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Seminar on

Technical Textiles

Need of today and tomorrow

Saturday, 26th March 2022

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THE TEXTILE ASSOCIATION (INDIA), MUMBAI UNIT

organises Seminar on

Technical Textiles - Need of today and tomorrow

Day & Date : **Saturday, 26th March 2022** (Time: 09.00 am to 05.00 pm)
Venue : **Hotel Fortune Park Galaxy,** Daffodil Hall, GIDC, N.H.No-08, Vapi – 396 195 (Gujarat)

The Textile Association (India), Mumbai Unit takes pleasure in announcing Seminar on "Technical Textiles - Need for today and tomorrow" on Saturday, 26th March 2022 at Hotel Fortune Park Galaxy, Vapi, Gujarat (India).

This seminar aims to give an opportunity to the textile technologists & experts to share their thoughts to meet thechallenges which will be highly productive and beneficial. This will give a rare opportunity to the participants to listen to such high quality experts.

TAI, Mumbai Unit Seminar

The seminars organized by The Textile Association (India), Mumbai Unit have always been on contemporary andinnovative topics deliberating on the subject by high profile and experienced speakers. The TAI, Mumbai Unit apart

from organising the events in Mumbai organises the seminar at Vapi for the benefit of the technicians from that cluster. The deliberations in this seminar will show the future trend to do more towards new arenas of research, innovation, market development and investments in technical textile business. In this seminar the experts from the field of technical textiles will address the gathering. There will be two Panel Discussion's wherein the panel members will discuss the participants' concerns on the theme. We are expecting over 200 delegates to participate in this seminar.

The Seminar will try to focus on the following topics:

- Latest trend in Weaving Preparatory M/C for the Technical Textile
- Industry 4.0 in Technical Textiles
- Technical Textiles: Emerging Growth & Opportunities
- Technical Textiles – Growth Potential and Prospects in India
- Govt. Policies & Strategies for Technical Textiles
- Technical Textile product Manufacturing/application in sectors like-health care, protective textiles/defense, construction, building materials, agriculture, etc.
- Development in software
- Geotextiles / Agrotextiles
- Medical textiles
- Protective clothing
- Sports Textiles/ Construction Textiles

Panel Discussion: **1) Emerging Opportunities in Technical Textiles**
2) Technological Advancements in Technical Textiles

An Appeal:

The success of our Seminars depends on the financial support from our valued sponsors. You have been very supportive and proactive in the activities of TAI, Mumbai Unit and we look forward for the same support and active participation in this seminar. Your participation in this seminar by way of sponsorships, advertisements and delegates will help us to organise this seminar in the best possible manner. We assure you to provide maximum publicity and visibility to your valued products. The main advantage of participation will give an opportunity to exchange the views on the latest developments in the field of technical textiles and related areas.

The Textile Association (India), Mumbai Unit is honoured to invite you to be part of this event and appreciate your support for the seminar. Let us join hands to make this Seminar a grand success.

G. V. Aras	Haresh B. Parekh	Navin P. Agrawal
Seminar Advisor	Convenor	Jt. Convenor

For more details please contact:

THE TEXTILE ASSOCIATION INDIA tai

Mumbai Unit

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Progress of Indian Textile Industry and Union Budget 2022-2023

Indian textile industry is known for its diversification starting from production of raw materials up to the final product. It provides ample employment opportunities every year to both technical and non-technical people after the agriculture sector. The industry is always in front to provide economic growth to the country because of its foreign export business. The current pandemic situation in the year 2019-20 has created big impact on the industry starting from reduction in the capacity utilization, labour shortage and lack of on time delivery to the customer. However, it has also created opportunities for in-house development of medical and healthcare products especially personal protective clothing and masks. To capture the market, government has also taken initiatives to provide startup facility for the production of these products instead of importing the products from the other overseas country under the theme of 'Make in India-Campaign'.

