Chapter - 5

SUMMARY AND CONCLUSION

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In the present era of environmental consciousness, the new quality requirement not focuses on the innate performance and durability of the material but also the process used for the production of that material should not harm the environment at all. Natural colorants/dyes are one of the way to create a product which can be environment friendly. The art of dyeing with the dyes obtained from the plant sources has gained attention not only from the safety point of view but they are also good for health, environment and the most important they have novelty and aesthetic quality.

Today consumers are frequently transforming from synthetic to nature-based products**,** they are demanding eco-friendly, non-toxic and hygienic textile and the consumption of antimicrobials is increasing day by day. Precise research and development activity are trying to keep steps by developing various and effective solutions which are safe for the human being and environment. It is mentioned that the market for the natural dyestuff is very limited. Vegetable dyed and printed materials is not extensively available to the mass consumer **(Mishra,2014)**

There is an increasing affection towards natural materials whose apparent sources are- chitosan from animal sources and guar gum and vegetable dyes from plant sources. As people are getting more aware and concerned about environment conservation their health, hygiene an effort has been made in the present study to develop textile material using bioactive medicinal dyes on natural fabric and all the natural and eco-friendly thickeners such as guar gum and chitosan.

Various natural dyes were analyzed and out of the abundance of natural sources from which colouring material can be extracted, six sources from vegetable origin having medicinal properties were selected for the present study. All these dye sources (Madder, Katha, Annatto seed, Turmeric, Palash and Marigold) falls under the category of Red and Yellow dye and their tint and shades. Affinity of these dyes were assessed on the selected fabric and after that printing process was done.

For the present study regenerated cellulosic fabrics, **Lyocell** and **Bamboo** was chosen as they are said to have good affinity towards natural dye sources. As Lyocell and Bamboo both are regenerated cellulosic fabric, but they possess different properties and texture because of these variation in the properties both the fabric were selected for the study to optimize the difference in the printing and its characterization.

Natural thickeners were selected for the present study for the preparation of the printing paste for printing of the fabric through screen printing. A chitosan is a biopolymer, which is non-toxic and generally used for an effective antimicrobial finish and also used to increase the dye uptake of the fabric because of having mordanting property **(Abdou et al., 2013)** enhanced the printing quality and is affinity on the fabric including antimicrobial property on the fabric. Guar gum was also used for the preparation of printing paste because of its viscous and sticky nature and ability to absorb water to add good colour value to the printed material. Therefore, in the present research work blend of both the thickener on various ratio were developed along with only guar gum paste to analyse the difference in the fastness of the printed material.

Natural dyes with Medicinal properties: For the present research work Six natural dyes of plant sources were used for printing of the fabric through hand screen printing. It was observed that all the selected dyes found to have good affinity on both the regenerated cellulosic fabric. As the dye was in powdered form therefore its extraction was done in methanol to get the smooth extract in pigment form which was convenient for preparation of paste. Among all the selected dyes four of the dyes – Katha, Palash, Marigold and Annatto seed had best result on all the parameter of characterization and antimicrobial activity.

Development of Printing Paste: Two natural thickeners were selected for the printing of the fabric. Four recipes of various blend ratios of the thickener and guar gum pate was developed for printing. Among all the developed ratios for printing cellulosic fabric (Lyocell and Bamboo) three of the recipes with the ratio – 25%GG+75%CH, 75%GG+25%CH and 50%GG+50%CH were found to have best result for colour fastness, physical strength and antimicrobial property as well.

Characterization of Printed Lyocell Fabric:

- Regenerated- Lyocell fabric was chosen for printing with selected natural dyes. It was observed that among all the printed samples with six dyes, fabric printed with Katha dye had best colour fastness to washing with all the developed recipes. It was graded between 5, 4-5 on both colour change and colour staining part. Whereas fabric printed with Turmeric dye had the poor fastness to washing among all the dyes used.
- There was no much difference observed for Rubbing fastness of the printed fabric. All the dyes were ranged between 4-5 to 5, only 50% GG+50% CH ratio of Annatto seed had poor result for wet rubbing and 75%GG+25%CH ratio of Madder dye had poor result in wet condition.
- Annatto seed dye, Turmeric dye and Marigold dye was observed to have the best fastness towards perspiration on both acidic and alkaline solution. Three of the ratios 75%GG+25%CH, 25%GG+75%CH and 50% GG+50% CH gave the best result.
- Fabric printed with Katha and Palash dye was observed to have good sunlight fastness with all the developed recipes graded 5 on the scale.
- For physical assessment of the printed fabric it was observed that the tensile strength and tearing strength of the fabric was increased in both warp and weft direction after printing. Palash, Madder and Katha dye were found to have best result among all the dyes used with the ratio 50% GG+50% CH and 100% Guar gum paste. While for tearing strength best result was observed on fabric printed with Madder dye with the recipe of the ratio 50% GG+50% CH and 100% Guar gum paste.
- Antimicrobial activity of printed Lyocell fabric was assessed by qualitative method. In grey fabric antimicrobial activity was observed no against the gram positive bacteria *S.aureus* and gram negative bacteria *E.coli*. In the printed fabric category it was observed that fabric printed with Annatto seed dye had antimicrobial activity against both *S.aureus* and *E.coli* bacteria with three of the ratios of thickener 75%GG+25%CH, 25%GG+75%CH and 50% GG+50% which was followed by Katha dye and Madder dye.

