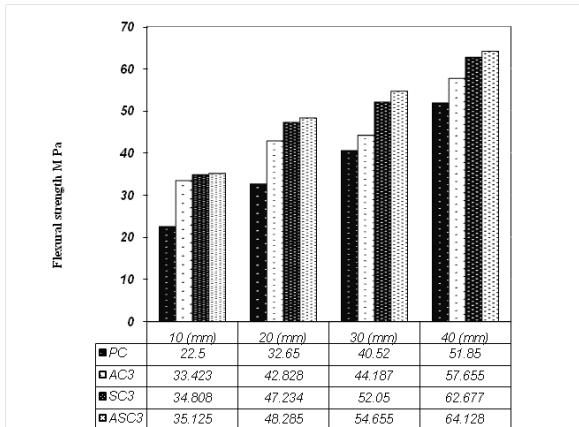


Graph 10: Impact strength of PC, AC3, SC3, ASC3 samples in various sizes

From the graph 10 it can be clearly observed that Sample ASC3 has higher impact strength of 27.63 M Pa and sample PC has a lowest impact strength of 12.56 M Pa. It was clearly found that impact strength of surface modified fibre samples such as AC3, SC3, ASC3 shows variation when compared to sample PC.

Flexural strength: The testing of the prepared composites was done for various sizes for all the samples. The observation are as follows:

Flesural strength (M Pa) of composites of various sizes



Graph 11: Flexural strength of PC, AC3, SC3, ASC3 samples in various sizes

The graph 11 clearly depicts that flexural strength was higher for sample ASC3 (64.12 M Pa) which was followed by SC3 (62.877 M Pa). Minimum flexural strength was noticed in sample PC (51.85 M Pa).

Morphological Study(SEM analysis): SEM analysis was performed by using a JEOL - MODEL 6390 electron microscope.

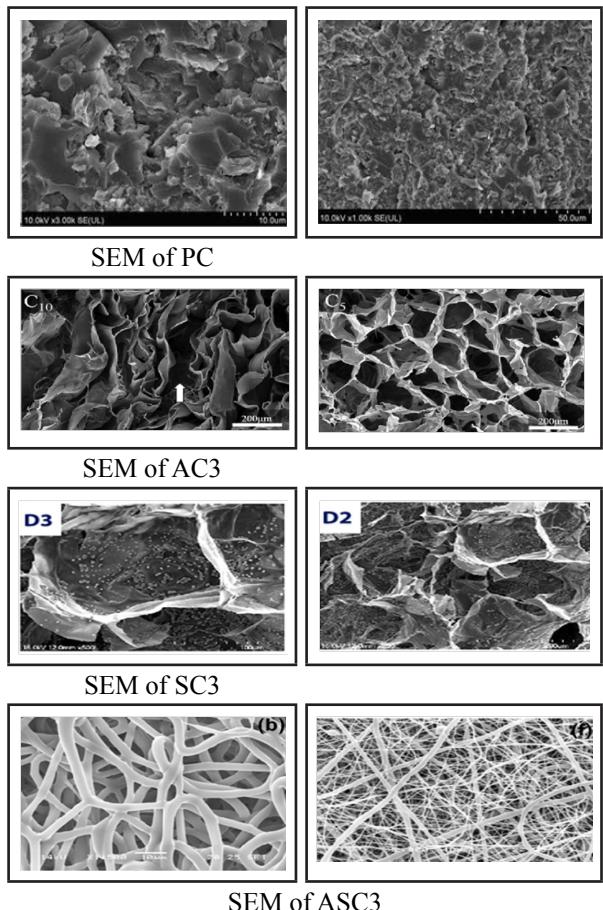


Plate 2: SEM of prepared samples

In the PC sample which is not reinforced with the fiber. The fractured surfaces of each composite revealed extensive interfacial delamination between the fibre and the matrix. It indicates that ligno cellulosic fibres were hardly wetted by the PP fibre matrix with a gap developing around the fibres. The fibres also stay intact after fracture. Pulled-out fibres and gaps are generally observed when the adhesion between fibres and matrix is not sufficient, and this suggests poor fibre-matrix compatibility. This results in low tensile modulus and tensile strength of the composites. In contrast the composites made of treated fibres were found to be uniformly coated by the matrix. This indicates that the fibres are more compatible with the PP fibre matrix.

## Conclusion

Natural fibres are currently attracting a lot of attention for reinforcement. Fibre reinforced composites consists of fibre as reinforcement and a polymer as a matrix. There is a wide selection of natural fibre used as reinforcement in polymer composites such as kenaf, hemp, jute, and coir. The present work focused on extraction of Betel nut (*Areca catechu*) leaf fibre and Sunnhemp fibre (*Crotalaria juncea*) with alkali treatment process by

using 6% of sodium hydroxide solution, composite preparation and determination of mechanical properties of composite. Various fibre tests were performed on the untreated fibres. The treated fibres were converted to mat by interlacing of the fibre bundles. 3 kinds of mats were made Sunnhemp fibre, Betel nut fibre and a hybrid of both Sunnhemp and Betel nut fibre. The investigation of mechanical and morphological properties of the treated. Both the fiber properties made the fiber suitable for composite. The composites also showed better properties than that of the standard Polyester composite sample. Out of all the composites prepared, combination of Areca nut and Sunnhemp reinforced composites showed the best results.

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# **Zero Waste Designs for Girls Wear: A Sustainable Approach**

*Vidushi Saraf and Samita Gupta*

## **ABSTRACT**

*Apparel sector is one of the major sectors competing for natural resources and is gaining awareness of the environmental risks and is ready to act. The first step is for the companies to measure their environmental impacts and understand areas where they can improve as a sustainable approach. With this idea, the present research is an attempt to introduce and exhibit the concept of zero waste fashion. Zero-waste fashion refers to items of clothing that generate little or no textile waste in their production. There are two general approaches: Pre-consumer zero waste and Post Consumer Zero waste fashion. The majorly focus of this research is on Pre-consumer approach. Pre-consumer zero-waste fashion eliminates waste during manufacture. Zero-waste fashion is a holistic approach that works on various components like designing, sketching, pattern cutting, draping to eliminate wastages during manufacturing. Even the small percentage of discarded waste in a garment making will make a significant difference while producing garments in a mass scale. So a Zero waste fashion requires deliberate consideration and creativity to work within constraints to invent beautiful new forms of fashion. In this research first a survey was done to know the behaviour of Kids wear manufacturing industries towards the generated waste and the concept of sustainability. Moving forward a series of garments were designed and constructed keeping sustainability and zero waste concept in mind. The next step was to see whether these designs are acceptable to the common people or not for which again a survey was conducted.*

**Keywords:** fabric waste, fashion design, girls wear, pattern making, sustainability, waste management, zero waste.

## **Introduction**

A zero-waste garment refers to a garment that has been designed and pattern cut in such a way that when the garment is cut, all of the fabric is in the garment, and none is left behind as off-cut waste. Zero-waste fashion design refers to the activities and design processes that lead to such garments. Zero-waste fashion, however, is a broader term, with potentially multiple interpretations. The common goal as an industry and as a global community should be zero-waste fashion. (Rissanen, 2013).

Today the children's clothing business has evolved into one of the most successful clothing manufacturing industries. Clothing manufacturers have been challenged to meet the demands of children and young teenagers for new trends and designs. Manufacturers are geared toward supplying attractive-looking clothing to the retail market to entice these new-age consumers. The setup of the children's clothing market today is fast-moving and stylish. The retail market sells clothing that is inventive and eye-catching, catering to children's senses and desire to have beautiful clothes that are aesthetically pleasing. The market has definitely recognized children as an important consumer group when it comes to fashion and clothing. This means that the entire apparel market must change and adjust toward the constant and changing values of this

young population: the tweens and teens generation. Manufacturers and retailers need to withstand these fickle markets. (Zakaria, 2016).

Conventional attempts at improving the efficiency of fabric use focus on the manufacturing stage. Pattern engineering refers to the practice of modifying a garment pattern in order to achieve a better yield on fabric and thus reduced fabric cost for a garment. This usually entails shifting, adding or eliminating a seam, and it occurs during manufacture after design, usually based on a suggestion by the marker maker or sample cutter. Depending on the size of the company, these roles may be performed by the same person. Sample cutters are usually the first to notice the overall efficiency of fabric use. If too much fabric is wasted, their suggestions guide the pattern maker to cut a more efficient pattern to reduce waste. The sample cutter is the person cutting the sample garment from fabric; depending on the size of the company, this may not be a separate role and maybe performed by the pattern cutter (Fasanella, 1998). Reuse in the hierarchy refers to using fabric waste as fabric; the function as well as the material (fibre) of fabric is retained. Cutting garments from fabric appears somewhat like cutting cookies from rolled out dough. Unlike cookie dough, however, the fabric scraps left behind cannot be combined and "kneaded" into new fabric of the same quality as

the original fabric. Fabric waste can nevertheless be reused in a number of ways, for example by weaving rag rugs or making small items such as wallets.

The amount of pre-consumer fabric waste created during fashion manufacture is significant. Historical and contemporary examples of such designing show that it is possible to design without creating fabric waste, but the relative rarity of the contemporary examples suggests that barriers exist in fashion industry practices to the adoption of a zero-fabric waste approach. An important source of many of these barriers is the current system used to manufacture multiple garments. An investigation of the possibility of zero waste fashion must therefore take into consideration industry conventions that come into play after the design and manufacture of one-off sample garments. While there is literature that may be drawn on to understand these industry processes as they are currently practiced there is at present no literature that investigates these processes from a zero-waste perspective.

## **Methodology**

The study was conducted in two phases; phase I and phase II.

Phase I of the detailed study: included construction of main questionnaire 1 which had five sections; personal information, industry composition, raw materials used, waste generation and management behaviour and awareness about zero-waste. This questionnaire was constructed to analyse the types of waste generated by the company and management behaviour of the wastes by the company also, whether the companies know about zero-waste and whether they would promote and accept this concept. After the construction of the main questionnaire the data was collected using purposive sampling and then analysed using statistical analysis and anova. Phase II of the detailed study: included designing of girls wear using zero fabric waste concept, ten designs of girls wear were made using Corel Draw X6. Designs were made suitable for ten year old girls. Four upper garments, four lower garments and two dresses were designed. Twenty swatches of fabric were collected from different markets of Kolkata from which a 100% cotton based fabric was selected for the construction of the garments. Basic bodice, skirt, dress block was constructed to suit the sizes for 10 year old girl. Basic blocks were adapted to suit each pattern. Fabric Layout Plans were developed on Optitex 19 ensuring zero fabric waste. Fabric Layout Pictorial Depiction was done using Corel Draw X6. The fabric for the garments

was cut according to the respective layouts taking all the necessary allowances. The set of ten patterns were stitched using the selected fabric and coded as Kids wear 1 to 10 (GW 1 to GW10).

Costing of each garment was done on the basis of raw material cost, working hours, electricity and other overhead expenses. Twenty percent profit margin was kept. Acceptability of zero-waste garments amongst the respondents was assessed. Respondents were selected through ‘purposive sampling’. The assessment was done in two parts.

- ◆ Part 1: In Buyers perspective i.e. the mothers of young girls were requested to make their daughters wear the garments and score the questions accordingly. The most suitable designs were scored as 1,2,3,4 and 5 corresponding to average, fair, good, very good and excellent respectively. The questionnaire analysed the fabric attributes, garment attributes and the overall suitability of the garments.
- ◆ Part 2: In Manufacturing units perspective i.e. the manufacturers of Girls wear were requested to score the questions after having a look at the garments. The most suitable designs were scored as 1,2,3,4 and 5 corresponding to average, fair, good, very good and excellent respectively. The questions analysed the fabric attributes, garment attributes, overall suitability of the garments and promotion and introduction of the concept in the company.