The current financial budget for 2022-23 is also planned to boost the current growth of textile industry. The government has made an announcement to provide infrastructure development. Government has allocated Rs.17,683 crores to Cotton Corporation of India (CCI) for the procurement of cotton for the years 2021-22 and 2022-23 under Minimum Support Price to facilitate CCI to reduce its losses incurred for procurement of over two crores bales of cotton during the last two years that had greatly benefited the farmers to sustain the area under cotton. Apart from the cotton sector, the government has also provided strong platform for the man-made fiber and technical textile industry for the value-added products. The new Production-Linked Incentive (PLI) scheme for production of man-made fibers and technical textiles sector will run over the next five years. The scheme is expected to bring in 7.5 lakh new job opportunities. The new initiative by the government will help switch the business from cotton textiles to new need-based products using man-made fiber. The initiative intends to increase technical textile production and reclaim India's place as one of the world's top suppliers of apparel and textiles. While India continues to be one of the world's top producers, its share of worldwide production and exports has steadily declined over the last decade as smaller countries such as Bangladesh and Thailand have surpassed it.

The current proposed budget is not only helpful for the traditional textile business but also for the new young entrepreneurs to start the business for production of need based and tailor made products to meet both domestic and export demands under the umbrella of new vision of technical textiles.

Dr. V. D Gotmare
Chairman, Editorial Board – JTA

Mr. R. K. Vij, President - TAI

New Year with Sustained Growth & Challenges!!

As we are into New Year 2022, we take this opportunity to wish our members a Joyful, Safe and Prospective New Year. We look to this year of prospering after last two years of Pandemic related challenges. It is said "Even the darkest night will end and sun it will rise".

This New Year has arrived with opportunities and to focus on new priorities in the textile field. Our resolutions is to work together for a developed economy as Textile is the 2nd largest in terms of employment after the agriculture.

The Textile Association (India) is being the voice of Industry and Trade, we will focus on several cohesive strategies for India's sustained growth in textile value chain and is advocating new recommendations to the Indian Government.

Further, as we move forward to Celebrate India's "Azadi Ka Amrit Mahotsav" in its 75th years of Independence, we would like to compliment our Prime Minister for steadily steering our economy in an excellent manner during the pandemic.
On economic front, GDP is estimated to grow to 9.2% during 2021-2022. This year our Textile Export will touch 40 US Billion Dollars after a gap of three to 4 years. The Farm Sector also to grow at 3.9% on the back of good monsoon in current the year. Manufacturing an estimated to grow in double digit due to strengthening demand and surge in new business / expansions in Textile. Govt. announced schemes in last two years like Performance Linked Incentive (PLI), Remission of Duties and Taxes on Export Products (RoDTEP), Rebate of State and Central Levies and Taxes (RoSCTL), Mega Textile Park Scheme and focus on MMF will further boost Textile Industry.

The Union Budget 2022-2023 is being presented in this crucial time with third wave of Pandemic. We have given our recommendation that budget should focus on ease of doing business, reduce cost of doing business and to create a level playing field for Textile and Trade. Also to insure stability in Tax Regime and lower GST rates as that would lead to better revenues & higher compliance's. We also asked to extend the 15% Income Tax for new Companies till 2025. Hassle free credit to MSME Companies, Export income of MSME should be made TAX Free for next 3 years as 70% Textile Companies are in small sectors.

We at the TAI, would like to acknowledge the excellent contributions made by our former Presidents to the growth of this prestigious 82 years old organization during their helm as Presidents. As a Special thanks to them, we will be publishing their profile in our coming Bulletin.

Finally, on the eve of 73rd Republic day of our Nation, I extend our hairiest Greeting and remember our brave leaders whose hard work and dedication helped us to take Nation Forward. Today, the Mantra of "NATION FIRST" is becoming the spirit of every citizens.

Meanwhile, stay safe, stay healthy and happy in the year 2022. God bless us all and should work together for the Textile Industry.

JAI HIND!!!

