

Design and Development of Sustainable Jamakkalam using Organic Cotton Blended with Unconventional Natural Fibre and Regenerated Fibre-Part I

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Abstract - This research work aims at the design and development of jamakkalam using organic cotton as warp and a blend of organic cotton with unconventional and regenerated fibres as weft. The warp yarn will be prepared using a rotor spinning machine with the yarn count as 5s Ne. In weft, yarn will be prepared using a blend of organic cotton with unconventional natural fibres (castor oil fibre and banana fibre) and regenerated fibre (bamboo fibre) in the ratio of 60:40. The count of the weft yarn will be 5s Ne. The weft yarn will be dyed using natural dyes. The above yarns will be converted into jamakkalams using handlooms. Design intervention in the jamakkalams will be done using jacquards, changing the weave (twill weave), and variation of pastel hues in the weft direction. With our design intervention, the jamakkalams would serve various aesthetic purposes. Product diversification is also undertaken. The raw material (organic cotton) was tested and reported. In-house testing was carried out for other fibres (banana fibre, bamboo fibre, castor oil fibre). The produced yarns and fabrics will be tested and evaluated for physical, mechanical and comfort properties.

Key Words: Organic cotton, banana fibre, natural dyeing, rotor spinning, handloom, jacquard

1. INTRODUCTION

In the late 19th century, jamakkalam was brought into the market as competition for British-made textiles. They are usually woven with coarse yarns and comply to six standard colors- red, blue, green, white, orange, yellow. Jamakkalam is a tradition that dates back to nearly two centuries and reflects rich craftsmanship. The relevance of jamakkalam in today's world is slowly declining. It is necessary to act upon its revival. This begins with understanding the origin, the art and the artisans who are involved in the making of jamakkalam.

Jamakkalam originated in a place called Bhavani in Erode district, Tamil Nadu. It was initially woven by a community of weavers called Jangamars. They used colored coarse threads. Bhavani jamakkalam is a GI-tagged product. Initially, jamakkalams were woven by independent weavers in their houses. With time, the usage of handlooms supervised by master weavers came into

existence. Handlooms and contract weavers were leased by master weavers. Trade merchants own these handlooms and they procure raw materials such as thread from neighbouring cities of Coimbatore, Salem and Karur. Nearly 20,000 weavers take part in the development of jamakkalam with two-third of the workforce comprising women. The critical acclaim gained by the product led to the production of jamakkalams by other weavers replacing the production of traditional sarees and other clothes [1]. There are various types of handlooms which include pit loom, stand loom and other looms that are mentioned below in Figure 1.

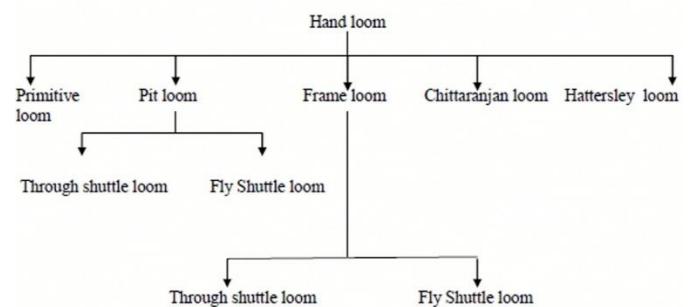


Fig -1: Classification of handloom

Jamakkalams are woven using pit looms. Bhavani jamakkalams are exported to various countries such as the United Kingdom, United States, Sweden, Germany, Italy, and Singapore. In the year 1993, the Swedish company IKEA started importing jamakkalams from Bhavani to be sold across its stores. Since the year 2000, handwoven Bhavani jamakkalams have been facing challenges due to power-loom products.

Since the 2000s, the hand woven jamakkalams from Bhavani have faced competition from power-loom products. A subsidy is offered to the weavers by the government and laws are implemented to outlaw the usage of power looms. Government-run co-optex stores help in selling these blankets. Blankets produced in Maharashtra, Solapur and cheap imports from neighbors China, Sri Lanka and Bangladesh serve as competition for Bhavani jamakkalams and have resulted in

the decline in popularity and demand of Bhavani jamakkalams [2]. The rich handloom heritage is still trying to survive but is failing apparently due to machines and market expectations. Nowadays people prefer to buy jamakkalams that are made using synthetic materials since they are cheap. These jamakkalams are of poor quality. The main goal of the paper is to implement the usage of sustainable and regenerated fibres in the development of jamakkalams to increase their quality and to incorporate designs to make them aesthetically pleasing in customers' eyes.