Statistical analysis of data was done using two-way ANOVA factor was done.

## **Results and Discussions**

Phase I: Waste Management in Kids wear Manufacturing Units was studied.

### 3.1.1 Disposal of Industry Waste in the Kids wear Manufacturing Units

Table 1: Distribution of Respondents on the Basis of Disposal of Industry Waste

Disposal of Industry Waste	Weighted score	$\bar{X}$	Rank
In landfills	156	2.3	III
In drains	175	2.5	II
Sell off as scrap waste	312	4.4	I
Recycle or Reuse waste	102	1.5	IV

Most of the industries were more likely to sell off the scrap instead of reusing or recycling the scrap waste. The results also showed that next most used

practice was to throw off the scrap in drains or landfills which are very harmful for the environment as textiles contained synthetics also.

### 3.1.2 Measures taken to Reduce Apparel Waste

Table 2: Distribution of Respondents on the Basis of Measures taken to Reduce Apparel Waste

Measures taken to Reduce Apparel Waste	Weighted score	$\bar{X}$	Rank
Choose designs with minimum cutting waste	175	2.5	II
Use apparel cutting waste in another garment	145	2.1	IV
Sell off the scrap	179	2.6	I
Throw away the apparel cutting waste	156	2.3	III

There were units who were willing to take a step and measures to reduce the waste produced. Though the most preferred option was selling off the scrap but choosing designs with minimum cutting wastage was also preferred by the respondents. Therefore more work is required on zero fabric waste designs in the apparel industry.

### 3.1.3 Barriers Faced in Managing Waste

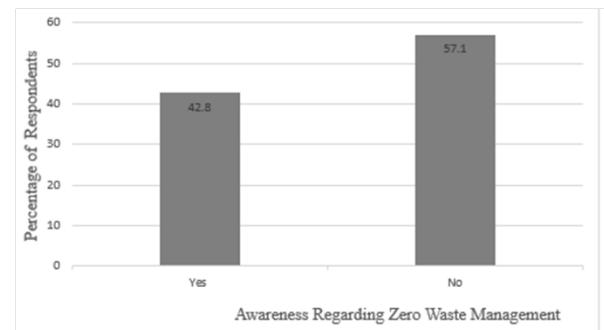
Table 3: Distribution of Respondents on the Basis of Barriers Faced in Managing Waste

Barriers Faced in Managing Waste	Weighted score	$\bar{X}$	Rank
Extra time involved	275	3.9	I
Extra money involved	145	2.1	III
Extra man power involved	102	1.5	V
No platform to use the waste effectively	182	2.5	II
No platform to dispose off the waste	155	1.9	IV
Any other	95	1.3	VI

From the table it can be clearly seen that the three top ranked reasons for barriers faced in managing waste were found to be extra time involvement, no platform to use the waste effectively and extra money involvement. Industry was not willing to spend extra time or money in managing waste. They were not having proper platforms to dispose off the waste nor did they have extra labour which this

process was involved. Other barrier as suggested by the respondents was lack of proper knowledge on effective waste disposal. Therefore, awareness on such issue could be taken up by the academicians.

### Awareness Regarding Zero Waste Management



Graph 1: Distribution of Respondents on the Basis of their Awareness Regarding Zero Waste Management

Majority of respondents were not aware about the concept of zero fabric waste designs for garments. Therefore, a challenging project to increase this awareness could be undertaken by design institutes.

### Reasons behind Preference towards Zero Waste Patterns

Table 4: Distribution of Respondents on the Basis of Reasons behind Preference Towards Zero Waste Patterns

Reasons behind Preference towards Zero Waste Patterns	Weighted score	$\bar{X}$	Rank
To reduce cost of production	182	2.5	I
To preserve the environment	145	2.1	III
Wish to try out as an innovative product	155	1.9	IV
It will add to the market value of the product	156	2.3	II
Any other	102	1.5	V

Respondents were willing to adapt to zero-waste patterns mainly to reduce the cost of production and add to the market value of the product. Environment comes to the third place followed by motivation to try out an innovative product.

Phase II: Study on Acceptability of Constructed Garments from the perspective buyers (Part 1)

### Fabric Attributes for Constructed Garments

Table 5: Distribution of Respondents on the Basis of their Preference for the Fabric Attributes for Constructed Garments

Attributes	Weighted score	$\bar{X}$	Rank
Fabric texture	181	3.6	II
Colour combination	158	3.2	IV
Design/aesthetic appeal for the fabric	183	3.7	I
Comfort (due to used fabric)	181	3.6	II
Overall suitability of the fabric	173	3.5	III

Respondents were highly satisfied with design and aesthetic appeal of the fabric. Fabric texture was also well accepted by the respondents. Comfort of garments as per the fabric was found to be highly satisfactory after fit trial by young girls; probably because of use of cotton based fabric

### Garment Attributes for Constructed Garments

Constructed garments were shown to the respondents and they were asked to wear these garments. Following attributes were considered for assessment:

1. Design of the garment
2. Ease of wearing and taking off the garment
3. Comfort of the garment
4. Suitability of design
5. Quality of stitching
6. Overall appearance

Table 6: Distribution of Respondents on the Basis of their Preference for Garment Attributes for Constructed Garments

Garment no.	1		2		3		4		5		6		$\bar{X}$ (cum.)	Rank
	WS	$\bar{X}$												
GW1	173	3.5	183	3.7	198	3.9	147	3.2	143	3	175	3.6	3.5	III
GW2	126	2.2	143	3	147	3.2	134	2.7	171	3.4	134	2.7	2.9	VI
GW3	183	3.7	145	3.1	147	3.2	173	3.5	196	3.8	198	3.9	3.5	III
GW4	132	2.6	126	2.2	132	2.6	126	2.2	173	3.5	134	2.7	2.6	VIII
GW5	132	2.6	132	2.6	147	3.2	173	3.5	173	3.5	175	3.6	3.2	V
GW6	134	2.7	200	4	198	3.9	173	3.5	198	3.9	183	3.7	3.6	II
GW7	141	2.9	198	3.9	200	4	147	3.2	143	3	134	2.7	3.3	IV
GW8	143	3	173	3.5	198	3.9	145	3.1	145	3.1	141	2.9	3.2	V
GW9	134	2.7	130	2.5	126	2.2	130	2.5	145	3.1	143	3	2.7	VII
GW10	200	4	200	4	196	3.8	198	3.9	173	3.5	183	3.7	3.8	I

As per the clothing components that were used for the construction of girls wear it was seen that garment GW10 (Handkerchief skirt) was the most preferred garment. This was followed by response for garment GW2 (cape with fringes at neck). Garment GW1 (tie-up string top) and GW3 (Reversible jacket) was third preferred garment. Garment GW4 was not preferred.

### Overall Suitability of the Constructed Garments

Following attributes were considered for assessment:

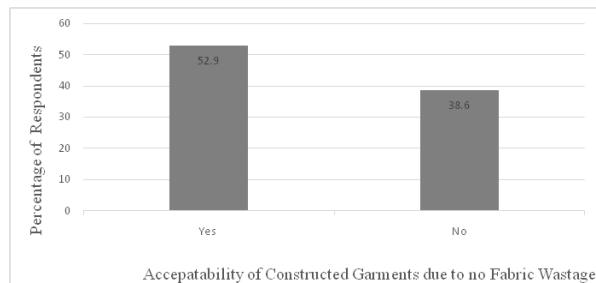
1. Overall fit
2. Overall comfort
3. Overall design
4. Cost effectiveness

Table 7: Distribution of Respondents on the Basis of their Preference for Overall Suitability of Constructed Garments

Garment no.	1		2		3		4		X (cum.)	Rank
	WS	$\bar{X}$	WS	$\bar{X}$	WS	$\bar{X}$	WS	$\bar{X}$		
GW1	198	3.9	177	3.7	175	3.6	171	3.4	3.7	II
GW2	173	3.5	171	3.4	167	3.2	138	2.9	3.3	V
GW3	175	3.6	134	2.7	177	3.7	173	3.5	3.4	IV
GW4	134	2.7	130	2.5	124	2.2	124	2.2	2.4	VII
GW5	167	3.2	173	3.5	130	2.5	134	2.7	3.1	VI
GW6	196	3.8	200	4	198	3.9	198	3.9	3.9	I
GW7	198	3.9	198	3.9	171	3.4	143	3	3.5	III
GW8	173	3.5	173	3.5	175	3.6	167	3.2	3.5	III
GW9	124	2.2	120	2	128	2.4	126	2.3	2.2	VIII
GW10	200	4	200	4	198	3.9	177	3.7	3.9	I

As per the clothing suitability that were used for the construction of girls wear it was seen that garment GW10 (Handkerchief skirt) and GW2 (cape with fringes at neck) was the most preferred garment. This was followed by response for garment GW1 (tie-up string top). Garment GW7 (tie-up skirt) and GW8 (pameled skirt) was third preferred garment. Garment GW9 was not preferred.

#### Acceptability of Constructed Garments due to No Fabric Wastage



Graph 2: Distribution of Respondents on the Basis of Acceptability of Constructed Garments due to no Fabric Wastage

Interestingly, majority of the mothers of young girls, who were the respondents; after knowing that the garments were made with no fabric wastage, showed great interest towards buying them. There were still some amount of the population who were not interested in buying the garments. This shows that general concept of no wastage and concern for the environment is slowly seeping into the mindset of consumers and may promote marketability of products.

Phase II: Study on Acceptability of Constructed Garments from the perspective manufacturing units (Part 2)

#### Fabric Attributes for Constructed Garments

Table 8: Distribution of Respondents on the Basis of their Preference for the Fabric Attributes for Constructed Garments

Attributes	Weighted score	$\bar{X}$	Rank
Fabric texture	173	3.5	III
Colour combination	175	3.6	II
Design/aesthetic appeal of fabric	175	3.6	II
Overall suitability of the fabric	179	3.8	I

According to the garment manufacturing units, the fabric was appropriate for its overall suitability and the colour combination and design was also appropriate for kids wear. However, fabric texture was not considered very appropriate. Probably more smooth texture for fabric would be preferred for kids wear.

#### Garment Attributes for Constructed Garments

Following attributes were considered for assessment:

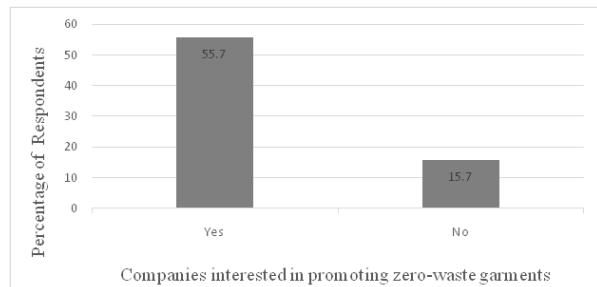
1. Design of the garment
2. Quality of stitching
3. Overall appearance

Table 9: Distribution of Respondents on the Basis of their Preference for Garment Attributes for Constructed Garments

Attributes	1		2		3			
Garment no.	WS	$\bar{X}$	WS	$\bar{X}$	WS	$\bar{X}$	$\bar{X}$ (cum.)	Rank
GW1	173	3.5	175	3.6	159	2.8	3.3	VI
GW2	175	3.6	157	2.7	173	3.5	3.2	VII
GW3	175	3.6	177	3.7	175	3.6	3.6	IV
GW4	157	2.7	175	3.6	167	3.2	3.1	VIII
GW5	167	3.2	159	2.8	175	3.6	3.2	VII
GW6	177	3.7	179	3.8	179	3.8	3.8	II
GW7	179	3.8	173	3.5	177	3.7	3.7	III
GW8	173	3.5	173	3.5	173	3.5	3.5	V
GW9	159	2.8	167	3.2	157	2.7	2.9	IX
GW10	200	4	200	4	200	4	4	I

As per the clothing components that were used for the construction of girls wear it was seen that garment GW10 (Handkerchief skirt) was the most preferred garment. This was followed by response for garment GW6 (cape with fringes at neck). Garment GW7 (tie-up skirt) was third preferred garment. Garment GW9 was not preferred.