R. K. VIJ
President
The Textile Association (India)

Adaptation of Animal Motifs Sourced from Ancient Indian Sculptures to Cartoon Figures. Part-2: Development of Prints for Children-Wear

Deepali Singhee[1]*, Heena Sachdeva[2] & Krishnakali Bhattacharyya[3]

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Abstract:
Cartoons form the imaginary world of children and are mostly a western concept. Though Indian folk tales / Jataka tales based on animals have been popular since ages, today most Indian children are attracted to well known animal-based cartoon characters popular in other countries. In India, animals have been used in plenty, on art forms and richly ornate architectural monuments that are found all over the country. A study was undertaken to develop cartoon figures from these identified animal/bird/other fauna-based motifs present on ancient Indian monuments as suitable prints for children and provide variety in design through motif modification and cartoonization. The developed new Indian cartoons were printed on t-shirts meant for young children using the digital printing technique and a survey was conducted to explore their acceptance in light of the more popular western cartoons. All the three categories of the respondents (87.7%) liked the cartoonized versions of the selected animal, bird and other fauna motifs over other styles of modification. They found the cartoonised motifs developed to be cute, attractive, adorable, stylish, creative, eye appealing, inducing happiness (brought a smile on their faces) and funny/humorous. Among all the 15 cartoons developed, lion was the most liked.

Keywords: *Animal motifs, cartoons, digital printing, Indian prints, nursery prints, motif-styles*

Citation: Deepali Singhee, Heena Sachdeva & Krishnakali Bhattacharyya, "Adaptation of Animal Motifs Sourced from Ancient Indian Sculptures to Cartoon Figures. Part-2: Development of Prints for Children-Wear ", *Journal of the Textile Association*, **82/5** (252-259), (Jan-Fev'2022), https://doi.org/10.17605/OSF.IO/R3UKM

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1. Introduction

Young children in the age group of 1-14 years have always been attracted to cartoons. A cartoon is a type of illustration, sometimes animated, typically in a non-realistic or semi-realistic style [1]. Most of the cartoons are animal-based characters. Among the most popular animal-based cartoons, Winnie the Pooh (bear); Goofy, Snoopy, Scooby Doo and Shiro (dog); Dorarmon, Garfield, Tom and Sylvester (cat); Mickey Mouse, Jerry and Pikachu (mouse/rat); Bugs Bunny (rabbit); Piglet (pig); Eeyore (donkey); Penelope (Kuala), Tolee (kuala); Rintoo (tiger); Hoho (monkey), Lulu (rhino); Dino (dinosaur); Henry (penguin); Pink Panther and Uske Ekans (snake); Oggy (cockroach); Donald Duck and Affy Duck (duck); Woody Woodpecker, Tweety, Angry Bird and Road Runner (birds); Oswald (octopus); Pondi (dragon) and Madame Butterfly (butterfly) are mostly of American, Canadian, Japanese, Chinese, French and Finnish origins [2]. In India, Chota Bheem, Motu Patlu, Suppandi are popular, but they are based on human characters. No Indian cartoon from the animal kingdom is known; though in the Indian culture, animals hold an important place in both the real and mythical worlds and widely popular stories for children like Jataka tales are based on animal characters.

Some studies have reported sourcing and adaption of historical motifs and designs into their contemporized forms [4]. Though the impact of cartoon motifs on the behavior of children has been studied [5], very few such studies are available on development of cartoons figures. In one such study, Verma [6] developed colourful and modified cartoon motifs, successfully incorporated in the children's garment and studied its preference by children and their parents with an objective to improve creativity, acceptability and marketability of the garments apart from promoting appreciation of wildlife among the young children (3-5 years). Such studies are however limited and rare.

With the objectives of developing Indian cartoon figures, the current study was undertaken and animal, bird and other fauna motifs identified in our previous study were accordingly adapted to their cartoonized versions.

Thus, in the present research which is an extension (Part-II) of the previous study, a further attempt has been made to study the acceptance, preference and liking of the 'cartoonized' version of the different selected animals, birds and other fauna motifs by three groups of respondents, viz. mothers of 1-5 year old children, students, who are likely to take to design as their profession in future and established designers.

