POTENTIAL OF RICE HUSK AS A PACKAGING MATERIAL

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ABSTRACT

Humans cut down 80,000 to 160,000 trees around the world every day, and use many of them to make paper. (Beverly Law, 2021). Rice husk is an abundantly available waste material in all rice producing countries, and it contains about 30%-50% of organic carbon. (Singh, 2018) This research aims to evaluate the potential of rice husk as a packaging material. The rice husk. cornstarch and glue were gathered and set into different proportions. Set-up A (60% Rice husk, 0% Cornstarch, 40% Glue), Set-up B (40% Rice Husk, 20% Cornstarch, 40% Glue) and Set-up C (20% Rice Husk, 40% Cornstarch, 40% Glue). Eco-Safe Handmade Paper Production from Rice Straws with minor revisions was the method used in making the papers. The quality of paper produced from different proportions of rice husk, corn starch and glue was determined one day after the papers have fully dried. Ten respondents were asked to give off ratings to assess the color and texture of the produced paper. Tensile strength of paper is then measured. DESCRIPTIVE ANALYSIS was used to determine the difference in terms of color and texture of the produced paper from rice husk to that of commercial paper. ANOVA was used to determine if there is a significant difference in the tensile strength of the produced paper and the commercial paper. In terms of color and texture of the paper, Treatment C is more favored of the respondents. Tensile strength reveals that Treatment C is significantly higher than that of Treatment D (positive control). Researchers recommends the use of rice husk as a base material for paper packaging production.

CHAPTER 1

THE PROBLEM AND ITS SCOPE

This chapter is divided into five parts. (1) Background of the Study, (2) Purpose of the Study, (3) Significance of the Study, (4) Definition of Terms. (5) Delimitation of the Study.

Background of the Study

Making tons of paper from trees can harm the planet. Humans cut down 80,000 to 160,000 trees around the world every day, and use many of them to make paper. Some of those trees come from tree farm. But loggers also cut down forests to make paper, which means that animals and birds lose their homes (Beverly Law, 2021).

To reduce greenhouse gas emissions and preserve forests and their biodiversity, the Philippine Department of Environment and Natural Resources, local governments, and the general public adopt enhanced climate-related forestry policies. Improved forest policies have been passed, and incentives have been developed to help stop further forest degradation. As a result, forests are being protected and biodiversity is being preserved (U.S. Agency for International Development, 2023).

Rice husk has been considered as waste of the rice milling process. In this research, rice husk is attempted to be the base material in the production of papers. Natural materials are more environmental friendly and can help supply the demands of paper around the world and also to minimize the cutting down of trees (Moraes, et al., 2014).

The main goal of this research is to evaluate the potential of rice husk as a packaging material.

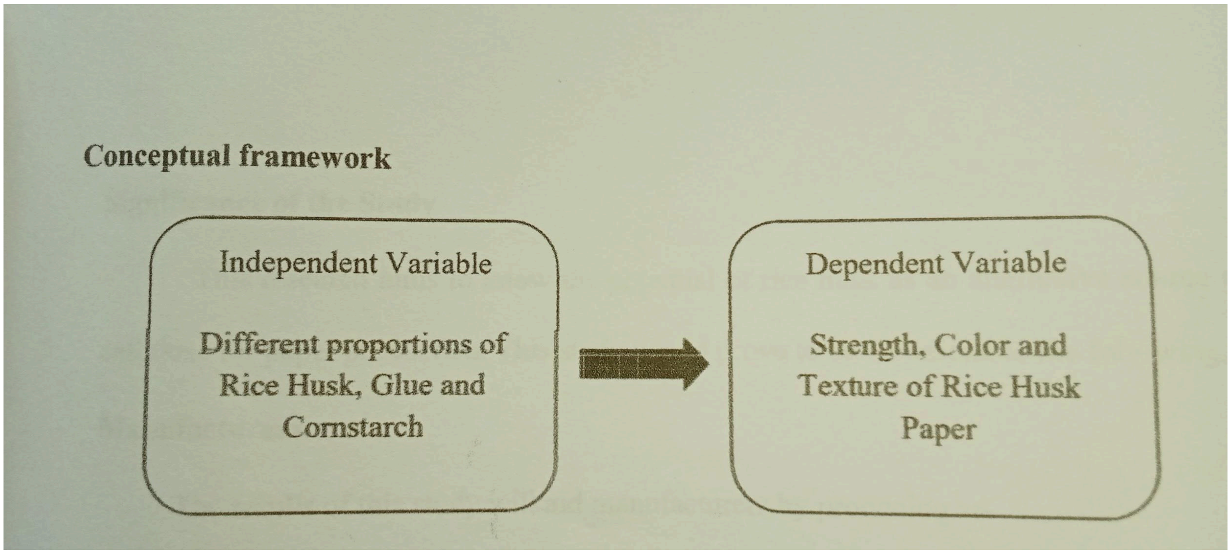

Figure 1.1 Independent Variable-Dependent Variable (IV-DV) Model in Determining the Potential of Rice Husk as a Packaging Material.

Statement of the Problem

This study aims to determine and evaluate the potential of rice husk as a packaging material.

Specifically, this study sought to answer the following questions:

1. Which among the different proportions of rice busk, cornstarch, and glue produces the best quality of paper in terms of strength, color and texture?
2. Is there a significant difference in the quality of paper produced from different proportions of rice husk, cornstarch, and glue in terms of strength, color and texture?

Hypothesis

There is no significant difference on the quality of paper produced from different proportions of rice husk, cornstarch, and glue in terms of strength, color and texture.

Significance of the Study

This research aims to know the potential of rice husk as an alternative source of cellulose for paper production. This study would prove to be beneficial to the following:

Manufacturers. The results of this study will aid manufacturers by producing an environmental friendly product that they can further develop to help decrease industrial waste.

Environment. The findings of this study can help in finding new ways of protecting the environment by finding alternative raw material in production of paper. This study also contributes to the reduction of rice waste by turning it into another product.

Future Researchers. This study can help future researchers that wish to address similar topics or choose to use the same variable as the study might use this as a starting point and a source of information.

Definition of Terms

Cornstarch. Sometimes referred to as cornflour, is a carbohydrate extracted from the endosperm of corn. This white powdery substance is usedfor many culinary, household, and industrial purposes (Moncel, 2022).

In this study, the cornstarch will be used to enhance the color and quality of the paper produced.

Mill. A device or machine for reducing something (as by crushing or grinding) to small pieces or particles (Merriam-Webster, 2023).