#### Interest towards promoting zero-waste garments



Graph 3: Distribution of Respondents on the Basis of their interest towards promoting zero-waste garments.

Table 10: Distribution of respondents on the basis of their preference for overall suitability of constructed garments

Attributes	1		2		3			
Garment no.	WS	$\bar{X}$	WS	$\bar{X}$	WS	$\bar{X}$	$\bar{X}$ (cum.)	Rank
GW1	194	3.7	196	3.8	194	3.7	3.7	II
GW2	188	3.4	186	3.3	180	3	3.2	IV
GW3	175	2.7	192	3.6	182	3.1	3.1	V
GW4	171	2.5	165	2.2	165	2.2	2.3	VI
GW5	190	3.5	188	3.4	173	2.6	3.2	IV
GW6	200	4	198	3.9	200	4	4	I
GW7	198	3.9	173	2.6	198	3.9	3.5	III
GW8	190	3.5	171	2.5	190	3.5	3.2	IV
GW9	161	2	163	2.1	171	2.5	2.2	VII
GW10	200	4	198	3.9	200	4	4	I

As per the clothing suitability that were used for the construction of girls wear it was seen that garment GW10 (Handkerchief skirt) and GW6 (cape with fringes at neck) was the most preferred garment. This was followed by response for garment GW (tie-up string top). Garment GW7 (tie-up skirt) was third preferred garment. Garment GW9 was not preferred. Constructed girls wear

Constructed garment were shown to fifty respondents in buyers prospective and they were asked to make there daughters wear the garments for a fit trial and fifty respondents in manufacturing units prospective. Views of respondents were recorded regarding the overall suitability, acceptance and clothing components and appearance.

According to Anova statistical analysis at 95% of significance we reject the null hypothesis of insignificant difference for different clothing components and conclude that there is insignificant differences among the garment attributes of developed samples for girls wear and that all the garments are not equally acceptable amongst the population.

<b>Unable to import this plate</b> 	
<ul style="list-style-type: none"> <li>◆ A tunic</li> <li>◆ Added panels for flares</li> <li>◆ Pockets on side seams</li> </ul>	<ul style="list-style-type: none"> <li>◆ A cape</li> <li>◆ Folded falling collar</li> <li>◆ Straight seams</li> </ul>
<i>Plate 5: GW5 Panelled dress</i>	<i>Plate 6: GW6 Cape with fringed neck</i>
	
<ul style="list-style-type: none"> <li>◆ A string top</li> <li>◆ Added gathers</li> <li>◆ Added flares</li> </ul>	<ul style="list-style-type: none"> <li>◆ Tie up tiered skirt</li> <li>◆ 2 layered</li> <li>◆ Added gathers to the second layer</li> </ul>
<i>Plate 1: GW1 Tie up strap top</i>	<i>Plate 2: GW2 Tubular dress</i>
	<b>Unable to import this plate</b> 
<ul style="list-style-type: none"> <li>◆ A reversible overlapping jacket</li> </ul>	<ul style="list-style-type: none"> <li>◆ Loose fitted pants</li> <li>◆ Elasticized waist and hem</li> </ul>
<i>Plate 3: GW3 Reversible overlapping jacket</i>	<i>Plate 4: GW4 Batwing Crop top</i>
<ul style="list-style-type: none"> <li>◆ A batwing top</li> <li>◆ Square neckline</li> <li>◆ Added pockets</li> </ul>	<ul style="list-style-type: none"> <li>◆ Handkerchief skirt</li> <li>◆ Drawstring used as tie up</li> <li>◆ Tassels made of left over fabric</li> </ul>
<i>Plate 5: GW5 Panelled dress</i>	<i>Plate 6: GW6 Cape with fringed neck</i>

## **Conclusion**

Since there was a lack of knowledge amongst the people on this concept of zero-waste, the response to this research was seemed quite positive and that people are willing to take a step forward to promote zero-waste and environment sustainability. Respondents were willing to accept this new concept and wanted to know more about zero-waste pattern making and designs. Majority of respondents were satisfied with the constructed garment and were keen on recommendation of such garments to others, probably they felt that the constructed garment had a good combination of comfort and aesthetic properties and yet they had moderate maintenance properties and were cost effective as-well.

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# **Effect of Formic Acid Pretreatment on the Dyeing of Bamboo Fabric with Reactive Dyes**

*Shally Agarwal and Shweta Tuteja Rakshit*

## **ABSTRACT**

*Innovation in textile has brought alternative plant based fibers such as bamboo into the spotlight and as a replacement to petrochemical based synthetic fibers. Bamboo as a raw material is a remarkably sustainable and versatile resource. In this study bamboo fabrics are selected and conventionally pretreated and subjected with 98% formic acid in different concentrations. An attempt has been taken to reformulate the dyeing process with the aim of increasing the color fastness and dye uptake capacity of the fibers. This research is focused on the study of the color fastness and dye uptake properties of pre-treated bamboo fabrics when dyed with different classes of reactive dyes. To fulfill the job the bamboo fabric was pre-treated with concentrated formic acid solution. Then dyeing was carried out with vinyl sulphone (remazol), bifunctional ME and monochlorotriazine (Procion) reactive dyes by exhaust method. The formic acid at different levels of concentrations 1%, 2%, 3%, 4% and 5% treated bamboo fabrics were then undergone different testing such as physical properties, color fastness properties, color difference K/s and SEM analysis. These treatments on bamboo fabrics were correspondingly compared with those of untreated bamboo fabric for its effectiveness. Statistical analysis using one way ANOVA was also conducted on the same. On the basis of color difference K/s, fabric strength and SEM analysis it was found that formic acid concentration that gave best result for dye uptake was 1% for monochlorotriazine dye, 2% for bi-functional ME dyes and 3% for vinyl sulphone (remazol) dye.*

**Keywords:** Bamboo fabric, Color fastness, Dye uptake, Formic acid, K/S, Reactive dye, SEM analysis

## **Introduction**

Dyes can generally be described as colored substances that have affinity to the substrates to which they are being applied. Dyes are soluble and/or go through an application process which, at least temporarily, destroys any crystal structure by absorption, solution, and mechanical retention, or by ionic or covalent chemical bonds (Gurses, 2016).

Organic molecules become colored, and thus useful dye molecule if they contain at least one of each of the radicals called chromophores and auxochromes. The chromophores give the dye molecule its particular color while the auxochrome intensify the hue of the dye molecule color, makes the dye molecule more water soluble, and improves the color fastness properties of the dyed or printed fiber (Gohl and Vilensky, 2005).

Textiles made from bamboo address the aim of sustainable development by utilizing a renewable resource to make clothes and other textile applications (Waite, 2009). Currently, bamboo is emerging as a natural, eco-friendly raw material in the textile industry due to its many attractive properties such as fastest growth rate of any known plant, antimicrobial properties, renewability, its biodegradability, its efficient space consumption, its low water use, its organic status and its carbon

sequestering abilities (Munjal, 2013). The bamboo fabric is highly versatile and can be used in bamboo intimate apparels, bamboo non-woven fabric, bamboo sanitary materials, bamboo bathroom series and bamboo fiber socks (Munjal, 2013).

Reactive dyes utilize a chromophore attached to a substituent that is capable of directly reacting with the fiber substrate. The covalent bonds that attach reactive dye to natural fibers make them among the most permanent of dyes. Reactive dyes are by far the best choice for dyeing cotton and other cellulose fibers (Shah, 1991). One great advantage in reactive colours is that they have almost a full range of colours and also having brightness and fastness (Venugopal, 1991).

The reactivity of these dyes is due to the chlorine atoms attached to the thiazine ring. When two chlorine atoms are present on the dyes molecule, as in the case of procaine yellow R, one of the chlorine atoms is so reactive, that it reacts with cellulose even at room temperature in the presence of an alkali. Hence such reactive dyes are called cold brand reactive dyes. When only one chlorine atom is present in the dyestuff molecule, the reactivity of the dye decreases considerably and the dyeing has to be carried out at a higher temperature (65-80°C). Hence these dyes are called Hot brand reactive dyes

(Gohl and Vilensky, 2005). The reactivity of reactive dyes are determined by two factors. The chemical structure and arrangement of the supporting groups and leaving groups, which jointly form the reactive group and the influence of the chromophoric system on the reactivity of the reactive system (Alberghina et. al., 1988).

## Methodology

**Collection of Fabrics:** 100% bamboo fabric was purchased from Shivaganesh Fabrics Pvt. Ltd., Tirupur, at the rate of Rs. 250 per meter. Physical characteristics of the fabric used are mentioned in Table 1.

Table 1: Construction particulars of test fabric

Fabric	Weave	Threads/inch		Weight (g/m <sup>2</sup> )
		Ends	Picks	
Bamboo	Plain	78	76	124

**Collection of Dye:** Reactive dye of Vinyl sulphone group (Remazol), Bifunctional group (ME Dyes) and Monochlorotriazine group (Procion H- Hot brand ) was selected for the study. The dyes were purchased from Keshu Dye Chem, Kolkata.

**Collection of Chemicals:** The chemicals used in the present study are as follows:

Table 2: Chemicals used in dyeing

Chemicals	Source
Formic Acid (98%)	Cyno Chem, Kolkata
Glauber's salt	Usha Instruments, Kolkata
Soda Ash	Usha Instruments, Kolkata

**Preparation of Fabric:** The bamboo fabrics were pretreated with 25ml/l hydrochloric acid, 60 min, 60°C using MLR 1:30 (desizing); scouring with 5gpl non-ionic detergent, 60 mins, at boil. The pre-treated bamboo fabrics were subjected with 98% formic acid with the concentration of 1%, 2%, 3%, 4% & 5% (owm) for 30 minutes at ambient temperature (27°C) (Jeyakodi 2016).

**Dyeing of fabrics:** The pre-treated samples with formic acid were dyed with Vinyl Sulphone (Remazol) group, Bi-Functional Me group and Mono-chlorotriazine (Procion H) reactive dye. The dyeing recipe used in the present research has been reported by Gnanapriya and Jeyakodi, 2016.

Dyeing was carried out with the concentration of 3% (owm) for reactive dyes at 60°C (Vinyl sulphone and Bi-functional ME Dyes) and boil

(monochlorotriazine dyes) for two hours with a material to liquor ratio of 1:30 as per the established technique of dyeing. Glauber's salt used for dyeing was 60 gpl (Vinyl sylphone and bi-functional dyes) and 70 gpl (monochlorotriazine dyes). 20 gpl of soda ash was used. The dyed samples were washed with deionized water, soaped with 2% (owm) non-ionic soap powder and 1% (owm) Na<sub>2</sub>CO<sub>3</sub>, 60°C, 20 minutes, and dried.

## Testing and Evaluation

**Measurement of physical properties of bamboo fabrics:** The physical properties such as thickness, tensile strength, stiffness, crease recovery angle of the bamboo fabrics was measured by the standard established methods.