2. Methodology

a. Selection and classification of the identified motifs into categories (Same as Part-I of this study)
b. Modification of the selected motifs into different styles using Corel Draw (Same as Part-I of this study)
c. Adaptation of the stylized motifs into cartoonized forms

The motifs were also adapted into their corresponding cartoonized form using Corel Draw software (X-3 Version). Cartoonization has been dealt with separately and not

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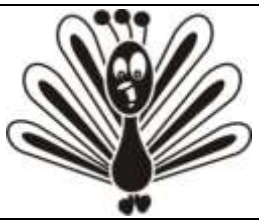
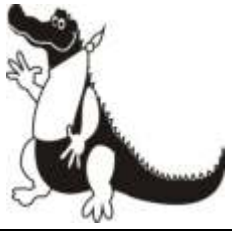
Animal				
				
Lion	*Elephant*	*Deer*	*Monkey*	*Camel*
Bird				
				
Peacock	*Parrot*	*Crow*	*Swan*	*Duck*
Other Fauna				
				
Fish	*Crocodile*	*Turtle*	*Frog*	*Snake*

Figure 2.1: Adaptation of the modified motifs into its cartoonized forms

included in the section on modified versions (natural, geometric and stylized) of the motifs as it involved rendering of a humanized character to the motif along with use of external unique accessories in some cases.

d. Printing of the T-shirts

White coloured readymade half-sleeve t-shirts made of 100% cotton jersey fabric (GSM 160) of size 20 (Length: 16½; Chest: 12½) suitable for age-group 3-5 years as available in the market were used. The t-shirts were procured from Ananda Garments (18, Acharya Prafulla Chandra Road, Kolkata-700009). The adapted cartoon motifs were digitally printed on the t-shirt in a neutral black colour using a direct to garment printing (DTG) machine at J.K Prints, Kolkata. The motifs were placed inside a 25 inch2 box outlined with a thin black line using. The motifs inside the black box were placed in the centre-front of the t-shirt. Thus, in order to maintain a synergy in appearance that would not create a bias and influence the subsequent responses by the respondents, a neutral coloured white background (of the t-shirt) was used to print neutral single coloured black motifs.

Animal				
				
Lion	*Elephant*	*Deer*	*Monkey*	*Camel*
Bird				
				
Peacock	*Parrot*	*Crow*	*Swan*	*Duck*

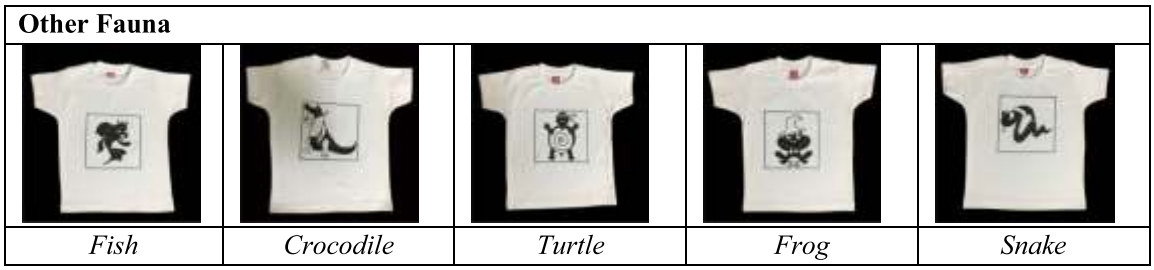


Figure 2.2: T-shirt printed with cartoonized forms

e. Selection of respondents

Most children in age group of 1-5 years are significantly influenced by cartoons and in some cases their obsession for cartoons has also been reported. The world of fantasy for these children also revolves around cartoons which are mostly adaptation of animal figures. Further due to the time-bound limitation imposed, the study was limited to exploration of influence of the cartoon-motifs developed for only 1-5 years olds only.

Since the prospective consumers of textiles and accessories printed with the developed cartoons motifs would be 1-5 year olds who were too young to give appropriate feedback based on a systematic research based questionnaire, the respondents for the study included their mothers (who understood their likes and dislikes and mostly made purchases of clothes and accessories), established apparel designers (who would expectedly use these motifs in their deigns for children wear) and prospective student-designers studying textiles and fashion design. The last group was added to understand the impact of the motifs developed on the budding new age designer visa-vis the established and experienced designers.