In this study, the mill will be used to pulverize the rice husk for easy pulping

Mold and Deckle. This tool has two parts, which make up its name. The mold is the bottom part that has a frame, usually wood, with some kind of screening stretched over it. The deckle is the top part and is a frame of the same size as the mold. The deckle fits on top of the mold and it helps to keep the pulp contained on the screen and creates the edges of the paper (Stout-Shoger, E., 2019).

In this study, it is used in the formation of a sheet of rice husk paper.

Potential. Say that someone or something is capable of developing into the particular kind of person or thing mentioned (Collins English Dictionary, 2023).

In this study, the researchers will test the potential of rice husk as a packaging material.

Pulping. Is the process where fibers are separated and treated to produce pulp. The wet pulp is then converted into paper at an integrated pulp and paper mill or is dried and transported from the pulp mill to a paper mill(Chandra, M. R. G. S., & Yadav, P. S.,2021).

In this study, the rice husk will be pulped using a mechanical pulping method.

Rice husks. A hard protective covering of rice grains which are separated from the grains during milling process. Rice husk is an abundantly available waste material in all rice producing countries, and it contains about 30%-50% of organic carbon(Singh, 2018)

In this study it is the biomass which was used as primary material for paper production.

Scope and Delimitation

The scope of this study is limited to the potential of rice husk as a packaging material. The researchers collected the milled rice husk at Barangay Leong, Cabatuan, Iloilo. Rice husk would then be strained using a strainer to get a finer pulp. Using a mold and deckle the paper would be formed. The researchers conducted this study at Barangay Tabucan, Cabatuan, Iloilo from March to April 2023.

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter presents the review of related local and foreign studies found in previous literature. This contains the conceptual literature, research literature, and a synthesis of all reviewed studies.

Conceptual Literature

This review of related literature contains information from previous researchers, articles, books, journals, and other literature, which are deemed significant to the current study. This section includes concepts on rice husk, cornstarch, pulping, paper production and paper.

Rice Husk

Rice husk (RH) is an agricultural byproduct. It is the hard outer protective layer that surrounds paddy grain and accounts for 20%-25% of its weight. It is eliminated during the rice milling process. Around 20% of the weight of rice is received as husk during milling. It is made of hard elements such as opaline silica and lignin. It's been utilized as a building material, fertilizer, insulation, and fuel. Rice husks were discovered to be less expensive and more abundant than typical particle board wood chips. It is also termite-resistant because to the silica content, which termites find difficult to consume. Rice husk has a high silica concentration, which makes it excellent for strengthening construction materials, resists fungal decomposition, resists moisture penetration, decomposes slowly, insulates well, and is renewable. (Norwex Movemen, Chand &Fahim. 2021)

Components of Rice Husk

Rice husk accounts for approximately 20% of the weight of rice and is composed of cellulose (50%), lignin (25%-30%), silica (15%-20%), and moisture (10%-15%). The bulk density of rice husk is modest, ranging from 90 to 150 kg/m3. Rice husk is a plentiful waste material in all rice producing countries, containing approximately 30%-50% organic carbon. (Waste and Supplementary Cementitious Materials in Concrete. 2018)

Corn Starch

Corn starch is a white, tasteless, odorless powder that is used in food processing. papermaking, and the manufacture of industrial adhesives; it is also included in many cosmetics and oral pharmaceutical products (Aronson, 2016).

Corn starch is used as a food, feed, and industrial raw material. Starch accounts for the majority of the biomass in corn hybrids and is the most essential and primary yield component in com breeding operations. Starch is made up of two polymers, branching amylopectin and linear amylose, which make up approximately 75% and 25% of maize starch, respectively (JK & YS, 2021)

Characteristics of Corn Starch

Corn starch is a popular thickening agent derived from com endosperm. When utilizing corn starch as a thickening agent a 1 to 2 ratio of cornstarch to water is normally used, or one tablespoon of cornstarch and two tablespoons of water (Dube, 2022) Cornstarch is made up of long chains of starch molecules that unravel and swell when heated in the presence of moisture. The thickening is caused by this swelling action, also known as gelatinization. The cornstarch will also assist absorb moisture from condensation and avoid the formation of a slimy texture. Comstarch should not be added directly to a hot liquid as this can generate lumps. Alternatively, make cornstarch and a room temperature or slightly chilly liquid, then swirl it into the hot liquid. This will ensure that the cornstarch molecules are distributed evenly before they expand and gelatinize (Moncel, 2022).

Pulping

Pulping involves either separating the fibers in water or releasing them from the lignin that holds them together. In order to pulp, fibers must pulp, fibers be separated and processed (Davidsdottir, 2013).

In general, mechanical pulps offer good sheet formation, enhance sheet bulk, increase sheet absorption, increase sheet opacity, and increase sheet resilience, but they decrease sheet strength (Cameron, 2016).

Mechanical pulping uses mechanical energy to weaken and separate fibers from wood via a grinding action. Chemical pulping is used for materials that need to be stronger or combined with mechanical pulping to give different characteristics to a product (BYJU'S, 2023).

Advantage of Pulping

The advantage of this method is its very high yield and the resulting fibers are quite short and frequently need to be mixed with strong, pricey chemical fibers in order to be strong enough to pass through the paper machine, coaters, and printing processes (Bajpai, 2016).

Paper Production

Paper production requires simply cellulose, which can be produced from a variety of plants of textile waste, as well as fresh water for processing the fibers and a screen to collect them. The importance of paper and papermaking is arguably equally important. despite the fact that the history of paper has traditionally been eclipsed by the history of printing. This is because paper is a relatively durable, affordable, and flexible material that not only promoted the spread of written culture throughout the world but also changed many other aspects of human activity (Bloom, 2017)

Types of Paper Production

The production of paper can be done in two ways, industrial and mamual. In manual papermaking, fibres are diluted in water before being drained through a screen to produce a mat of intertwined fibers. Over time, this approach hasn't undergone much modification. In order to manually create paper, there are five steps. Making a paper using industrial methods reduces the amount of human labor required and speeds up manufacturing. The utilization of industrial manufacturing has increased due to technical advancements. In fact, it is incredibly unlikely to find a business that still makes paper by hand (T., 2021).

Advantage of Paper Production

Some advantages of papermaking includes the following: It possess one of the main advantages of handmade paper, that is 100% recycled and wood free. It can be used for a multitude of tasks, including writing and printing. Handmade paper was produced with at least 50% less water and 75% less energy than machine-made paper. Moreover, it reduces air pollution by 70% and wastewater production by up to 90% (Singh, 2020)

Disadvantage of Paper Production

Some disadvantages of papermaking include the uses of toxic chemicals like chlorine and chlorine compounds to break down the wood pulp and bleach paper. By products of these powerful and hazardous compounds include boiler ash, effluents, sludge, and suspended particles (Achlim, 2021).