2. LITERATURE REVIEW

This paper speaks about the critical state of the jamakkalam business. The jamakkalams were predominant in many of the Tamil households. The jamakkalam is losing its sheen due to the fake counterparts and the production that takes place illegally across the country. The jamakkalam making business might be on run only for one or one and a half years. In the last few years, the potentiality of the traditional jamakkalams has become bleak. It is mainly because the artisans involved in the making of jamakkalams are moving to cities for bigger opportunities [3].

Jamakkalams has various uses, they are woven in different sizes to meet various requirements and they can also be customized. With the changes ongoing in our lifestyle, the traditionally woven Bhavani jamakkalams are on the verge of extinction. In Bhavani, only a handful of weavers are involved in weaving carpets and most of them are above the age of 60 and are not able to pass on the weaving culture to the next generation because of the disinterest shown towards the art. Bhavani jamakkalam is a GI-tagged product and the state's pride is strictly reserved for handloom weaving. Initiatives have been taken to revive Bhavani jamakkalams of heritage value by motivating weavers in Salem, Erode, Mahendranthavadi and Kumarapalayam of Tamil Nadu to weave them. Korvai patterns from these jamakkalams are obtained using additional incentives and are then marketed to the customers. The introduction of pastel hues, design patterns and combination of colors would make the jamakkalams more alluring for home decor [4].

The Bhavani handwoven jamakkalam known for its rich culture is currently losing its glory because of the challenges imposed on them and are on the edge of closure. In villages present in Bhavani and Anthiyur, the major industry next to agriculture is weaving. Initially, more than twenty thousand families weaved jamakkalams in their houses using pit looms. Individuals installed handlooms of ten numbers at their place and wages were provided for weavers. In 2005, the Government of India recognized jamakkalams as a Geographical indication. It is currently facing many obstacles as the production is carried out in power looms violating handlooms according

to the Reservation of Articles for Production Act established in 1985. The improper overseeing from the side of officials resulted in the poor price of jamakkalams that were made in power looms. There is a drastic decrease in the families involved in weaving. This in turn risks the presence of the industry in the years to come. Many weavers ended giving up weaving because of the poor income, piling of stocks at societies, GST imposed on them and the ongoing competition from power looms. To turn the sector into a profitable one, it is suggested to revise the wages and to take necessary actions against power looms that produce carpets. It is also important to make the youngsters aware of the weaving art and to train them to pursue weaving in order to save the industry from extinction [5].

This research states the struggle of the weavers in reinventing the Bhavani jamakkalam which was once an integral part of our society. In the perspective of today's world, Jamakkalam is slowly seen as a product from the past. Yarns are sourced from societies that are cooperative in the region. Yarn subsidy is offered by the government. For selling their end products, weavers usually give back the finished carpets to the societies. Jamakkalams are sold independently by a few weavers. Based on the length of the woven carpet wages are determined. The money made is not sufficient. Weavers earn only Rs. 1500-Rs. 2000 even if they work for the entire week. A worker who is unskilled earns twice that. The members involved in this article have plans to develop the skills of the weavers, incorporate new designs and work with various fabrics. They are also focusing on the instalment of the jacquard box [6].

The power loom has become a nightmare for the weavers of Bhavani, Erode district. For nearly 200 years jamakkalams are being woven in Bhavani, Cauvery and the regions of Amirtha rivers. In Periamolapalayam village, approximately 40 looms and 120 weavers were present in the year 2015. Presently there are only 25 looms with 60 weavers operating on them. These weavers are mostly above the age of 50 years. Back in the day, at least 1000 jamakkalams were dispatched in a week from the village. But now the scenario has changed to a position where it is difficult to send out at least 100 jamakkalams. There was a huge market for Bhavani jamakkalam in Maharashtra, Karnataka, Andhra Pradesh and Odisha. Even now some jamakkalams are exported to Gulf countries to be used as prayer mats. The mode of transportation was mostly by trucks, posts or rails. This is retaliated by power looms offering alternatives that are cheaper. Jamakkalams that are weaved by hand are priced at Rs 25 per square foot whereas jamakkalams woven by power looms are priced at Rs 25 per square foot [7].

This article's objective is to figure out the dependence of carpet weavers on weaving for their livelihood. This study reveals that 89.10% of people's livelihood depends on

weaving. Many people in the poverty line depend on the weaving of carpet for income without having any additional source of income. The dependency of weavers on carpet weaving increased with the severity of the economic condition and vice versa [8].