Also to understand a designers' point of view for the developed new cartoon motifs, the responses were collected from them under two categories, experience and established designers who would expectedly use these motifs in their deigns for children wear and new-age budding designers prospective student-designers (in the age group of 19-22 years) studying textiles and fashion design. The last group was added to understand the impact of the motifs developed on the budding new age designer visa-vis the established and experienced designers. The main objective of this study was to explore whether the designs developed would be acceptable to prospective consumers; designers who would use the motifs in their designs and mothers of children who would buy the end product.

Also due to time limitation and difficulty in identifying sufficient numbers in each of the three categories of respondents, 30 numbers of respondents in each of the three categories were selected and they formed the population for the survey (N=90). In this way purposive sampling method was used to select the sample (respondents).

The main objective of this study was to explore whether the designs developed would be acceptable to prospective consumers; designers who would use the motifs in their designs and mothers of children who would buy the end product with the developed designs.

f. Preparation of questionnaire

A structured questionnaire with a closed format was prepared to get accurate and reliable results within the limited time. The required sets of the questionnaire was typed, printed and photocopied to provide multiple copies for all the respondents.

The questionnaire for this part of the study was divided into four sections (the remaining 5 sections of the questionnaire can be traced to Part-I of this study), so that the analysis could be done systematically.

i) Section 1: Dealt with the personal information of the respondents (open-ended).
ii) Section 2: Dealt with the most favourite cartoon of the respondents (open-ended).
iii) Section 3: Dealt with the best preference of selected and classified motifs (animal, bird and other fauna) in their adapted cartoonized form by the respondents.
iv) Section 4: Dealt with the preference of selected and classified cartoonized motifs (animal, bird and other fauna) in their printed form.

g. Collection of data

The respondents were shown the selected motifs printed as tabulated charts on paper as and when required. Small sized t-shirts digitally printed with the cartoonized motifs were also shown to the respondents. Respondents' feedback was collected through the printed questionnaires. After collection of the information, all the data were complied, tabulated and analyzed.

d. Analysis of the data

The data collected was analysed through ranking, weighted scores and analysis of variance (2-way ANOVA).

3. Results and Discussion

3.1 Most favourite cartoon of the respondents

All three groups of respondents (mothers of 1-5 year old children, prospective student-designers and established-designers) gave varied responses with respect to their favourite cartoons. After tabulating their open-ended choices, characters that were preferred by 5 or more respondents were identified and listed and the results are shown in Table 3.1.

Table 3.1: Most favourite cartoons of the respondents

Sl. No.	Groups of respondents	Name of the preferred cartoon with frequency =5	Frequency (f) of respondents who mentioned the said cartoon as their favourite
1	Mothers	Doraemon	13 out of a total of 30
2	Student-designers	Tom and Jerry	5 out of a total of 30
		Mickey Mouse	5 out of a total of 30
		Shin Chan	5 out of a total of 30
3	Established-designers	Tom and Jerry	11 out of a total of 30

Doraemon was liked most by mothers; Tom and Jerry, Mickey Mouse and Shin Chan was assigned the highest number by prospective student-designers (age group of 19-22 years) and among the established-designers, Tom and Jerry got the maximum response. This indicated that none of the well-known cartoons received any common preference by all the respondents except for Tom and Jerry, which were liked by both the prospective student-designers and established designers (Table 3.1).

Among these cartoons favoured, Mickey Mouse, Tom and Jerry are of America origin and Doraemon and Shin Chan is of Japanese origin. They have been derived from the cat (Doraemon and Tom of Tom & Jerry) and mouse (Mickey Mouse and Jerry of Tom & Jerry) families with only Shin Chan being a human figure.

Other cartoons favoured by the respondents included Chota Bheem by mothers; Donald Duck, Powepuff Girls, Dexter, Tweety and Ben10 by prospective student-designers and Angry Birds by the established-designers. However none of these received any special preference by majority of the respondents within each group (mothers of 1-5 year old children, prospective student-designers and established-designers) and the frequency of their preference was less that 5 ($f < 5$) (Table 3.2).

Student-designers gave multiple responses not showing any one favourite cartoon unlike the other respondents (Tables 3.1 and Table 3.2). This could be probably due to the influence of their personal taste that is devoid of any knowledge of consumer acceptance in comparison to the responses by the experienced mothers and established-designers. The former probably relied more on the likes and dislikes of their children, while the responses by the established-designers were based on the probable liking by the expected consumers.