Categories of Paper Production

There are numerous varieties of paper used, including recycled paper, tracing paper, bond paper, copy and copier paper, kraft paper, woven paper, and filter paper. litmus paper, and manilla paper (Anton, 2023).

Daily writing and printer paper, called a bond, is thin and smooth. Few papers, especially paper used for arts & crafts, are thicker and occasionally textured. Cardboard is a rough, thick type of paper utilized to make boxes and other packaging. The paper used for newspapers, called newsprint, is thin and cheap. Converted paper is made from used paper or leftover bits of modern paper. People use paper to make books, cards, gift wraps, cash, egg cartons, and hundreds of other commodities (Vedantu Improvement Promise (VIP), 2023).

Uses of Rice Husk

In the study of Ryoko & Masafumi (2019), the feasibility of a rice husk recycling scheme in Japan to produce silica fertilizer for rice plants, the essential condition for heat recovery is that the silica in rice husk ash must be amorphous. The current recycling methods, however, are not stable. They anticipated that the amount of recycling will shrink in the future; therefore, the amount used for incineration is flexible and can be estimated to be much larger. Assuming six working hours per day and 220 d per year, the amount of husks produced overall would equate to a burning rate of 250 kg h Amorphous silica effectively promotes the healthy growth of rice plants. Researchers found out that using the heat from burning rice husks to heat water was sustainable and feasible. On the other hand, burning rice husks to generate electricity was not sustainable; its high operational costs and the low sales price of electricity meant that this pathway was not economically viable. According to the findings of the researchers, rice husk ash may be designated as a permitted silica fertilizer by the Ministry of Agriculture, Forestry. and Fisheries.

Corn Starch

According to Yan,et al. (2016), starch coated filler can be used to create high filler content paper products. A new technology of coating starch on the clay surface was developed to increase the strength qualities of high filler filled papers. The coated starch's stability and impact on paper qualities were investigated. It was discovered that the starch coating on the clay surface inflated when exposed to water. This inflated starch coating such compressive strength, thermal conductivity, dynamic stiffness, improvement in impact sound insulation, sound absorption, and transmission loss.

Related Studies

This section contains a review of the data and procedures from studies made in the past that is related to the current research. This contains both local and foreign studies on topics that are included in the scope and limitations of the study.

In the study of Khado, et. al. (2015), the suitability of producing cardboard from rice husk, thus, reducing the amount of pulping material required from virgin wood. Rice husks and depithing bagasse were oven-dried and stored for further use. The maceration fluid is prepared by mixing 1 part of 30% hydrogen peroxide solution, 4 parts of distilled water, and 5 parts of glacial acetic acid. The bursting index was 1.88, 1.55, and 1.26 kPa m2/g, respectively. The optimal rice husk mixed waste paper ratio was (20/80) with a tensile index of 21.52 N m/g with an edgewise compressive resistance of 2.75 kN/m and a bursting index of 1.35 kPa m2/g. Thus, these cardboards are suitable for packaging as corrugating medium, wrapping and insulating board.

Rice Husk

In the study of Antunes et al. (2019), the primary goal of the paper is to suggest a novel rice husk-based composite material. This article details an experimental investigation of the mechanical, thermal, and acoustic characteristics of brand-new composite boards manufactured from discarded rice husk intended for use in building. In this investigation, rice husk was combined in weight percent ratios of 50/50 and 75/25 with either expanded cork granules or recycled rubber granules. 20% of the mass of the fillers were bound using a polyurethane pre-polymer based on TDI. Small boards were created in sufficient numbers to allow for small-scale testing and evaluation of attributes on the filler surface that considerably contributes to filler-filler bonding. Even with unmodified corn starch, the tensile qualities of hand sheets formed from starch coated clay could be boosted by more than 15% compared to the typical method of adding cationic or amphoteric potato starch directly to 50% bleached softwood pulp/50% bleached hardwood pulp.

Uses of Corn Starch

The researchers Encalada, et. al. (2018) investigated the use of cornstarch as an adhesive in paper products made from recycled paper. The researchers found that cornstarch could be used as an adhesive in recycled paper products, but the bonding strength was lower than when using synthetic adhesives. Cornstarch has also been used as an adhesive in the production of paper-based packaging materials, such as boxes and envelopes. In these applications, cornstarch is typically used in combination with other natural polymers, such as cellulose, to improve the bonding strength and water resistance of the finished product. Overall, the research suggests that cornstarch can be used as an adhesive in paper products, although it may not be as strong as synthetic adhesives in some applications. It may be more suitable for use in eco-friendly products where biodegradability and renewable sources are important considerations.

Pulping

The researcher Sridach (2017), examines certain physical and chemical features of non-wood pulps that affect papermaking. Organic solvent-based pulping technologies that are less polluting are of interest for pulp production. The delignification of the Organosolv pulping process depends on the type of Organosolv processes and cellulosic sources used. Catalysts, solvent concentration, cooking temperature, cooking time, and liquor to raw material ratio are all factors that determine the qualities of pulp and paper.

Methods of Pulping

In the study of Drake (2021), comprehensive overview of the various classic pulping methods as well as a description of contemporary developments in pulping processes. A study of several pulping procedures has demonstrated that the mechanical pulping process delivers high pulp yields per unit volume of wood of poor quality (low strength, bonding, fiber shape, etc.) as compared to chemical pulping methods.

Semi-chemical pulping has been reported as an efficient method of circumventing the drawbacks of the mechanical pulping process. Recent changes to pulping processes over the last decade have been examined and demonstrated to be motivated by a goal to save energy and minimize chemical requirements while increasing pulp yields and quality.

In the study of Jiménez, et. al. (2018), the examination of alternative raw materials such as vine shoots, cotton stalks, Leucaenaleucocephala, and Chamaecytisusproliferus, as well as the pulp obtained from each, with the goal of identifying potential viable substitutes for standard pulping raw materials. A comparison of the chemical characteristics of vine shoots, cotton stalks, L. leucocephala and Ch proliferus and diverse agricultural residues (olive prunings, wheat straw, sunflower stalks, sorghum stalks, rice straw and sugarcane bagasse), vegetable non-wood, hardwood and softwood indicate that Ch. proliferus and cotton stalks are the best raw materials among those investigated on the grounds of their increased contents in holocellulose and a-cellulose, and their decreased contents in ethanol-benzene.