**Dyeing and K/S analysis of bamboo fabrics:** The K/S values ('K' and 'S') indicate the absorption coefficient and scattering coefficient respectively of the colorant that predict the behavior of the dyes on the textile materials of reactive dyed cotton fabrics were determined by AATCC Test Method -135 using a Data color SF 600 plus spectrophotometer interfaced to a PC. Measurements were taken regarding colour presence, brightness, dullness and colour intensity. Each fabric was folded once so as to give two thickness and average of five readings were taken each time.

**SEM study of bamboo fabrics:** The surface morphology of modal and cotton fabrics was observed in SEM (JOEL JSM-6360 model microscope, Japan).

**Color fastness analysis of the bamboo fabrics:** The treated and dyed samples were washed under condition ISO-III Test Method to determine the color change effect of dyed fabrics. Light fastness tests , were carried out according to IS: 2454-1984 method. The samples were exposed to fade-o-meter to determine the color change. IS: 766-1984 standardized crock meter was used to determine the rubbing fastness of natural dyed fabrics under wet and dry condition to assess the color change and staining property. 'Perspirometer' was used to determine the fastness of coloured textiles to the effect of perspiration.

**Statistical Analysis:** In order to analyze whether there exist any significant difference by varying the concentrations of the formic acid, the one-way ANOVA technique has been used in the analysis. The hypothesis for the test is as follows:

$H_0$ : There is no significant difference by varying the concentrations of formic acid ( $\mu_1 = \mu_2 = \mu_3$ )

$H_1$ : There is a significant difference by varying the concentrations of formic acid ( $\mu_1 \neq \mu_2 \neq \mu_3$ )

The average scores of the test results were tabulated in proper manner and the F-statistics computed.

## Result and Discussion

**Fabric Thickness Test:** Fabric thickness was measured for the untreated and treated bamboo fabric dyed with all the three class of reactive dye. Table 3 clearly shows that by varying the concentration of formic acid from 1% to 5% there is no change in the thickness value and it is in range of 0.31mm to 0.32mm.

Table 3: Fabric Thickness of Untreated & Pretreated Bamboo Fabric at Different Concentrations of Formic Acid for the Different Class of Reactive Dyes

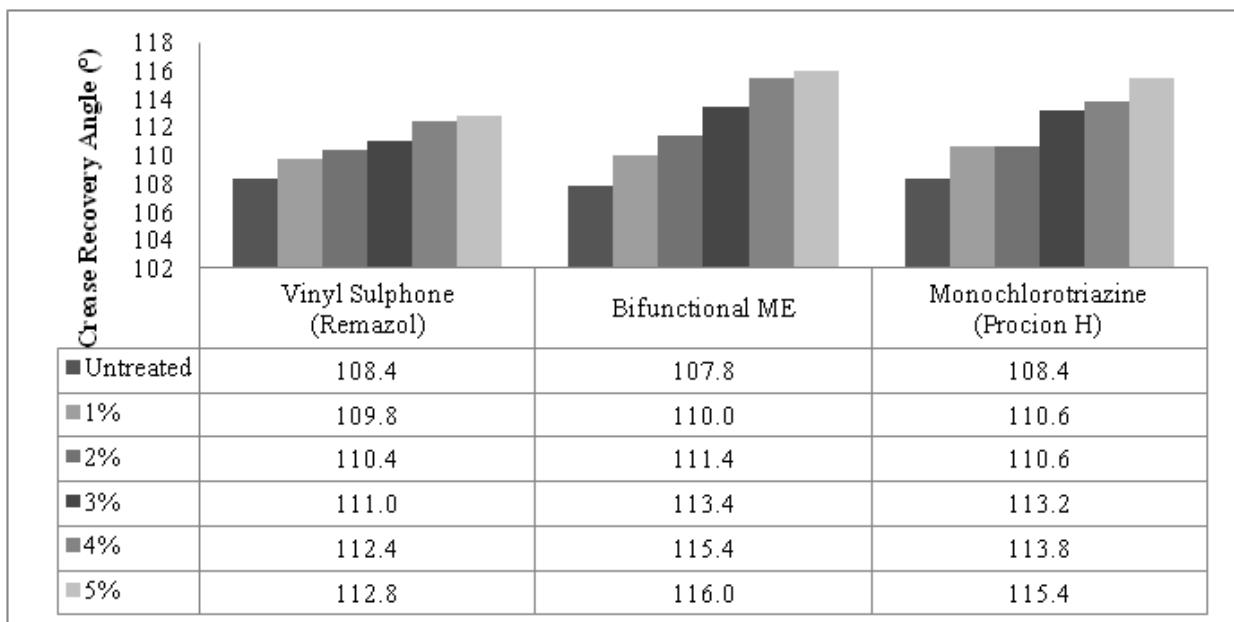
Concentration of formic acid for pre-treatment	Reactive Dyes		
	Vinyl Sulphone (Remazol)	Bi-functional ME	Mono-chlorotriazine (Procion H)
	Thickness (mm)		
Untreated	0.31	0.31	0.32
1%	0.32	0.32	0.32

2%	0.31	0.31	0.32
3%	0.32	0.32	0.32
4%	0.32	0.32	0.32
5%	0.32	0.31	0.32

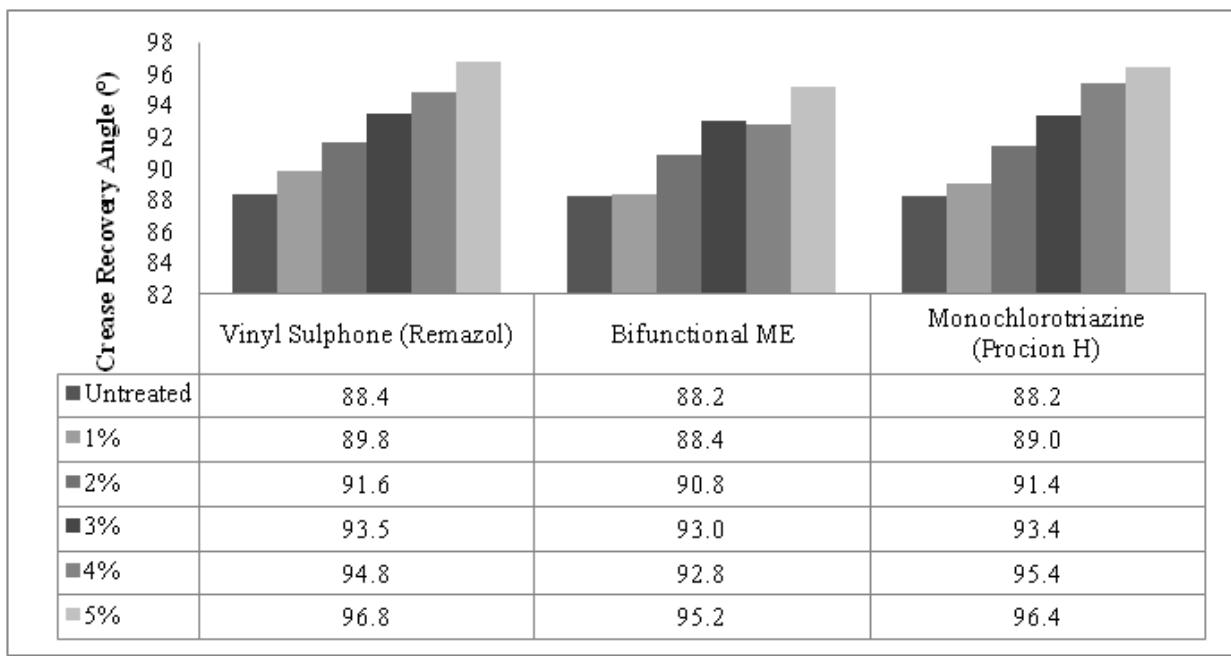
The statistical analysis revealed no significant effect by varying the concentrations of formic acid in the thickness value of vinyl sulphone and bi-functional dyes as  $p > 0.5$  whereas, monochlorotriazine dye showed significant effect on the thickness value by varying the concentration of formic acid as  $p < 0.5$ .

**Fabric Crease Recovery Test:** Crease recovery angle was measured for both warp and weft directions of fabrics and compared with untreated samples.

Perusal of Graph 1 & 2 reveals that there is slight increase in the crease recover angle at all the concentrations of formic acid as compared with the untreated one for all the three different class of reactive dye exhibiting better recovery from crease after treatment. The crease recovery angle is higher in warp direction as compared to filling direction.



Graph 1: Crease Recovery Angles of Untreated & Pretreated Bamboo Fabric at Different Concentrations of Formic Acid for the Different Class of Reactive Dyes (Warp Direction)

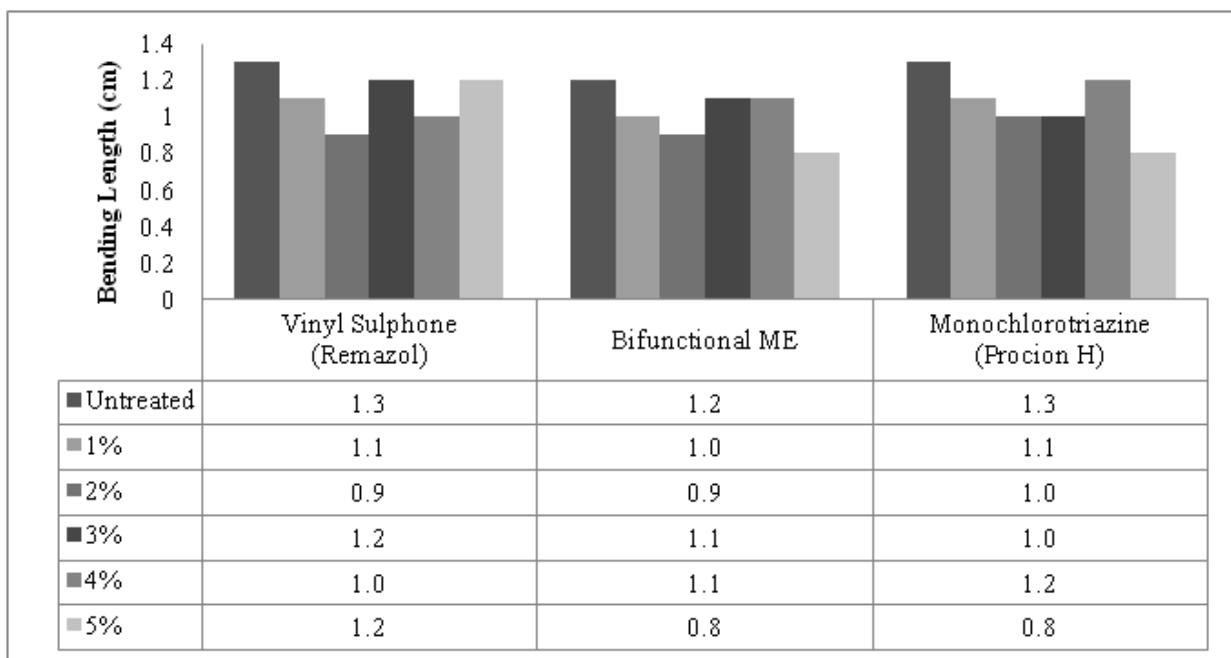


*Graph 2: Crease Recovery Angles of Untreated & Pretreated Bamboo Fabric at Different Concentrations of Formic Acid for the Different Class of Reactive Dyes (Weft Direction)*