Table 3.2: Other favoured cartoons of the respondents

Sl. No.	Groups of respondents	Name of the preferred cartoon with highest frequency	Frequency (f) of preference
1	Mothers	Chota Bheem	4 out of a total of 30
2	Student-designers	Donald Duck	2 out of a total of 30
		Powerpuff Girls	2 out of a total of 30
		Dexter	1 out of a total of 30
		Tweety	1 out of a total of 30
		Ben 10	1 out of a total of 30
3	Established-designers	Angry Birds	4 out of a total of 30

Results thus indicate that among the well-known cartoons, differences exist among the respondents with respect to their preference/liking and no visible trend of favouritism can be seen among them. Also only Chota Bheem was a cartoon of the Indian origin that was mentioned as a favourite by some respondents (4 respondents out of a total of 30 mentioned it as their favourite cartoon character).

3.2 Preference of the adapted cartoonized version of the selected motifs

Researchers have found a strong impact of cartoons on school going children which is reflected on their lifestyle, dressing sense and behaviour [6]. Thus, newly developed cartoon prints would increase the design and motif palette suitable for young children, which the manufacturers of clothing and other products for children can use to increase the acceptability of their products among children and enhance sales. In the present study, an attempt has accordingly been made to adapt the selected animal, fish and other fauna motifs into their respective 'cartoonized' versions apart from the modified natural, geometric and stylized versions explained earlier that can be used suitably as prints on children's clothing and accessories. The corresponding results with respect to the best choice of the respondents are given in Table 3.3.

In order to identify the most preferred cartoonized motif, the respondents were asked to select one motif that among each category (animal, bird and other fauna) they liked the most. For this they were shown printed version of the each cartoonized motif on paper (Figure 2.1).

Data on the most liked choice in Table 3.3 reveal that among the cartoonized animal motifs, lion motif was most preferred by all the respondents with respect to the frequency of preference (f 17 by mothers, f 13 by student-designers and f 16 by established-designers) followed by deer. Camel was the least liked and was ranked by only one respondent

Table 3.3: Frequency of best choice (rank-1 only) for the adapted cartoonized version of the selected motifs (animal, bird and other fauna) by all the three respondents (mother, student-designers, established-designers)

Cartoonized Animal Motif					Cartoonized Bird Motif					Cartoonized Other Fauna Motif				
	M	S	D	Tot		M	S	D	Tot		M	S	D	Tot
Lion	17	13	16	**46**	Peacock	9	3	1	**13**	Fish	15	11	11	**37**
Elephant	7	4	4	**15**	Parrot	13	11	17	**41**	Frog	5	6	7	**18**
Camel	0	1	0	**1**	Crow	1	8	2	**11**	Crocodile	5	4	10	**19**
Deer	3	8	5	**16**	Duck	5	5	5	**15**	Turtle	4	2	1	**7**
Monkey	3	4	5	**12**	Swan	2	3	5	**10**	Snake	1	7	1	**9**
N	30	30	30	**90**	N	30	30	30	**90**	N	30	30	30	**90**
M - mother, S - student-designers, D - established-designers, Tot - total frequency of preference														

(student-designer) out of a total of f 90. The results corroborate with those reported in Table 3.1 (motifs as found on sculpted monuments) and Table 3.3 (motifs as found in nature in their realistic forms) in Part-I of this study where lion was also the most preferred and camel the least preferred.

Among the birds, the cartoonized version of the parrot was preferred the most (f 13 by mothers, f 11 by student-designers and f 17 by established-designers) matching with the earlier results (Table 3.1 and Table 3.5 in Part-I of this study) for the established-designers. This result however, deviates from the earlier feedback on bird motifs in their sculptured and realistic forms by the mothers and students (Table 3.1 and Table 3.3 in Part-I of this study) where both had preferred peacock over parrot. Thus, all respondents found the cartoon of the parrot more appealing than the peacock.