In the handicraft sector, the carpet industry is one of the major industries which play a vital role in revenue, employment and exports along with being the living source for many people even in the present day of village areas of Kashmir. The industry faces many issues such as lack of credit facilities, poor wages for labourers who work hard, the poor economic and social background of weavers, involvement of middlemen etc... This study on marketing and credit facilities was conducted in light of such problems. The article emphasizes the owners of industry who employs weavers to work for them. The study was conducted on a group of 30 owners picked from 2 blocks of the district Kulgam. The result of the study showed that the progress of the carpet industry was affected by the insufficient access of the owners to marketing and credit channel [9].

In this paper, the origin of the fabric made from castor beans which are bio-based is discussed. The latest range of fabrics that are eco-friendly and manufactured from natural materials was announced by Rubelli, an Italian fabric house, owned by the family. The fabric is made by the combination of two components: eco-polyamide which is extracted from castor bean and co-viscose. Rubelli serves a colorful merge of past and present which operates a number of 28 electronic jacquard looms of the latest generation along with handlooms from the 18th century. Rubelli took a year to manufacture the latest fabric. This fabric matches the quality and texture of manmade fibres, the main difference is that the fabrics made by Rubelli are sustainable. Castor bean is a crop that can be grown easily and it is not consumed as food. Large quantities of water are not required. Due to these reasons and their enormous oil content, castor beans are gaining a name in the biofuel industry [10].

This article states how polymers made from castor beans could serve as a replacement for conventional plastics. The latest polymer blend produced from castor beans is lighter and stronger than other structural materials that are conventional. Researchers suggest that it would improve the fuel efficiency and safety of cars. Castor beans contain a poison called ricin. It can be turned into polyamide 11 which is a thermoplastic from the polymer family of nylon. In Japan, they have infused polyamide 11 and polypropylene which is a household plastic to create a super-strong polymer blend. This could be a replacement for the plastics that are used today. Though the material has enhanced toughness values, its stiffness is quite low. This problem could be sorted out by reinforcing the material with ceramic fibres which includes carbon [11].

This report discusses the handloom sector of India and the concerned government reports. Handlooms known for their rich tradition is slowly losing their significance because of affordable and attractive synthetic materials. As a result of the 'Make in India' campaign and allocation of space below other priority sectors by the planning commission in the economic sector, the handloom sector is attaining its unique identity once again. Germany, the UK, France and USA are included in the top 10 countries where the handloom products are exported from India. The handloom brand was launched by the Indian government to ensure its production flexibility, adaptability, uniqueness and openness towards innovation. In comparison with the second handloom census, there is a considerable decrease in handloom weavers. To change this scenario, the Indian government-initiated schemes and provided craft museums, exhibitions, e-commerce and centres for trade facilities. Research on handloom established the necessity for awareness and publicity [12].

This article talks about the potentiality of natural dyes in the dyeing of textiles. Everlasting and attractive dyes can be made using a suitable dye extraction process and by using dyeing techniques that are appropriate. Natural dyes are renewable, biodegradable, eco-friendly and safe for human health. But these dyes required mordants to fix themselves in the material that is meant to be dyed. Not all synthetic mordants are eco-friendly. The dye color on the fabric depends not only on the mordant that is used but is also dependent on the dyeing technique implemented. Along with the various advantages that natural dyes provide, there are also some cons to this type of dyeing. These include the difficulty surrounding the reproducing of shades, color change possibility which might be due to sun, air and sweat. The scientific research on textile dyeing using natural dyes is still incompetent. To upcome the limitations that the natural dyes impose, there is a requirement for further scientific studies [13].

In this paper, fabrics made from organic cotton were colored using various natural extracts like pomegranate peel, thyme, madder root, henna, walnut shell, sage tea, Vulgaris root and horse chestnut. Pre-mordanting coloring technique is used to carry out the dyeing process using mordants like potassium aluminium sulphate, citric acid, copper sulphate and potassium tartrate. The fabric colour was analyzed in terms of properties of fastness against light, rubbing, perspiration, washing and strength of the colour. The fastness and colour properties procured from the organic cotton fabrics which are dyed using natural stains turned out to be ranging from good to excellent [14].

3. EXPERIMENTAL WORK

3.1 Materials

3.1.1 Organic cotton

Organic cotton is cultivated using materials and methods that are less harmful to the environment. The benefits of producing organically are to maintain and replenish the fertility of the soil, reduction in the usage of pesticides and fertilizers that are toxic and build an agriculture that is biologically diverse. The usage of poisonous pesticides and fertilizers are excluded in the cultivation of organic cotton. In organic farming, the usage of seeds that are engineered genetically is restricted under federal regulations. Organic cotton accounts for 0.7 per cent of the entire production of global cotton [15].