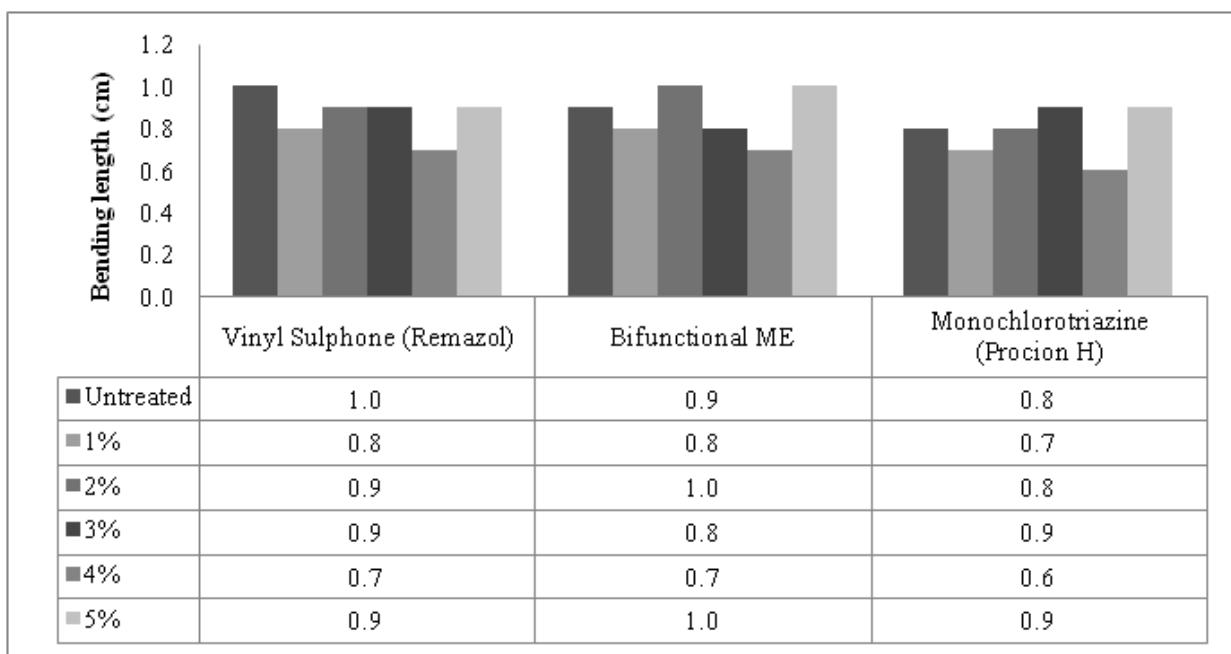
The statistical analysis indicated that bamboo fabric pretreated with five different concentrations of formic acid and dyed with monochlorotriazine dye and bi-functional dye showed significant difference ( $p > 0.5$ ) in crease recovery angle in both warp and weft direction. In case of vinyl sulphone dye statistical analysis reveal that there is no significant difference ( $p < 0.5$ ) in warp direction whereas there is a significance difference ( $p > 0.5$ ) in crease recovery angle in weft direction.

Fabric Stiffness Test: Stiffness of the untreated and treated reactive dyed bamboo fabric was observed by measuring bending length.

Perusal of the graphs 3 and 4 reveals that there is very slight decrease in the bending length values of the treated samples in both warp and weft directions.



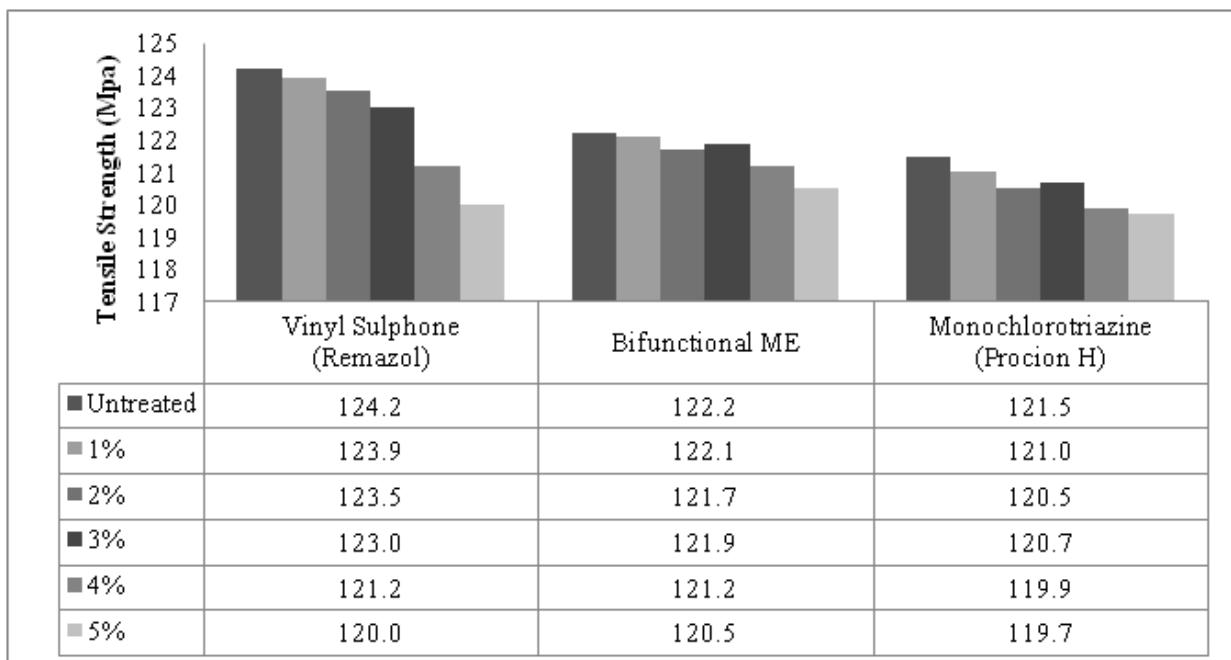
*Graph 3: Bending Length of Untreated & Pretreated Bamboo Fabric at Different Concentrations of Formic Acid for the Different Class of Reactive Dyes (Warp Direction)*



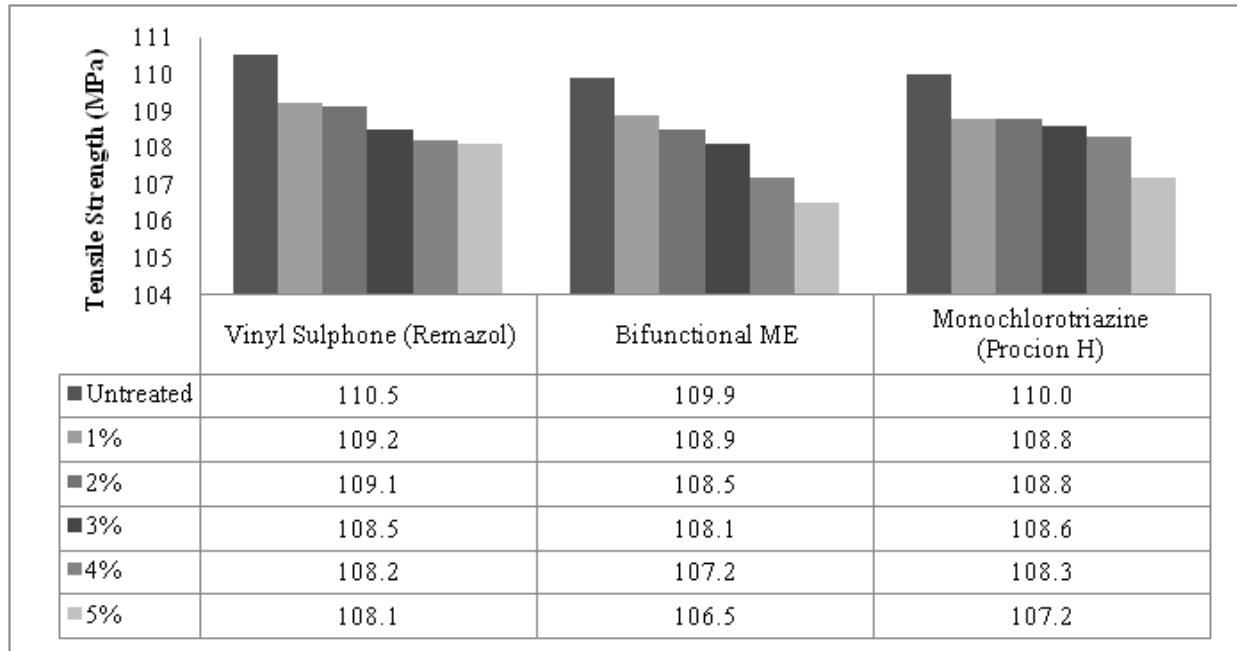
*Graph 4: Bending Length of Untreated & Pretreated Bamboo Fabric at Different Concentrations of Formic Acid for the Different Class of Reactive Dyes (Weft Direction)*

Fabric Tensile Strength Test: The breaking strength test of the untreated and treated reactive dyed bamboo fabric was carried out in both warp and weft directions.

Perusal of the graphs 5 and 6 reveals that there is decreasing trend in the tensile strength values with the increasing concentration of the formic acid of the treated samples in both warp and weft directions.



*Graph 5: Tensile Strength of Untreated & Pretreated Bamboo Fabric at Different Concentrations of Formic Acid for the Different Class of Reactive Dyes (Warp Direction)*



Graph 6: Tensile strength of Untreated & Pretreated Bamboo Fabric at Different Concentrations of Formic Acid for the Different Class of Reactive Dyes (Weft Direction)

Statistical analysis revealed that varying the concentrations did cause significant difference ( $p>0.5$ ) in the tensile strength values of treated and reactive dyed bamboo fabric in both warp and weft directions.

Scanning Electron Microscopy (SEM) Analysis of Bamboo Fabric: The analysis of SEM images of no formic acid treated and formic acid treated and reactive dyed woven bamboo fabrics are given in the representative Figures 1, 2, & 3.