Paper Production

In the study of Tariq(2021), sugarcane bagasse from pastry businesses in Duque de Caxias, RJ, was utilized to make paper using traditional methods. In this contest, the pulping procedure was carried out by heating the fibers in an alkaline pressure cooker, washing, and drying. The resulting fibers were then molded on an A4 screen. There were two sheets and three reproductions made. The results showed that the paper production was efficient, and the physical measurements, grammage, area, mass, thickness, height, and width, calculated using ANOVA and Tukey's Method, showed equal values in each case, indicating the production's quality. The paper produced is of the same quality as regular paper, but without the need for chemicals or the use of as much water as recycled browns.

Advantage of Paper Production

The researchers Duncan & Fiscal (2016), seeks to evaluate the pulp and paper-making capabilities of maize husks. The chemical analysis of corn husk meal was performed in accordance with the Technical Association of the Pulp and Paper Industry (TAPPI) guidelines for the various components. TAPPI T 220 Physical Testing of Pulp Hand sheets was used to create laboratory paper sheets 134g/m2 from fiberized corn husk pulp (T 205 om-88) and test them for tensile strength qualities such as modulus of elasticity, elongation at break, breaking length, and tensile stiffness. The chemical study of corn husks reveals that cellulose accounts for roughly 44% of the corn husks. Despite the fact that the flexibility and runkel ratios in this study were very low, maize husk pulp can be blended with softwood, hardwood, or recycled paper pulps to generate paper with improved printability, ripping strength, and mechanical strength.

CHAPTER II

METHODOLOGY

This chapter deals with the research methods used in this study. It encompasses a discussion on research design, description of the study variable, gathering of materials, preparation of materials, experimental design and lay-out, experimental proper, data collection, and data analysis. It also presents the different schematic diagrams of the experimental procedures.

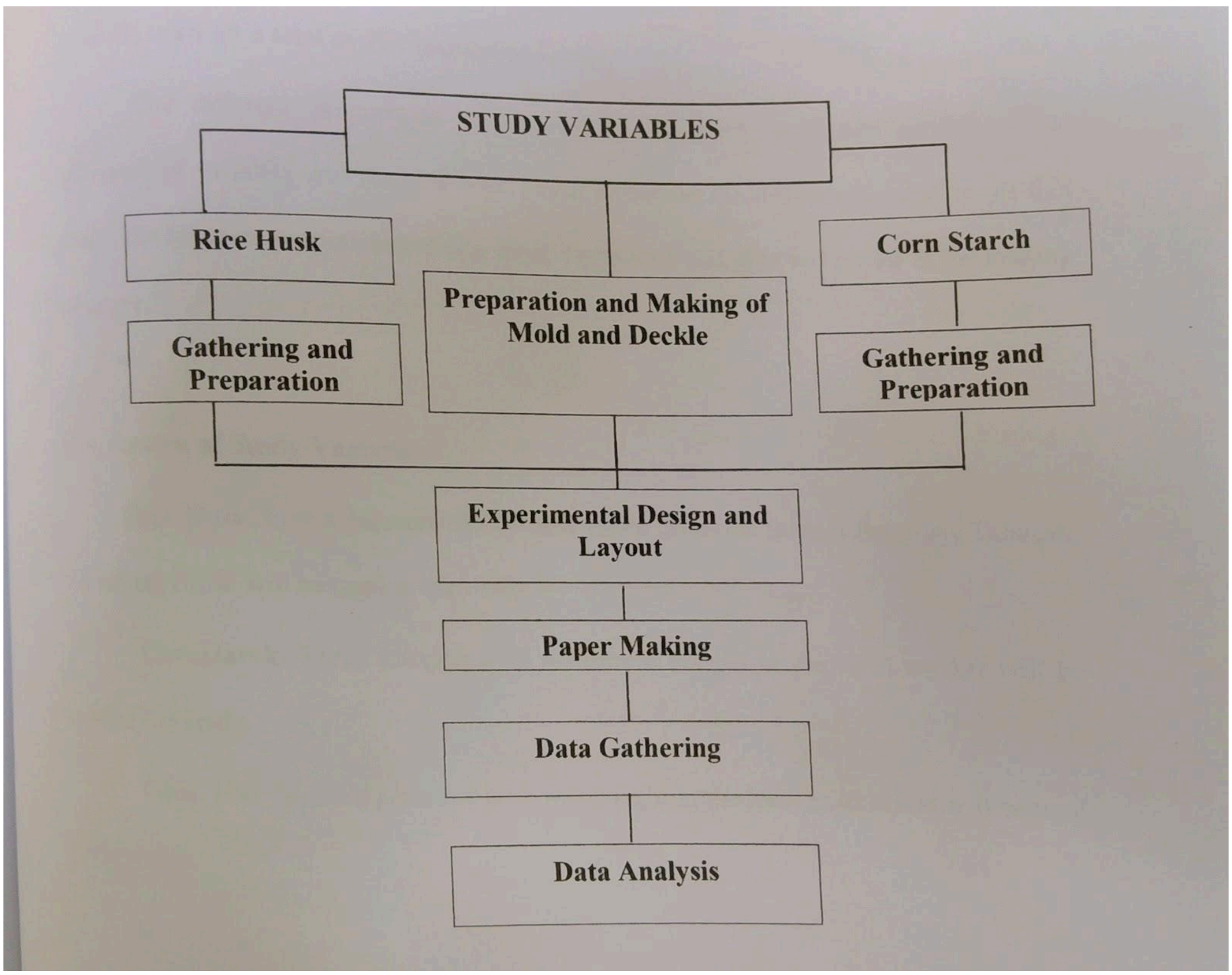

Figure 2.1 Schematic Diagram of Research Methodology

Research Design

This quantitative research was concerned with the potential of rice bunk esa packaging material. For the max verification of the results in this study, a Randomized Complete Block Design (RCBD) was chosen. A Randomized Complete Block Design is the standard design for agricultural experiments where similar experimental units are grouped into blocks or replicates. It is also used to control variation in an experiment by accounting for spatial effects in field or greenhouse. There were four (4) set-ups with three (3) trials for a total of 12 experimental units.

The different proportions of rice husk, cornstarch and glue served as the independent variable, and the rice husk paper served as the dependent variable. In this study, the different proportions of rice husk, cornstarch and glue were used in the making of paper.

Description of Study Variables

Rice Husk. Five kilograms of rice husk taken from one farm in Barangay Tabucan, Cabatuan, Iloilo will be used in the study.

Cornstarch. Three kilograms of cornstarch bought in the local market will be used in the study.