Fig -2: Organic cotton

3.1.2 Banana fibre

Banana fibre is also called Musa fibre. It is one of the strongest natural fibres. It is biodegradable and is obtained from the banana tree's stem. It is known for its durability. It is composed of walled cell tissue that is thicker. These are merged by gums that are natural. Cellulose, lignin and hemicellulose are present in the fibre. The spin ability, tensile strength and fineness of banana fibre is comparatively better than natural bamboo fibre. Ropes, woven fabrics, handmade papers and mats are made using fibres of banana [16].



Fig -3: Banana fibre

3.1.3 Bamboo fibre

Bamboo fibre is a regenerated fibre that is biodegradable and friendly to the environment. It is a natural cellulosic fibre. Along with being a green fibre, it also has UV protection properties and anti-bacterial properties. This results in it being a unique textile material. It is used for high-performance needs by being a composite material. This is because of its durability, high tensile strength and stability. Back in the day, bamboo fibre was used in

structural elements like corset ribs and bustles, but presently due to technology advancements, bamboo fibre is used in a wide variety of fashion and textile applications [17,18].



Fig -4 Bamboo fibre

3.1.4 Castor oil fibre

Castor oil fibre is a biopolymer that is derived completely from castor beans. It is a textile fibre with high performance and innovation of natural origin. It is manufactured for castor oil seeds that are cultivated in the arid regions not apt for other varieties of agriculture. This biopolymer does not affect the human food chain in comparison with other polymers that are bio-based and use products segregated for the sector of food and agriculture. It is a 100% renewable resource which does not need a huge water quantity [19].



Fig -5 Castor oil fibre

3.2 Methodology

3.2.1 Machinery

3.2.1.1 Carding machine

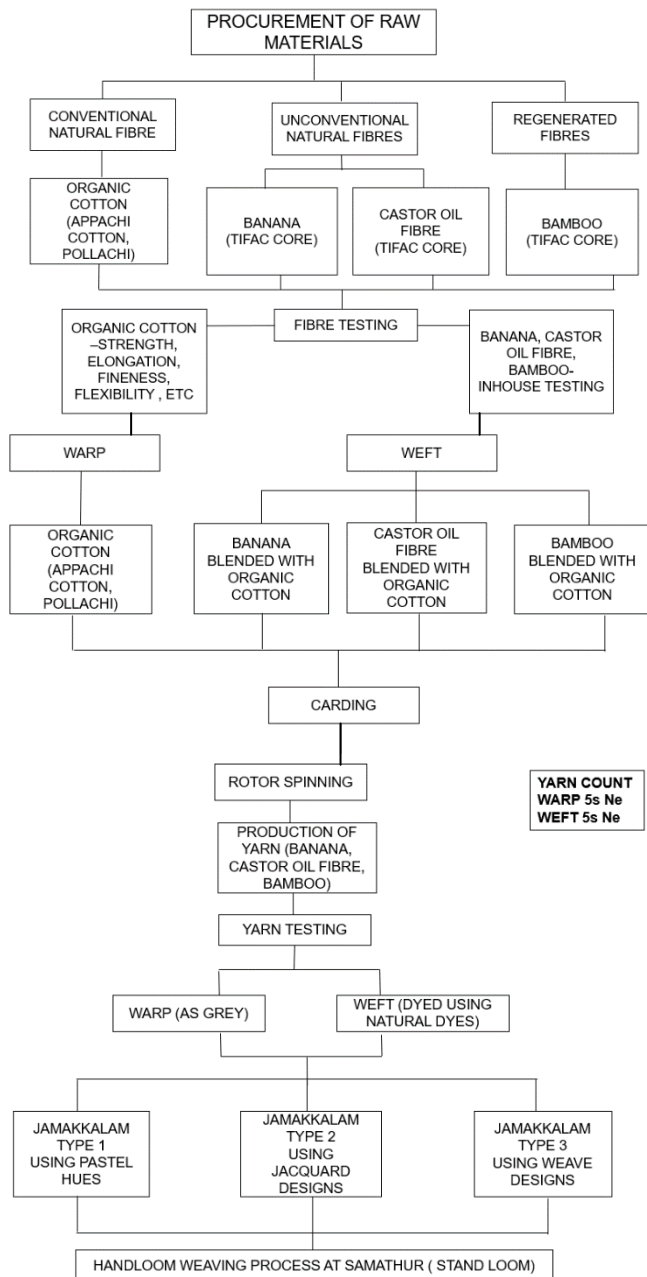
This process involves the conversion of feed material i.e., lap into a strand of fibres that are uniform. It is named a sliver. Carding process has to be of good quality in order to achieve yarns with good quality. This is because the quality of yarn depends on the quality of carding. The percentage of nep in the yarn fluctuates based on the carding process quality. Carding is known as the heart of spinning [20].