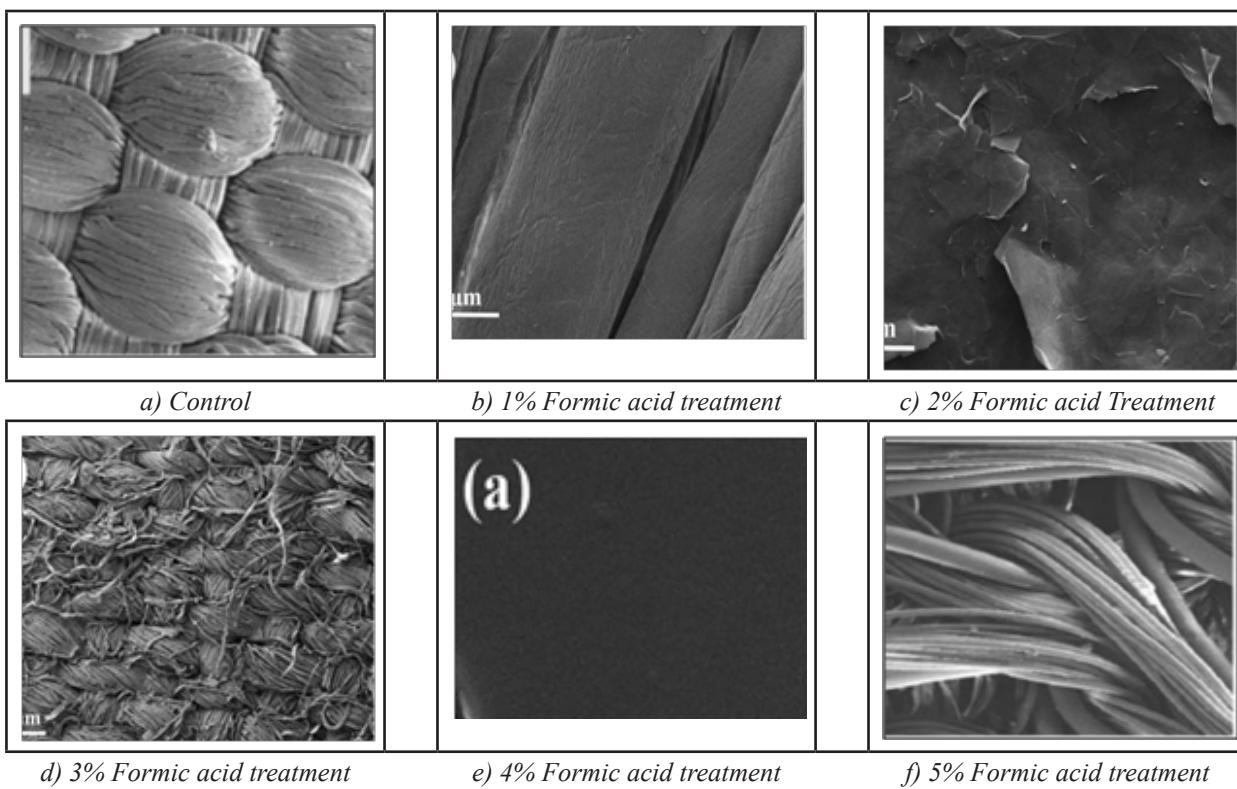
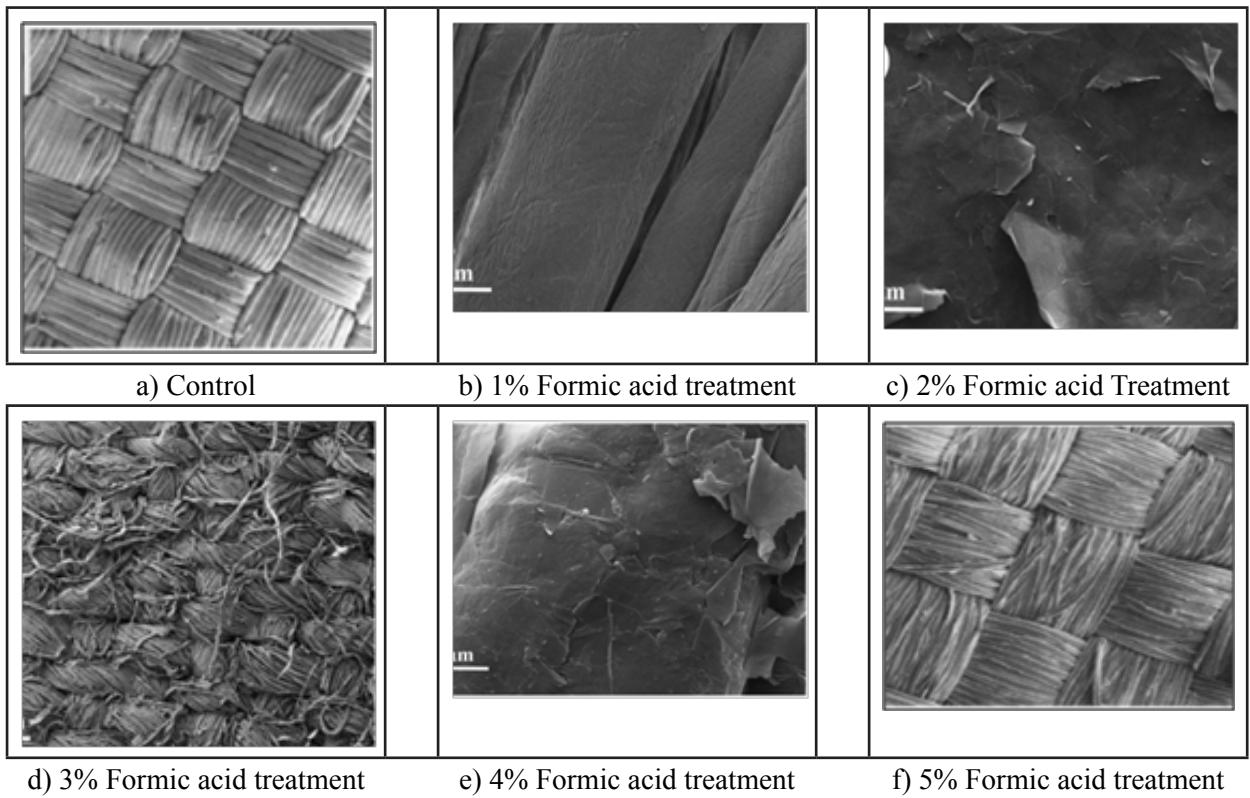


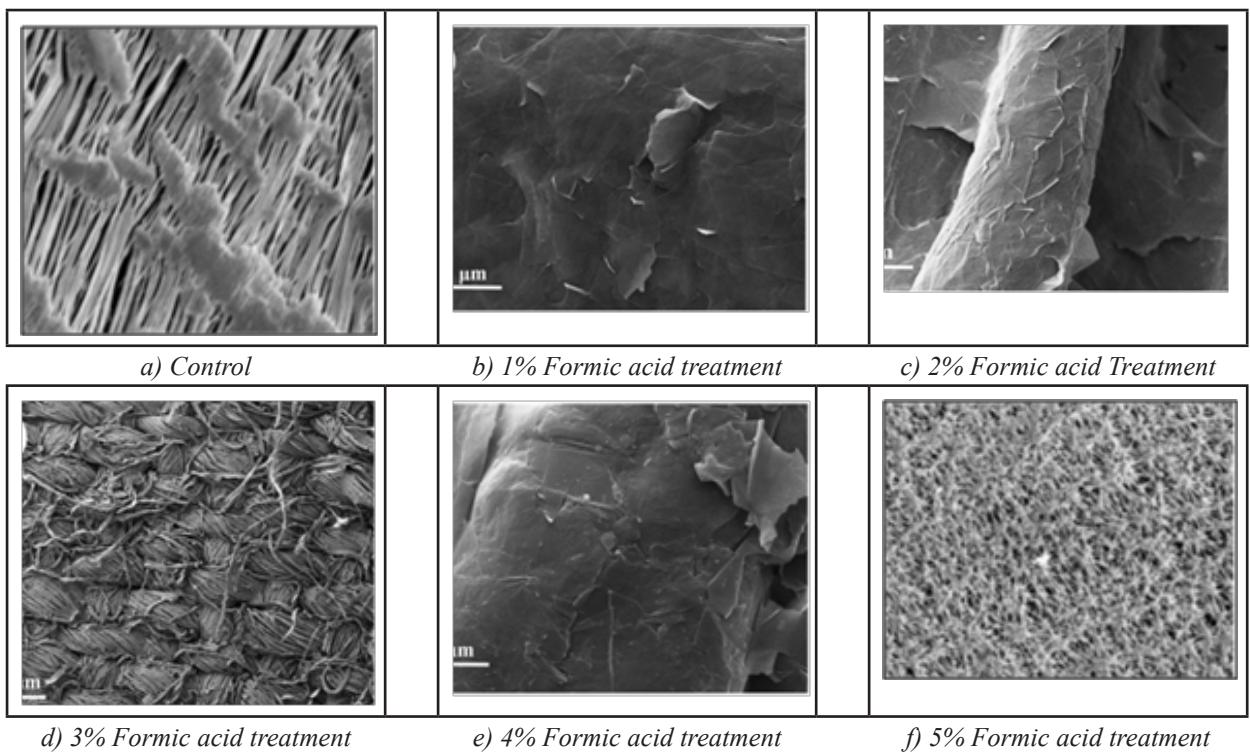
Figure 1 (a-f) : SEM Images of Untreated & Treated Bamboo Fabric dyed with Vinyl Sulphone-Remazol Dye



*Figure 2 (a-f) : SEM Images of Untreated & Treated Bamboo Fabric dyed with Bi-functional ME Dye*

It is very much clear from figures 1, 2, 3 for the three different class of reactive dyes that at the lower concentration of 1%, 2% & 3% their exist swelling along the direction of cross-section. Also the surface of the fiber was etched to some extent in this processing system which may be due to partial degradation of cellulose, which can be seen in the form of deposition on the surface.

As the concentration is increasing (4% and 5%), the morphological changes of fiber treated with formic acid can be seen, with the increased degree of degradation mainly at 5% concentration. Fibrils of the fibers can be seen due to breakdown of cellulose chains in bamboo fabric dyed with the three classes of reactive dye.



*Figure 2 (a-f) : SEM Images of Untreated & Treated Bamboo Fabric dyed with Mono-chlorotriazine Procion H Dye*

## Estimation of Surface Colour Strength and Related Colour Interaction Parameters

Table 4 shows the effect of the different pretreatment concentrations of formic acid on K/S values along with other colour interaction parameter, including total colour difference ( $\Delta E$ ), changes in hue ( $\Delta H$ ), changes in chroma ( $\Delta C$ ), general metamerism index (MI) and the colour difference index (CDI) values indicating overall dispersion in the colour difference data by a single indicator.

It may be noted that the variation in  $\Delta E$  values for changes in pretreatment concentrations are not much variable ranging from 67.449 to 69.994 (Vinyl Sulphone), 75.461 to 76.993 (Bi-Functional ME) & 68.817 to 70.696 (Procion H).

$\Delta L$ ,  $\Delta a$ , and  $\Delta b$  indicate further implication of the colour difference in terms of lightness / darkness ( $\Delta L$ ), redness / greenness ( $\Delta a$ ) and blueness / yellowness ( $\Delta b$ ) respectively and analysis of these

through individual colour difference parameters for pre-treated reactive dyed bamboo fabric shows very less variations in all the cases.

Changes in hue ( $\Delta H$ ) for vinyl sulphone class of dye was found to be negative, indicating that there is no major change in predominating hue, except showing some hypsochromic or bathochromic shift in the colour / tone. However, for the other two class of reactive dye it was a positive  $\Delta H$  value.

The MI varies from 0.02 to 0.31 (Vinyl Sulphone), 16.20 to 16.59 (Bi-functional ME dyes) and 0.12 to 0.35 (Procion H) exhibiting that the data is not much widely dispersed in the respective class of dye and are within a particular control condition.

From the study, it may thus be summarized that the optimum condition for pre-treatment concentration of formic acid can be 3% for vinyl sulphone (remazol) dye, 2% for Bi-functional ME dye and 1% for mono-chlorotriazine class of dye.

Table 4: Colour Strength and Related Parameters of Untreated and Pre-Treated (Formic Acid) Bamboo Fabric Dyed with Reactive dyes.