Glue. Five hundred grams of glue was bought in the local market and will be used in the study.

Gathering and Preparing of Rice Husk

The researchers manually collected five kilograms of milled rice husk. After collecting the rice husk, it is strained using a strainer to get the finer pulp. The rice husk is then measured and prepared for the experiment.

Gathering and Preparation of Cornstarch

The experiment make use of three kilograms of cornstarch that were purchased from the local market. The cornstarch was then measured and prepared for the experiment.

Gathering and Preparation of Glue

The experiment make use of 500g grams of glue that were purchased from the local market. The glue was then measured and prepared for the experiment.

Preparation of Mold and Deckle

A mold and deckle is a two-piece papermaking instrument (basically a screen and frame) that is used to mold each sheet of pulp during the handmade papermaking process. Two picture frames were purchased locally to be used in the creation of a DIY (do it yourself) mold and deckle. The second frame will be positioned on top of the mold, and will serve as the deckle.

Experimental Design and Layout

This study has four treatments and each treatment setup was replicated three times Set-up A (60% Rice husk, 0% Cornstarch, 40% Glue), Set-up B (40% Rice Husk, 20%

Cornstarch, 40% Glue) and Set-up C (20% Rice Husk, 40% Cornstarch, 40% Glue) while Set-up D is the positive control or the commercial paper. To maximize the verification of the study's results, a Randomized Complete Block Design (RCBD) was used and the treatments were assigned via Lottery Method.

Table 2.1 The Composition of the Rice Husk Paper in Each Set-ups.

SET-UP	RICE HUSK	CORNSTARCH	GLUE
A	60%	0%	40%
B	40%	20%	40%
C	20%	40%	40%

Table 2.2 Different Trials of Experimentation

TRIALS		
I	II	III
C	B	A
A	A	D
B	C	B
D	D	C

Legend:

A-Rice Husk (60%), Cornstarch (0), Glue (40%)

B-Rice Husk (40%), Cornstarch (20%), Glue (40%)

C-Rice Husk (20%), Cornstarch (40%), Glue (40%)

D-Positive Control (+) Commercial Paper

Paper Making

The treatment set-up was formulated using 300 grams of solution. Three clean containers were prepared, each with a different concentration of rice husk, cornstarch and glue. The first container which was labeled A contains, Rice Husk (60%), Cornstarch (0), Glue (40%) is composed of 180 grams of rice husk, 0 grams of cornstarch, and 120 grams of glue. Second container which was labeled B contains, Rice Husk (40%), Cornstarch (20%), Glue (40%) is composed of 120 grams of rice husk, 60 grams of cornstarch, and 120 grams of glue. Finally, the third container which was labeled A contains; Rice Husk (20%), Cornstarch (40%), Glue (40%) is composed of 60 grams of rice husk. 120 grams of cornstarch, and 120 grams of glue. The researchers will manually mix the treatments while wearing gloves. The papers will be formed using mold and deckle. The papers will be sun dried one day. The papers will then be kept for one day. Finally, the quality of papers made from different proportions of rice husk, constarch, and glue will be determined in terms of color, texture, and strength.

Data Collection

The quality of the papers produced from different concentrations of rice husk and cornstarch were determined after the papers had fully dried for two days. Both qualitative and quantitative data were gathered among the samples. The color and texture of the papers were gathered through a survey. Ten respondents gave ratings to the produced paper. The research then used a rating scale with the following level; 1- poor, 2- weak, 3-good, 4- very good, and 5- excellent to assess the color and texture of the produced paper.

In collecting data in terms of strength, the ultimate tensile strength formula is used:

$UTS = Fg/A$

Legend:

UTS-Ultimate Tensile Strength

Fg-Force of Gravity (Weight)

A-Cross-sectional Area

Rice husk paper at various concentrations was selected and compared to regular paper to determine its strength.

Data Analysis

Descriptive Analysis. This was used to determine the difference in terms of color and texture of the produced paper from rice husk to the commercial paper.

Mean. This was used to determine the average tensile strength, color and texture of the produced paper.

Standard Deviation. This was used to test the homogeneity of the strength of the produced paper.

ANOVA. This was used to determine if there is a significant difference in the tensile strength of the produced paper and the commercial paper.All inferential analysis were computed at 0.05 alpha.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter presents the results generated from the experiment conducted followed by the interpretation of the results.

Descriptive Analysis

Ten respondents were asked to rate the quality of paper produced from different proportions of rice husk, corn starch and glue in terms of strength, color and texture.

The result shows that Treatment C has the highest rating mean of 4.4 in terms of texture, 4.5 in terms of color, and 0.22 for the tensile strength. The following chart and table below show the data and results of the survey.

Table 3.1 Interpretation of the Rating Results for the Survey

Numerical Rating	Condition of Paper	Descriptive Rating
4-5	Excellent	The texture is smooth and the color is much better than commercial paper.
3-3.99	Good	The texture is a bit rough and the color is better than commercial paper.
2-2.99	Average	The texture is rough and the color is similar to the commercial paper.
1-1.99	Poor	The texture is very rough and the color is not good.

Table 3.2 Tabular representation of survey result

	Ratings of TREATMENT A		Ratings of TREATMENT B		Ratings of TREATMENT C	
No. of respondents (r)	Color	Texture	Color	Texture	Color	Texture
1	5	5	5	5	4	5
2	3	3	5	5	5	5
3	2	2	2	2	4	4
4	4	2	4	4	5	5
5	3	2	3	3	4	4
6	3	5	4	4	5	3
7	4	3	4	4	5	5
8	3	3	4	4	5	5
9	3	2	3	3	4	4
10	3	3	3	3	4	4