3.2.1.2 Rotor spinning machine

Rotor spinning is also called open-end spinning. This process consists of spinning and winding operations. By using the open-end system, the sliver is transformed into a

yarn directly. The yarn is wound on package cones. The yarn count can be set based on the requirement. The machine enables greater production per unit and an expanded production cycle. The yarn is produced with twists without the necessity of package rotation. This allows higher speeds of twisting with comparatively less power cost [21].

3.2.2 Flowchart



Identification and procurement of sustainable raw materials are done. Conventional natural fibre such as organic cotton, unconventional natural fibres such as banana and castor oil fibre and regenerated bamboo fibre are used in making the jamakkalam. Organic cotton is used in warp and a blend of organic cotton with banana, bamboo as well as castor oil fibre is made and individually used for the first, second and third types of jamakkalams respectively. The blend ratio for all three consists of 60% organic cotton and 40% of the respective fibre. Fibre testing is done before the blending process. The results are obtained. The fibre then undergoes carding process. Carding process is done to remove the foreign impurities and to blend the fibres as mentioned above. After the removal of impurities, a trumpet is placed to aid in the formation of slivers. The sliver is produced. The further spinning process is carried out after the preparation of the sliver. Sliver is passed into the rotor spinning machine through which the yarns are produced. The yarn count is set to 5s Ne for all the yarns. Once the yarns are tested, it is ready for dyeing. In warp, the yarns are left as grey whereas in weft the yarns are dyed. Once the yarns are ready, the weaving is done at Samathur in stand loom instead of using the pit loom. In the weaving process, jacquard for spot designs, twill weave and pastel hues for the jamakkalam 1,2 and 3 respectively are introduced.

3.2.3 Testing methods

3.2.3.1 Uster HVI 100

The testing for organic cotton was carried out in SITRA-South India Textile Research Association. USTER HVI 1000 was used to identify the properties. This global reference tool is used for the classification of cotton and provides results that are reliable and more accurate. It only takes seconds to complete the test and requires only one operator. It immediately provides results on 11 essential quality characteristics such as strength, length, fineness, moisture content, the color of the fibre etc.



Fig -6 Uster HVI 100

The goal is to manufacture jamakkalams from sustainable fibres which include conventional natural fibres, unconventional natural fibres and regenerated fibres. In order to make the jamakkalam aesthetically pleasing incorporation of various design, aspects are carried out.

4. RESULTS AND DISCUSSION

4.1 Organic cotton (Uster HVI 100)

Once the organic cotton sample was subjected to the Uster HVI 100 machine, the following results were obtained:

The trash area and the trash count of the given organic cotton sample were identified to be 0.22(%) and 14 respectively. The span length was estimated to be 31.63 mm for the standard 2.5% span length. The fibre had a uniformity ratio of 45.8%. The bundle strength of the sample was 25.3 g/tex. The measure of air permeability i.e., Micronaire turned out to be 3.32. The given sample had an elongation of 4.9%. The whiteness and yellowness of the sample were reported to be 79.9 and 9.3 respectively. The procured results were compared with the standard norms and the tested organic cotton proved to be suitable for spinning and further processes.

Table -1: Properties of tested organic cotton

1. Trash area (%)	0.22
2. Trash count	14
3. 2.5% span length (mm)	31.63
4. Uniformity ratio (%)	45.8
5. Bundle strength (1/8" gauge) (g/tex)	25.3
6. Micronaire	3.32
7. Elongation (%)	4.9
8. Whiteness (Rd)	79.9
9. Yellowness (+b)	9.3

4.2 In-house testing

In-house testing was done for banana fibre, bamboo fibre and castor oil fibre respectively. This included fibre length, strength, elongation, and fineness. The results revealed that the fibres were compatible with organic cotton.

5. CONCLUSION

In today's market, carpets are made from synthetic fibres as an imitation of jamakkalam that serves as an alternative to jamakkalams. These carpets have less durability and quality. The jamakkalam created using sustainable fibres will overcome the stated problem and provide great quality and durability. The incorporation of various design

aspects will make the jamakkalam attractive and alluring in the eyes of the customer. This in turn will increase the sales of the jamakkalams which will directly benefit the weavers who are dependent on weaving for their livelihood. As a result, the once perishing jamakkalam business is expected to make its way back. Further research will be carried out once the fibres are converted into yarns and then into jamakkalams. The yarns and the jamakkalams will be tested for their properties and reported. **(PART II)**

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