Varying Parameters	K/S at $\lambda_{max}$	$\Delta E$	$\Delta L$	$\Delta a$	$\Delta b$	$\Delta C$	$\Delta H$	MI (LABD)	CDI
<b>Vinyl Sulphone (Remazol)</b>									
Control	8.691	68.420	-47.811	32.938	36.200	40.799	-27.034	--	---
1%	8.614	67.449	-47.237	32.081	35.901	39.964	-26.850	0.35	-146.18
2%	9.007	68.537	-47.061	32.870	37.445	41.595	-27.431	0.12	-502.207
3%	9.808	69.994	-49.145	33.662	36.753	41.706	-27.285	0.28	-199.094
4%	8.376	68.035	-47.114	32.842	36.474	40.913	-27.113	0.26	-2254.34
5%	8.112	69.219	-48.285	33.253	36.798	41.434	-27.259	0.30	-455.385
<b>Bi-Functional ME</b>									
Control	1.094	76.804	-52.221	56.312	0.898	52.366	20.727	--	---
1%	1.094	76.993	-52.498	56.309	1.081	52.350	20.769	16.59	1.841212
2%	3.620	76.167	-51.533	56.084	0.529	52.168	20.597	16.47	1.825883
3%	3.605	76.125	-51.804	55.779	0.264	51.886	20.475	16.53	1.817306
4%	3.446	75.461	-51.127	55.501	-0.208	51.652	20.310	16.20	1.831599
5%	3.256	77.595	-54.131	55.576	1.451	51.593	20.711	16.52	1.885532
<b>Mono-Chlorotriazine (Procion H)</b>									
Control	8.359	70.429	-50.692	48.762	-3.587	45.422	18.096	--	---
1%	9.449	70.696	-50.311	49.578	-2.955	46.122	18.425	0.31	80.6912
2%	7.797	68.817	-48.292	48.893	-3.630	45.448	18.115	0.09	228.5799
3%	8.905	70.081	-49.692	49.336	-2.819	45.861	18.405	0.23	100.4464
4%	8.383	69.590	-48.881	49.434	-3.116	46.005	18.354	0.02	106.7823
5%	8.383	70.265	-49.874	49.405	-2.983	45.955	18.381	0.10	93.68157

### Colorfastness Testing

**Wash Fastness:** The washing fastness of all the samples was found to be good to very good. Both the test specimens (bamboo and cotswool) remained almost unstained and there was no significant color change of the dyed samples for all the samples dyed with reactive dyes (Table 5,6,7).

**Color fastness to crocking (rubbing):** Table 5,6,7 shows that crocking fastness rating was excellent for fabric in dry state and considerably good for the fabrics in wet state. Among the wet and dry test specimen for all the three class for reactive dye wet specimen stained slightly more than dry specimens

for all the three class of reactive dyes.

**Color fastness to perspiration:** Color fastness to perspiration test was conducted both against acid and alkaline artificial solutions of perspiration and it was observed that both the untreated and treated bamboo fabrics dyed with different class of reactive dye showed best result for alkaline perspiration solution (Table 5,6,7).

**Color fastness to light:** Both the untreated and treated bamboo samples, dyed with three different class of dye showed excellent to outstanding light fastness on grey scale (Table 5,6,7).

Table 5: Results for colourfastness to Light, Washing, Crocking & Perspiration for bi-functional ME Dyes

Conc. of Formic Acid	Light Fastness	Washing Fastness			Crocking fastness		Perspiration fastness					
		Staining		Colour change	Dry	Wet	Staining			Change in colour		
		Bamboo	Cotswool				Bamboo	Cotswool				
		Al.	Ac.	Al.	Ac.	Al.	Al.	Ac.	Al.	Ac.		
Untreated	7/8	3/4	3/4	4	5	4/5	4/5	4	4/5	5	5	4/5
1%	7/8	3/4	3/4	4/5	5	4/5	4/5	4	4/5	5	5	4/5
2%	7	4	3/4	4/5	5	4	4/5	4	4	4/5	5	5
3%	7	4	4	4	5	4/5	4	4	4/5	4/5	5	5
4%	7	4	4	4	5	4/5	5	4	4/5	4/5	5	5
5%	7	4	4	4/5	5	5	4/5	4	4	4/5	5	5

Table 6: Results for colourfastness to Light, Washing, Crocking & Perspiration for Vinyl Sulphone Dyes

Conc. of Formic Acid	Light Fastness	Washing Fastness			Crocking fastness		Perspiration fastness					
		Staining		Colour change	Dry	Wet	Staining			Change in colour		
		Bamboo	Cotswool				Bamboo	Cotswool				
		Al.	Ac.	Al.	Ac.	Al.	Al.	Ac.	Al.	Ac.		
Untreated	7/8	3/4	3/4	4	5	4/5	4/5	4/5	5	4/5	5	4/5
1%	7/8	4	3/4	4	5	5	4/5	4/5	4/5	4/5	5	4/5
2%	7/8	3/4	3/4	4	5	4/5	4	4	4/5	4	5	4/5
3%	7/8	4	4	4	4/5	4/5	4	4/5	4/5	4	4/5	4
4%	7	4	4	4/5	4/5	4/5	4	4	4	4/5	4/5	4
5%	7	4	4	4/5	4/5	4	4	4	4	4/5	4/5	4

### Conclusion

Hence, from the above experiments it was inferred that formic acid at low concentration can be used safely as a pre-treatment in dyeing bamboo fabrics with reactive dyes of all the three classes (vinyl sulphone, monochlorotriazine and bi-functional dyes). 1%, 2% and 3% concentration of formic acid have showed good results when subject to physical tests such as tensile strength, crease recovery angle and bending length. The SEM analysis have also

showed that 1% to 3% acid concentration have shown less degree of degradation compared to 4% and 5% concentration. The K/s readings have shown maximum value of optical density at 1% for monochlorotriazine dye, 2% for bi-functional ME dye and 3% for vinyl sulphone (remazol) dye. The color fastness test have also proved that formic acid pre-treatment at low concentration have shown excellent to good fastness properties on bamboo fabrics.

Table 7: Results for colourfastness to Light, Washing, Crocking & Perspiration for Procion-H Dyes

Conc. of Formic Acid	Light Fastness	Washing Fastness			Crocking fastness		Perspiration fastness								
		Staining		Colour change	Dry	Wet	Staining			Al.	Ac.	Al.	Ac.	Al.	Ac.
		Bamboo	Cotswool				Bamboo	Cotswool							
		Untreated	7/8	3/4	3/4	4/5	5	5	4/5	4/5	5	4/5	5	4/5	4/5
1%	7/8	3/4	3/4	4/5	5	5	4/5	4/5	5	4/5	5	4/5	5	4	
2%	7/8	3/4	4	4	5	4/5	4/5	4	4/5	4	5	4	5	4	
3%	7	3/4	4	4	4/5	4/5	4/5	4	4	4/5	4/5	4/5	5	4	
4%	7	4	4	4/5	4/5	4/5	4	4	4	4	4/5	5	4		
5%	7	4	4	4/5	4/5	4	4	4	4	4/5	4/5	4			

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# **Effect of Printing with Natural & Synthetic Thickeners on Silk Fabric with Reactive Dyes**

Ria Agarwal and Shweta Tuteja Rakshit

## **ABSTRACT**

*The study was taken up in order to test if natural thickening agents could formulate almost similar intensity of colour as that of synthetic thickening agents on silk without losing its properties and keeping in mind the environmental concerns in recent times for a better future. Printing of mulberry silk samples with reactive dye using six different thickeners (three natural and three synthetic) and physical and colourfastness properties of the printed silk samples was found out and statistically analyzed using one way ANOVA. Thus, from the experiments which was carried out to find the 'Effect of Printing with Natural & Synthetic Thickeners on Silk Fabric with Reactive Dyes' it was concluded that overall psyllium showed good results in terms of both physical and colourfastness properties. Hence, psyllium can be used as an alternative to thickeners for printing on mulberry silk.*

**Keywords:** Colourfastness, Mulberry silk, Natural thickeners, Reactive dye, Synthetic thickeners

## **Introduction**

Printing is a complicated process as the printing paste consists of colorants, thickeners, special chemicals and processing media which can influence the rheology of the pastes and subsequent migration into the fabric (Teli et. al., 2015). The colouration is achieved either with dyes or pigments in printing paste. Thickeners play an important role to obtain right colour, sharpness, levelness and good hand in the printing process. Compatibility and stability of the thickener with other ingredients present in the printing paste is of paramount requirement (Shosha et. al., 1994).

Silk has been called the Queen of Textiles' and perhaps rightly so. Finer than human hair, strong as steel, light and versatile with an inherent shimmer and a satiny feel, silk stands apart from all other fabrics. It is not made from plants like cotton and hemp; rather it is made by silkworms and harvested from their cocoons (Bestseller Fund).

Man's urge to decorate his clothing and the fabrics of his environment, by means of printing, dates from the very earliest time and fabrics so patterned existed before woven or embroidered ones (Joyce, 1974). Screen printing is simply an improved method of stencil printing in which no "ties" are required, thus giving the designer a much wider scope and freedom in planning his design than the earlier methods (Prayag, 1997).

Reactive dyes are so called because their molecules react chemically with the fibre polymers of some fibres to form a covalent bond between the dye molecule and fibre. The fibres most readily

coloured with reactive dyes are the man-made and natural cellulose fibres, synthetic nylon, and natural protein fibres. One great advantage in reactive colours is that they have almost a full range of colours and also having brightness and fastness (Venugopal, 1991).

The purpose of the thickener is to produce a medium for the dye paste and the resultant product is called the printing paste. Thickeners used in textile printing are high molecular weight compounds giving viscous pastes in water. These impart stickiness and plasticity to the printing paste so that it can be applied to a fabric surface without spreading and be capable of maintaining the design outlines even under high pressure. Their main function is to hold or adhere the dye particles in the desired place on the fabric until the transfer of the dye into the fabric and its fixation are complete (Gohl and Vilensky, 1999).

## **Methodology**

**Selection and Preparation of Fabric:** Mulberry silk was selected for the study. Before printing the plain off-white mulberry silk was degummed using 6gpl soap and 2gpl soda ash at 90-95°C for 90min. using MLR 1:20 (Singhee & Dhanania, 2016). Finally the fabric was rinsed with water and dried. The construction details of the fabric is listed in Table 1.

Table 1: Construction particulars of test fabric

Fabric	Weave	Threads/inch		Weight (g/m <sup>2</sup> )	Thickness (mm)
		Ends	Picks		
Silk	Plain	92	71	55	0.13

**Selection of dye:** Cold brand di-chlorotriazine type (Procion M) Reactive dye in red colour was selected for the study.

**Selection of method used for printing and preparation of screen:** Hand screen printing method was used to print the degummed silk fabric samples. The silk fabric was ironed to remove all the creases and folds before printing. Screen was prepared by stretching the nylon mesh tightly over the wooden frame. Design was drawn and painted with enamel, blocking out those portions which were not required to be printed.

**Selection and preparation of thickener:** Three natural and three synthetic thickeners are used in the present study and were prepared in the following ways:

**Sodium Alginate:** A paste of sodium Alginate was used by soaking overnight in distilled water followed by thorough mixing (Madhu & Patel, 2016).

**Carboxy Methyl Cellulose:** Direct method of making paste was used by mixing carboxy methyl cellulose powder in required amount of water accompanied by other auxiliaries needed. (Madhu & Patel, 2016).  
**Guar Gum:** A paste of guar gum was used by soaking overnight in distilled water followed by thorough mixing (Madhu & Patel, 2016).

**Tapioca:** The refined tapioca flour was mixed with water to form a paste and then heated until a thick paste with grey transparency was acquired (Bhosale et. al., 2015).

**Psyllium:** A thickener stock paste was prepared by adding a thickener powder in a small amount of warm de-mineralised water and continuously stirred with a mechanical stirrer until a smooth paste was not obtained. The prepared paste was stored for overnight.

**Aloe Vera in combination with starch:** Direct method of making paste was used by mixing starch with aloe vera accompanied by other auxiliaries needed. (Madhu & Patel, 2016).

**Testing and evaluation:** All the printed samples were conditioned for 48 hr at 65% ( $\pm$  2%) RH and 27°C ( $\pm$  20°C) as per standard IS: 6359-1917 (Bureau of Indian Standards, 1982) for each method of testing and evaluation described below:

## **Physical properties**

**Measurement of Fabric Thickness:** The method described in ISI (IS: 7702-1975) was used to measure the thickness of the samples. "Baker Thickness Tester" was used for the test.