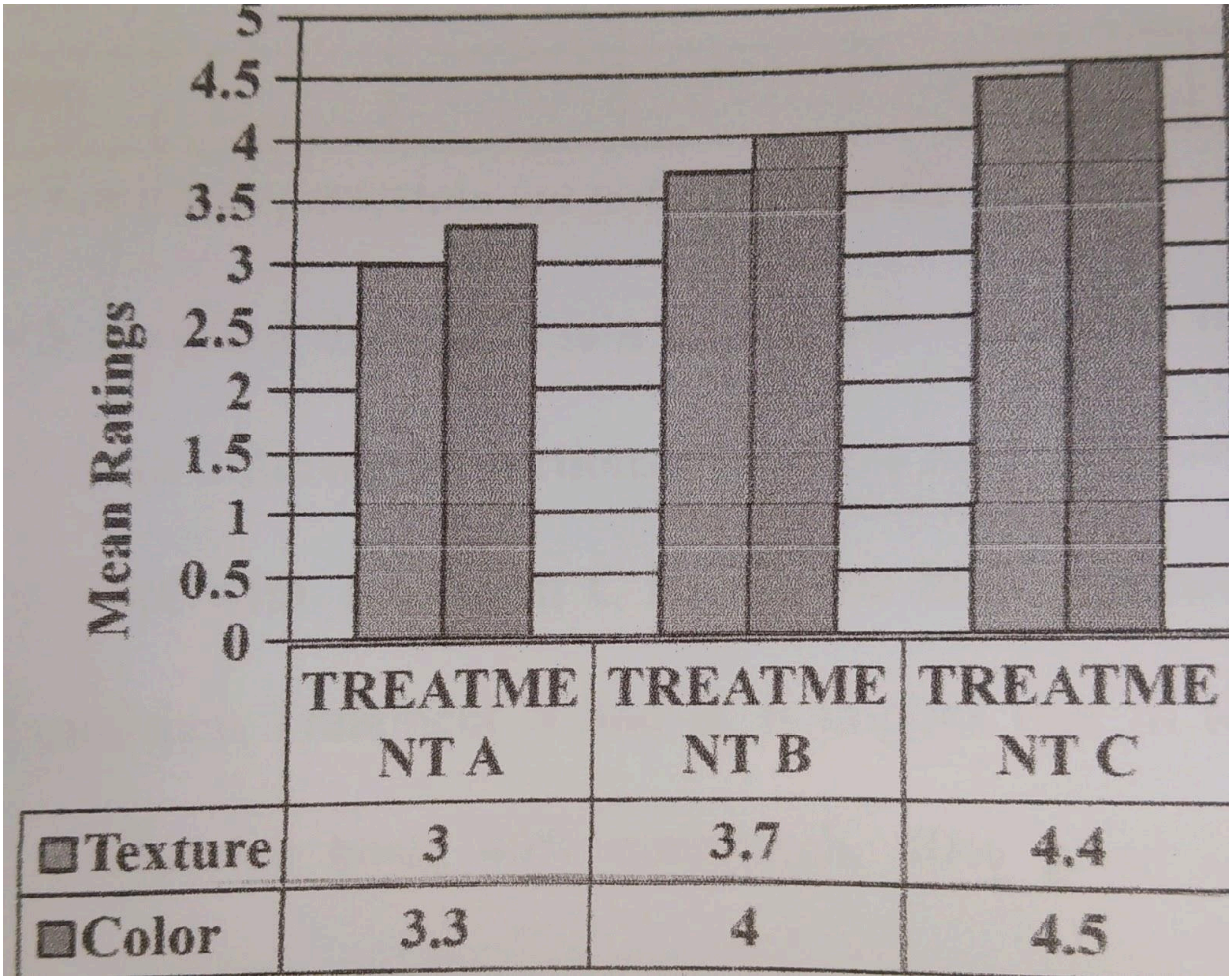

Figure 3.1 graphical representation of the survey results Tensile strength

Table 3.3 different measurement strength per treatment

Treatments	Replication			Total Treatment	Treatment Mean	Standard Deviation
	I	II	III			
A. Set-up A (Rice Husk, Glue)	0.0218	0.0224	0.0231	0.0673	0.0224^{c}	0.0006
B. Set-up B (Rice Husk, Cornstarch, Glue)	0.0241	0.0198	0.0237	0.0676	0.0225^{c}	0.0019
C. Set-up C (Rice Husk, Cornstarch, Glue)	0.2265	0.2360	0.2041	0.6666	0.2222^{a}	0.0134
D. Commercial Paper (+)	0.0304	0.0292	0.0298	0.0894	0.0298^{b}	0.0005
Grand Total				0.8909		
Grand Mean					0.0074	

Note: Similar superscripts are not significantly different.

ANOVA revealed that there is a significant difference in the tensile strength of produce paper from different proportions of the rice husk cornstarch, and glue and that of the positive control with Treatment C having the highest tensile strength followed by Treatment D and then Treatment A and B. It implies that in terms of tensile strength, Treatment C (20% rice husk, 40% cornstarch, 40% glue) is much better than the commercial paper.

Table 3.4 anova result for significance difference in the tensile strength among different treatments

ANOVA

Source of Variation	SS	Df	MS	F	P-value	F crit
Treatment	0.087663397	3	0.029221	390.9414	2.88E-07	4.757063
Blocks	0.00010106	2	5.05E-05	0.676027	0.543535	5.143253
Error	0.000448473	6	7.47E-05			
Total	0.08821293	11				

CV = 10.05%

Table 3.5 Different Measurement of Color per Treatment

Treatment	Replication										Total Treatment	Treatment Mean	Standard Deviation
	I	II	III	IV	V	VI	VII	VIII	IX	X			
Set A (Ricehusk 60%, Glue 40%, Cornstarch 0%)	5	3	2	4	3	3	4	3	3	3	33	3.3[a]	0.82
Set B (Ricehusk 40%, Glue 40%, Cornstarch 20%)	5	5	2	4	3	4	4	4	3	3	40	4[a]	0.95
Set C (Ricehusk 20%, Glue 40%, Cornstarch 40%)	4	5	4	5	4	5	5	5	4	4	45	4.5[a]	0.28
Set D Commercial Paper (+)	5	3	4	4	4	5	5	4	5	4	43	4.3[a]	0.67
Grand Total											161		
Grand Mean												4.025	

Our result showed that Treatment C which has the highest mean is not significantly different from Treatment D, B and A. Thus, it implies that the paper produced from different proportion of rice husk, corn starch and glue is not significantly different from the positive control in the terms of color.

Table 3.6 ANOVA results for significant color differences with several treatments

ANOVA						
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Treatment	9.1	3	3.033333	7.513761	0.000826	2.960351318
Block	9.9	9	1.1	2.724771	0.021121	2.250131477
Error	10.9	27	0.403704			
Total	29.9	39				

CV = 15.78%

Table 3.7 Different Measurement of Texture Per Treatment

Treatment	Replication										Total Treatment	Treatment Mean	Standard Deviation
	I	II	III	IV	V	VI	VII	VIII	IX	X			
Set A Ricehusk (60%, Glue 40%, Cornstarch 0%)	5	3	2	2	2	5	3	3	2	3	30	3[a]	**1.15**
Set B (Ricehusk 40%, Glue 40%, Cornstarch 20%)	5	5	2	4	3	4	4	4	3	3	37	3.7[a]	**0.95**
Set C (Ricehusk 20%, Glue 40%, Cornstarch 40%)	5	5	4	5	4	3	5	5	4	4	44	4.4[a]	**0.70**
Set D Commercial Paper (+)	4	4	5	5	3	5	5	4	3	4	42	4.2[a]	**0.79**
Grand Total											153		
Grand Mean												3.825	

Our result shows that Treatment C is not significantly different from Treatment D, B and A. Thus, it implies that the paper produced from different proportion of the rice husk, corn starch and glue is not significantly different from the positive control *in terms* of texture.