Characterization of Printed Bamboo Fabric

- It was optimized that fabric printed with Katha dye with all the four-recipe had good fastness to Washing as compared to other dyes used. Poor wash fastness to change in colour was observed with turmeric dye.
- For rubbing fastness of the printed Bamboo fabric excellent result was observed with Katha, Annatto seed dye and Turmeric dye in both wet and dry condition. Whereas poor rub fastness in wet condition was found of the fabric printed with Madder dye.
- No much difference was recorded in case of perspiration fastness of the printed Bamboo fabric. All the dyes were graded to between 4, 4-5 and 5 on gray scale on both acidic and alkaline solution. Whereas poor fastness was observed with Palash dye graded 2-3 with the ratio 25%GG+75%CH and 50% GG+50%CH.
- Fabric printed with Katha dye with all the recipe had good sunlight fastness with all the recipes developed, followed by three of the blend ratios of Palash dye.
- Both tensile and tearing strength of the fabric was increased after printing with the developed recipes. Best result was obtained with the ratio 50% GG+50%CH and 100%Guar gum paste in both the direction of the fabric.
- Grey Bamboo fabric was observed to have antimicrobial activity against both the gram positive and gram-negative bacteria. Among all the dyes, fabric printed with Annatto seed dye found to have antimicrobial activity with both *S.aureus* and E.coli bacteria. Whereas Katha dye, Madder dye and Marigold dye found to have such activity with *E.coli* but not in the presence of *S.aureus* bacteria.

Conclusion can be drawn from the present research work that four dye sources Katha, Palash, Marigold and Annatto seed had best affinity on both the regenerated cellulosic fabric, Lyocell and Bamboo. Out of four developed recipe of various blend ratio three of the ratios (75%GG+25%CH, 25%GG+75%CH and 50% GG+50%CH) had best results on all the parameters of assessment. Fabric printed with Katha dye, Palash and Annatto seed dye with the ratio 75%GG+25%CH and 25%GG+75%CH performed best among all. Whereas fabric printed with the ratio of thickener 50%

GG+50%CH and 100%Guar gum gave best physical strength to the fabric. Fabric printed with Annatto seed dye and Marigold dye with three of the ratios of thickener 75%GG+25%CH, 25%GG+75%CH and 50% GG+50%CH gave antimicrobial activity. These value addition on the regenerated cellulosic fabrics with not so common colouring and thickening agents can be additionally implemented with dye of the fabric before printing to enhance the fastness properties of the dye. These developed dye-thickener recipes in the study can control the growth of microbes on the fabric, which can be used as an alternative for the harmful synthetic dyes, therefore, these dyes can be used for kids clothing, smart textiles, medical textile and for carpet manufacturing.

Recommendations:

Developed printing paste with the natural sources and natural thickeners can be produced readily with certain specific equipment in short duration and independent from related variables like season and age. These dye sources and thickening agents are extensively found in nature. On the other hand, in view of the antimicrobial properties of the recipe developed it may be used in medicinal textiles. Therefore, this research work will greatly help in the production of large amount of eco-friendly and non-toxic products, which will be helpful in fulfilling commercial demand in India as well as in world market. The further research in this direction can be aimed as:

- Identification of additional colourants from natural sources and its properties can be analysed for propagation of making environment friendly products on commercial scale.
- Standardization of a systematic and scientific approach is needed to minimize the cost investment to produce an eco-friendly product.
- All these dyes can be used on protein fibre and fabric for printing with the use of different mordants to increase the durability of the dye on the fabric.
- As textile is mother industry of our country mentioned by NPC (National Productivity Council) further more research can be done in this direction with less capital more can be generated Which can give rise to the women empowerment.