**Measurement of Fabric stiffness:** To determine the stiffness of the fabric i.e. resistance of fabric to bending, cantilever test as described in ISI (IS: 6490-1971) was used. The instrument used was "Sasmira Stiffness Tester". Five samples both in warp and weft direction and bending length was calculated by following formula given by Booth (1974).

$$\text{Bending Length} = \frac{L \text{ cm}}{2}$$

Where, L = the mean length of overhanging portion in cm.

**Measurement of Crease Recovery:** Determination of wrinkle recovery or crease resistance of fabric, which enables a fabric to resist wrinkling or massing, was done by measuring the "crease recovery angle". Crease recovery angle was measured as per ISI (IS: 4681-1968) on "Sasmira Crease Recovery Tester".

**Measurement of fabric drapability:** Drape is the ability of the fabric to assume a graceful appearance in use. It is an important property of textile materials which allows fabric to orient itself into graceful folds or pleats as a result of force of gravity (Angappan and Gopala Krishnan, 1993). Drapability of fabrics was determined, using the instrument "MecDrape" and was expressed in terms of "Drape co-efficient". Drape co-efficient was calculated by the following formula:

$$F = \frac{\text{Mass of shaded area} \times 100}{\text{Mass of unshaded area} \times 100}$$

Small value of F indicates better drapability of the fabric and the large value of F indicates poor drapability.

**Measurement of Breaking Tenacity:** Breaking strength of the fabric can be described as a measure of resistance of the fabric to a tensile load or stress in either warp or weft direction (Angappan and Gopala Krishnan, 1993). "Grab Strength Tester" was used for observation with test method described in ASTM D5034 to measure the breaking strength of the samples.

### Colourfastness properties

Wash Fastness: Colour fastness to washing (Bureau of Indian Standards, 1982) of the printed silk samples was determined as per IS: 764-1984 method using a launder-o-meter following ISO-III wash fastness evaluation method.

Rubbing Fastness: Colour fastness to rubbing (dry and wet) (Bureau of Indian Standards, 1982) was assessed as per IS: 766-1984 method using a motorized semi-automatic digital crockmeter from MAG Solvics Pvt. Ltd., Coimbatore and using grey scale as per ISO-105-AO3 (extent of staining).

Perspiration Fastness: Perspirometer was used to determine the fastness of coloured textiles to the effect of perspiration.

Light Fastness: Colour fastness on exposure to UV-light (Bureau of Indian Standards, 1989) was determined as per IS: 2454-1984 method using a xenon arc (Fade-O-Meter).

### Statistical Analysis

Analysis of Variance (ANOVA): In order to analyze whether there exist any significant difference in the physical properties using different thickeners, the one-way ANOVA technique has been used in the analysis. The hypothesis for the test is as follows:  
 $H_0$ : There is no significant difference ( $\mu_1 = \mu_2 = \mu_3$ )  
 $H_1$ : There is a significant difference ( $\mu_1 \neq \mu_2 \neq \mu_3$ )

## Results and Discussion

### Physical properties

Fabric thickness test: The average thickness values of silk samples printed with synthetic thickeners was 0.21 mm (guar gum), 0.17 mm (sodium alginate) and 0.15 mm (CMC) whereas it samples printed with natural thickeners the values were as .15 mm (tapioca) and 0.16 mm for both psyllium as thickener and combination of aloe vera with starch (Table 2).

It was observed that samples printed with guar gum as a thickening agent showed the maximum thickness value whereas tapioca showed least value which means there was change in the thickness values.

The statistical analysis revealed significant difference in the thickness between the samples printed with different thickening agents since the value of F is greater than the value of F critical.

Hence it can be concluded that printing with different thickening agents does make a difference in the thickness of the fabric.

Fabric crease recovery test: Table 2 with average crease recovery angle in the warp direction for silk printed samples shows the lowest crease recovery angle when printed with guar gum ( $106.4^\circ$ ) and highest when printed with psyllium ( $129.6^\circ$ ) which means that there exist a stiffness in the samples when printed with synthetic thickeners.

A similar trend was found in the weft direction (Table 2) when printed with different thickeners with psyllium ( $110.6^\circ$ ) at and guar gum ( $91.2^\circ$ ).

The statistical analysis revealed significant difference in crease recovery for both warp and weft directions printed with different thickening agents since the value of F is greater than the value of F critical.

Hence, it can be concluded that for silk printing with reactive dyes psyllium as a thickening agent and is the best option as it showed the maximum crease recovery value in both warp and weft directions.

Fabric stiffness test: The average bending length values of silk samples printed with synthetic thickeners in the warp direction (Table 2) are 1.42 cm (CMC), 1.54 cm (sodium alginate) and 1.56 cm (guar gum). Printing with natural option the values are 0.80 cm (psyllium), 0.82 cm (aloe vera with starch) and 0.97 cm (tapioca).

The average bending length values of silk samples printed in the weft direction (Table 2) was are 1.46 cm (CMC), 1.57 cm (sodium alginate) and 2.12 cm (guar gum) when printed using synthetic thickeners and the values 1.20 cm (psyllium), 1.22 cm (aloe vera with starch) and 1.38 cm (tapioca) with the natural thickeners.

The statistical analysis revealed significant difference in bending length for both warp and weft directions printed with different thickening agents since the value of F is greater than the value of F critical.

Hence, it can be said that psyllium has the least stiffness in both warp and weft direction whereas sample printed using guar gum has the maximum stiffness.

Table 2: Fabric thickness, crease recovery & bending length of silk samples printed with different thickeners

Thick- eners	Physical properties				
	Thick- ness (mm)	Crease Recovery (o)		Bending Length (cm)	
		Warp	Weft	Warp	Weft
Sodium Alginate	0.17	120.8	108.0	1.54	1.57
<b>Synthetic Thickeners</b>					
Sodium Alginate	0.17	120.8	108.0	1.54	1.57
Carboxy Methyl Cellulose	0.15	110.6	106.4	1.42	1.46
Guar Gum	0.21	106.4	91.2	1.56	2.12
<b>Natural Thickeners</b>					
Psyllium	0.16	129.6	110.6	0.80	1.20
Tapioca	0.15	119.4	105.2	0.97	1.38
Aloe Vera with starch	0.16	121.2	109.6	0.82	1.22

Fabric drapability: Silk samples printed with different thickening agents showed different values. It was observed that samples printed with sodium alginate and guar gum showed the maximum drape co-efficient value which shows that these samples do not have a good drape whereas with 60% drape co-efficient, sample printed with aloe vera with starch, psyllium and CMC all with smaller drape co-efficient value (60%) exhibit better drapability (Table 3).

Table 3: Fabric drape co-efficient and tensile strength of silk samples printed with different thickeners

Thickeners	Physical properties			
	Drape co- efficient (%)	Tensile Strength (MPa)		
		Warp	Weft	
<b>Synthetic Thickeners</b>				
Sodium Alginate	80	119.7	108.4	
Carboxy Methyl Cellulose	60	75.0	55.0	
Guar Gum	80	118.2	112.8	
<b>Natural Thickeners</b>				
Psyllium	60	119.9	107.6	
Tapioca	75	114.5	111.6	
Aloe Vera with starch	60	104.0	90.4	

Fabric Tensile Strength Test: In case of samples printed with natural agents, the strength values in the warp direction (Table 3) were highest for psyllium i.e. 119.9 MPa and least with aloe vera with starch

(104.0 MPa). In the weft direction (Table 3) the values reported were 11.6 MPa (tapioca), 107.6 MPa (psyllium) and 90.4 MPa (aloe vera with starch).

The statistical analysis revealed significant difference in breaking strength for both warp and weft directions printed with different thickening agents since the value of F is greater than the value of F critical.

It clearly reveals that overall the strength values are better for samples printed with natural thickening agents as compared with the synthetic agents.

### Colourfastness properties

Light Fastness: Light fastness of printed silk samples was tested and results are presented in Table 4. It was observed that overall the light fastness values are excellent to outstanding (7/8) which was exhibited by four samples printed with sodium alginate, CMC, psyllium and tapioca respectively. Guar Gum and aloe vera with starch had fastness values between good to excellent (6/7)

Table 4: Fabric colourfastness to light and crocking of silk samples printed with different thickeners

Thickeners	Colourfastness properties		
	Light fastness	Crocking fastness	
		Wet	Dry
<b>Synthetic Thickeners</b>			
Sodium Alginate	7/8	3	4/5
Carboxy Methyl Cellulose	7/8	3	4/5
Guar Gum	6/7	3	5
<b>Natural Thickeners</b>			
Psyllium	7/8	3/4	4/5
Tapioca	7/8	2/3	4
Aloe Vera with Starch	6/7	3	4

Crocking/ Rubbing Fastness: Crocking fastness rating was excellent for fabric in dry state and considerably good for the fabrics in wet state. Among the wet and dry test specimen for the entire printed samples wet specimen stained slightly more than dry specimens (Table 4).

For samples printed with different thickeners, the staining on the dry specimen ranged from 4 (slight to negligible staining), 4/5 (negligible to no staining) to 5 (no staining) whereas for wet specimens the values were 2/3 for tapioca i.e. considerably stained with best in psyllium i.e. 3/4 (slightly stained) on grey scale to staining.

**Wash Fastness:** Wash fastness to change in color of all the printed silk samples was found to be 4 (very good fastness) on all the cases except 3/4 (good to very good) for sodium alginate on grey scale.

The wash fastness value in terms of staining was better in cotton in majority of the cases than on silk. The ratings on cotton were negligible (4) while slightly stained to negligible (3/4 to 4) for staining on silk on grey scale (Table 5).

Table 5: Fabric colourfastness to washing and perspiration of silk samples printed with different thickeners

Thickeners	Colourfastness properties								
	Washing fastness			Perspiration fastness					
	Staining		Change in Colour	Staining			Change in Colour		
	Silk	Cotton		Silk	Cotton		Al.	Ac.	Al.
<b>Synthetic Thickeners</b>									
Sodium Alginate	3/4	4	3/4	3/4	3/4	3/4	4	4	3/4
Carboxy Methyl Cellulose	3/4	4	4	3/4	3/4	3/4	4	4	3/4
Guar Gum	4	4	4	4	4	4	4	3/4	4
<b>Natural Thickeners</b>									
Psyllium	3/4	4	4	3/4	4	4	4	3/4	4
Tapioca	4	3/4	4	4	4	3/4	3/4	4	3/4
Aloe Vera with starch	4	4	4	4	4	4	4	4	3/4

**Perspiration Fastness:** From table it can be seen that the in case of alkaline solution the value falls in the range 3/4 to 4 for staining of adjacent fabrics for all samples printed with six different thickening agents i.e. psyllium, aloe vera, sodium alginate, tapioca, CMC, guar gum and in the range 3/4 to 4 for change in color of dyed fabrics.

For the acid solution, the range lies between 3/4 to 4 (slightly to negligible stained) for the staining of adjacent silk & cotton fabrics and 3/4 to 4 for change in colour for all samples printed with six different natural and synthetic thickening agents.

From the above results it can be concluded that although perspiration fastness for all the samples printed with different thickening agents was found to be best but the results were better for guar gum and aloe vera with starch (Table 5).

## Conclusion

Thus, from the experiments, which was carried out to find the ‘Effect of Printing with Natural & Synthetic Thickeners on Silk Fabric with Reactive Dyes’ it was concluded that overall psyllium showed good results in terms of both physical and colourfastness properties. Hence, psyllium can be used as a safe natural alternative to thickeners for printing on mulberry silk.

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