Table 3.8 ANOVA Results for significant textural differences between several treatments

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	11.675	3	3.8916667	6.153733529	0.002509	2.960351
Columns	13.025	9	1.4472222	2.288433382	0.046605	2.250131
Error	17.075	27	0.6324074			
Total	41.775	39				

CV = 20.79%

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This study aimed to evaluate the potential of rice husk as a packaging material The study was conducted on April 15-16, 2023 at Barangay Tabacan, Cabatuan, Iloilo. Rice husk were gathered at Barangay Leong, Cabatuan Iloilo. Corn starch and glue were purchased at the local market. Rice husks were strained to obtain finer pulp.

This study has four treatments and each treatment setup was replicated four times, Set-up A (60% Rice husk, 0% Cornstarch, 40% Glue), Set-up B (40% Rice Husk, 20% Cornstarch, 40% Glue) and Set-up C (20% Rice Husk, 40% Cornstarch, 40% Glue) while Set-up D is the positive control or the commercial paper. Randomized Complete Block Design (RCBD) was used and the treatments were assigned via Lottery Method. The paper making process was based on Eco-Safe Handmade Paper Production from Rice Straws (2016) with minor revisions. The quality of paper produced from different proportions of rice husk, corn starch and glue was determined one day after the papers have fully dried. Ten respondents were asked to give ratings to assess the color and texture of the produced paper. Tensile strength of paper was then measured. ANOVA was used to determine if there is a significant difference in the tensile strength of the produced paper and the commercial paper.

Conclusion

The paper produced from different proportions of rice husk, cornstarch and glue has a potential as a packaging material in terms of color, texture, and tensile strength.

There is a significant difference in terms of tensile strength of the produced paper from different proportions of rice husk, cornstarch, and glue two days until the papers had fully dried. Tensile strength results show that Treatment C has the higher tensile strength compare to the Treatment D or positive control. According to the survey results, Treatment D or the positive control is not significantly different from Treatment C, B. and A. This implies that the paper produced from different proportions of rice husk. cornstarch and glue is not significantly different to that of commercial paper (+) control in terms of color and texture.

Recommendations

The researcher recommends using rice husk as a base material for making paper. especially for packaging. Rice husk can be a useful raw material for the pulp and paper industry. It provides dual benefit by solving the rice husk waste management problem of farmers and provides a solution for alternate raw material for paper.

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APPENDICES

APPENDIX A

CALENDAR OF EVENTS

MARCH 2023						
SUN	MON	TUES	WED	THURS	FRI	SAT
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30 We had a mold and deckle made	31	

APRIL 2023

SUN	MON	TUES	WED	THURS	FRI	SAT
						1
2	3	4 Collected rice husk from	5	6	7	8
9	10	11	12	13	14	15 Air-dried the produced paper
16 Air-dried the produced paper	17 End of air-drying	18 Conducted a survey	19 Measured the tensile strength	20	21	22
23	24	25	26	27	28	29
30						

APPENDIX B

EXPENDITURES

Materials	Quantity	Price per item	Total Cost
Rice husk	7 kg	Php 15.00	Php 105.00
Cornstarch	1 kg	Php 96.00	Php 96.00
Glue	4 pcs	Php 25.00	Php 100.00
Soy Glue	3 pcs	Php 6.00	Php 18.00
TOTAL			Php 319.00

APPENDIX C

LETTERS AND SURVER FORM

April 24, 2023

Borrowed Item
* Vernier Caliper
* Triple Beam Balance

Borrower:

Sophia Bianca Bañas

Republic Act of the Philippines
Department of Education
Region VI – Western Visayas
Schools Division of Iloilo
CABATUAN NATIONAL COMPREHENSIVE HIGH SCHOOL

SURVEY FORM

Potential Commercial Value of Paper From Rice Husk

Name (optional) Occupation

Direction: Please rate our paper by shading base on your preferences

TREATMENT A (60% Rice Husk, 0% Cornstarch, 40% Glue)

COLOR	TEXTURE
5 – excellent	5 – excellent
4 – very good	4 – very good
3 – good	3 – good
2 – poor	2 – poor
1 – weak	1 – weak

TREATMENT B (40% Rice Husk, 20% Cornstarch, 40% Glue)

COLOR	TEXTURE
5 – excellent	5 – excellent
4 – very good	4 – very good
3 – good	3 – good
2 – poor	2 – poor
1 – weak	1 – weak

TREATMENT C (20% Rice Husk, 40% Cornstarch, 40% Glue)

COLOR	TEXTURE
5 – excellent	5 – excellent
4 – very good	4 – very good
3 – good	3 – good
2 – poor	2 – poor
1 – weak	1 – weak

TREATMENT D (Commercial Paper)

COLOR	TEXTURE
5 – excellent	5 – excellent
4 – very good	4 – very good
3 – good	3 – good
2 – poor	2 – poor
1 – weak	1 – weak

Signiture Over Printed Name

APPENDIX D

COMPUTATION

Table 4.3 ANOVA result for significance difference in the tensile

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Treatment	0.087663397	3	0.029221	390.9414	2.88E-07	4.757063
Blocks	0.00010106	2	5.05E-05	0.676027	0.543535	5.143253
Error	0.000448473	6	7.47E-05			
Total	0.08821293	11				

Table 4.6 ANOVA result for significance difference in terms of color among different treatments

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Treatment	9.1	3	3.033333	7.513761	0.000826	2.960351318
Block	9.9	9	1.1	2.724771	0.021121	2.250131477
Error	10.9	27	0.403704			
Total	29.9	39				

Table 4.8 ANOVA result for significance difference in texture among different treatments

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Rows	11.675	3	3.8916667	6.153733529	0.002509	2.960351
Columns	13.025	9	1.4472222	2.288433382	0.046605	2.250131
Error	17.075	27	0.6324074			
Total	41.775	39				

DMRT Strength

Treatment	Means	Rp	Rp	Difference
C	0.6666[a]	3.649	0.0182	0.6484
D	0.0894[b]	3.586	0.0179	0.0715
B	0.0676[c]	3.460	0.0173	0.0 503
A	0.0673[c]			

Computation of C.V.

$$CV = \frac{\sqrt{\text{Mean Square (Error MS)}}}{\text{Grand Mean}} \times 100\%$$

$$CV = \frac{\sqrt{7.47E-05}}{0.0074} \times 100\%$$

$$CV = \sqrt{0.010095} \times 100\%$$

$$CV = 10.05\%$$

$$S_{\bar{x}} = \sqrt{\frac{\text{Error MS}}{\text{Replication}}}$$

$$S_{\bar{x}} = \sqrt{\frac{7.47\text{E} - 05}{3}}$$

$$S_{\bar{x}} = 0.005$$

$0.6484 >$ lower means (D, B, A) — $0.6484 > 0.0894$; $0.6484 > 0.0676$; $0.6484 > 0.0673$ Treatment C is significantly different to Treatment D, B, and A.

$0.0715 >$ lower means (B and A) — $0.0715 > 0.0676$; $0.0715 > 0.0673$ Treatment D is significantly different to Treatment B and A.

$0.0503 <$ lower mean (A) — $0.0503 < 0.0673$ Treatment B is not significantly different to Treatment A

DMRT Color

Treatment	**Means**	**rp**	**Rp**	**Difference**
C	4.5^{a}	3.144	1.26	3.24
D	4.3^{a}	3.049	1.22	3.08
B	4^{a}	2.902	1.16	2.84
A	3.3^{a}			

Computation of C.V.

$$CV = \frac{\sqrt{\text{Mean Square (Error MS)}}}{\text{Grand Mean}} \times 100\%$$

$$CV = \frac{\sqrt{0.4037037}}{4.025} \times 100\%$$

$$CV = 15.78\%$$

DRMT Texture

Treatment	Means	Rp	Rp	Difference
C	4.4[a]	3.144	1.572	2.828
D	4.2[a]	3.049	1.5245	2.655
B	3.7[a]	2.902	1.451	2.249
A	3[a]			

Computation of C.V.

$$CV = \frac{\sqrt{\text{Mean Square (Error MS)}}}{\text{Grand Mean}} \times 100\%$$

$$CV = \frac{\sqrt{0.6324074}}{4.023.835} \times 100\%$$

$$CV = 20.79\%$$

APPENDIX E

PICTORIALS

Plate 1. Rice Husk

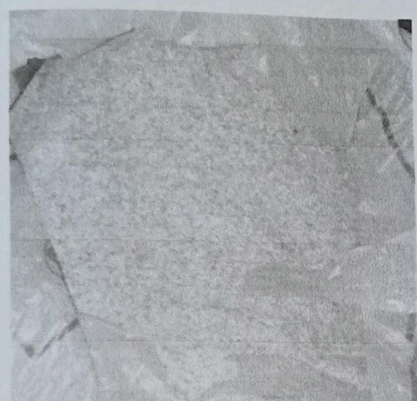


Plate 2. Cornstarch

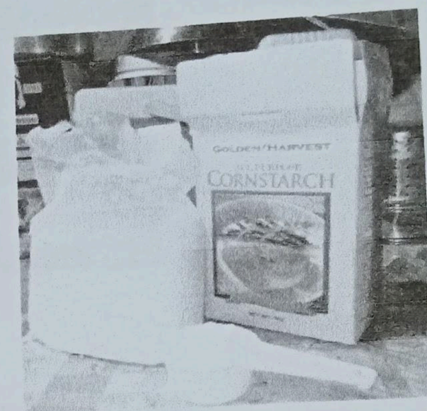


Plate 3. Glue

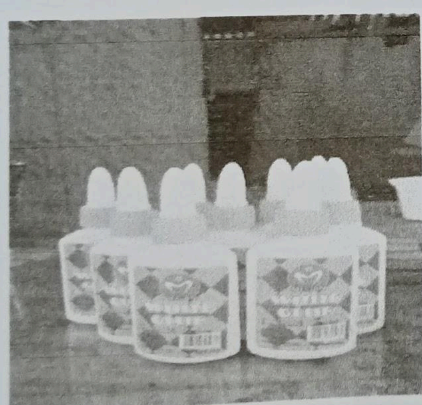
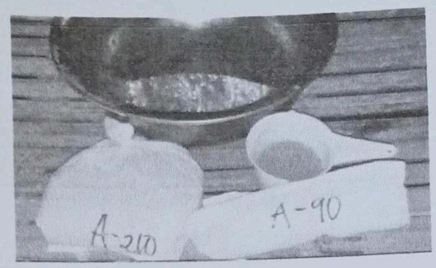


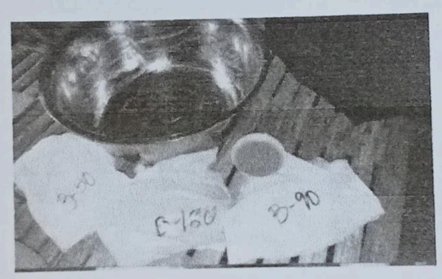
Plate 4. Sifting of rice husks

Plate 5. Measurements of each treatment

Treatment A. (60% Rice Husk, 0% Cornstarch, 40% Glue)



Treatment B. (40% Rice Husk, 20% Cornstarch, 40% Glue)



Treatment C. (20% Rice Husk, 40% Cornstarch, 40% Glue)

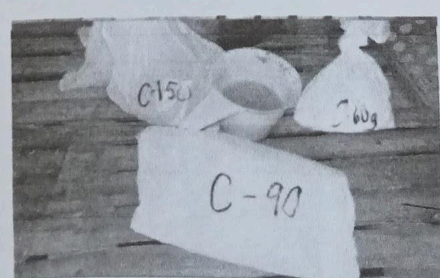


Plate 6. Molding

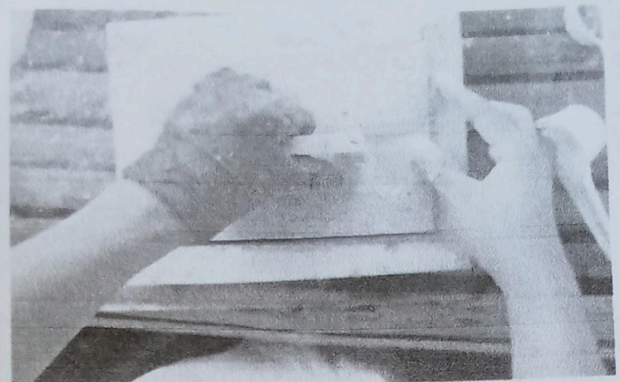


Plate 7. Sun dry

Plate 8. Tensile Strength