Among the responses for the cartoonized version of other fauna motifs, most respondents also preferred the fish motif and did not much appreciate the cartoonized turtle and snake (Table 3.3). Frog and crocodile motifs were also appreciated in their cartoonized forms.

Among all the motifs, the lion motif was assigned the highest number of liking (f 46 out of 90 respondents) by all the three respondents. The descending order of the cartoonized versions in each category of animals, birds and other fauna with respect to the total number of liking (total frequency of liking) by all the three respondents (mothers, student-designers and established-designers):

Animal Cartoon: Lion > Deer > Elephant > Monkey > Camel
Bird Cartoon: Parrot > Duck > Peacock > Crow > Swan
Other Fauna Cartoon: Fish > Crocodile > Frog > Snake > Turtle

An analysis of variance (ANOVA) was used to verify whether any difference exists among the three respondents (mother, student-designers, established-designers) for the best choice of the developed cartoonized motifs.

The above results indicate that calculated F value for respondents is equal to 23.48 which is greater than the critical value for F0.05;3,42 (=2.83) and so, Ho [there is no significant difference between the best choice for the adapted cartoonized version of the selected motifs (animal, bird and other fauna) among all the three respondents] is rejected and Ha [there is a significant difference between the best choice for the adapted cartoonized version of the selected motifs (animal, bird and other fauna) among all the three respondents] is accepted. Again, the F value for motifs, in their sculpted or natural-realistic forms is equal to 7.34 which is greater than the critical value for F0.05;14,42 (=1.94). This shows that Ho is rejected and Ha is accepted.

Thus, is may be concluded from the observations that, the three categories of respondents, namely mother, student and designer, significantly differ in their best choices for the adapted cartoonized version of the selected motifs (animal, bird and other fauna).

In order to summarize if the respondents like the cartoonized motifs over the other styles of modification, simple response in the form of 'yes' or 'no' was also collected (Table 3.4). In general, 87.7% of the respondents have liked the cartoonised version of the selected motifs more than any other style of modification (naturalized, geometrical and stylized) as is evident from the number of yes responses from the respondents in Table 3.4. These respondents found the cartoonised motifs cute, attractive, adorable, stylish, creative, eye appealing, inducing happiness (brought a smile on their faces) and funny/humorous.

Table 3.4: Preference of the cartoonized version over the other styles of modification

Respondents	Yes	No	Total
Mothers	26	4	30
Student	24	6	30
Designers	29	1	30
N	79	11	90

Table 3.5: Frequency of best choice (rank-1 only) for the t-shirts printed with the cartoonized version of the selected motifs (animal, bird and other fauna) by all the three respondents (mother, student-designers, established-designers)

Cartoonized Animal Motif					Cartoonized Bird Motif					Cartoonized Other Fauna Motif				
	M	S	D	**Tot**		M	S	D	**Tot**		M	S	D	**Tot**
Lion	18	16	23	**57**	Peacock	5	0	3	**8**	Fish	15	12	15	**42**
Elephant	3	1	0	**4**	Parrot	15	10	14	**39**	Frog	8	8	11	**27**
Camel	0	0	0	**0**	Crow	4	10	1	**15**	Crocodile	4	7	3	**14**
Deer	5	4	0	**9**	Duck	5	6	6	**17**	Turtle	2	2	0	**4**
Monkey	4	9	7	**20**	Swan	1	4	6	**11**	Snake	1	1	1	**3**
N	30	30	30	**90**	N	30	30	30	**90**	N	30	30	30	**90**
M - mother, S - student-designers, D - established-designers, Tot - total frequency of preference														

The results for the preference of the adapted and developed cartoons printed on the t-shirts (Table 3.5) completely corroborate with the results related to the most preferred cartoon motifs as tabulated in Table 3.3. Here again, lion is the most preferred cartoon motif, parrot the most favoured bird motif and fish the most liked among the other fauna motifs. However among the other motifs, significant difference exists with respect to the cartoon motif when printed on the t-shirts. Camel among animal motifs and snake among the other fauna motif were the least liked among the cartoons developed. On printing, duck, crow and swan - cartoons was preferred over peacock- cartoon, while turtle-cartoon was preferred over snake. The descending order of preference/liking of the cartoonized motifs as printed on the t-shirt with respect to the total number of liking (total frequency of first ranks) by all the three respondents (mothers, student-designers and established-designers) is given below:

Animal Cartoon: Lion > Monkey > Deer > Elephant > Camel
Bird Cartoon: Parrot > Duck > Crow > Swan > Peacock
Other Fauna Cartoon: Fish > Frog > Crocodile > Turtle > Snake

To verify if there was any significant difference between the of best choice (rank-1 only) for the t-shirts printed with the cartoonized version of the selected motifs (animal, bird and other fauna) by all the three respondents, analysis of variance (multiple ANOVA) of the weighted scores (WS) was carried out.

Results indicate that calculated F value for respondents is equal to 0.00 which is less than the critical value for F0.05;2,28 (= 3.34) and so, Ho [there is no significant difference between the best choice for the t-shirts printed with the cartoonized version of the selected motifs (animal, bird and other fauna) by all the respondents] is accepted and Ha [there is a significant difference between the best choice for the t-shirts printed with the cartoonized version of the selected motifs (animal, bird and other fauna) by all the respondents] is rejected. Again, the F value for cartoonized version of selected motifs is equal to 15.66 which is greater than the critical value for F0.05;14,28 (= 2.06). This shows that Ho is rejected and Ha is accepted.

Thus, is may be concluded from the observations that, the three categories of respondents, namely mother, student and designer, had similar preferences in their best choices for the t-shirts printed with the cartoonized version of the selected motifs (animal, bird and other fauna).

Finally, the respondents were asked to identify the most preferred (only one) cartoonized version of the motifs as printed on the t-shirts irrespective of the different motif category (animal, bird and other fauna). The results pointed to lion being the most preferred cartoon motif developed with 27.7% of respondents favouring it over others (Figure 3.1).

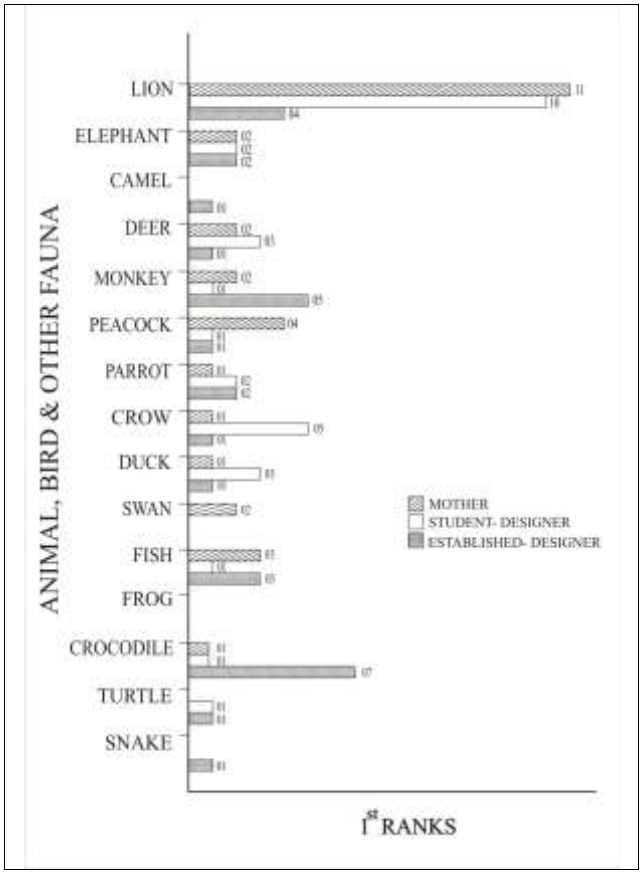


Figure 3.1: Most favourite (rank-1 only) cartoonized motifs developed irrespective of the category (animal, bird and other fauna).

To verify if there was any significant difference among the respondents for their liking for the cartoonized motifs developed irrespective of the category (animal, bird and other fauna), analysis of variance (multiple ANOVA) of the weighted scores (WS) of the ranks assigned by all the respondents (N = 90) to the three different styles of the cartoonized motif was carried out.

Results indicate that calculated F value for respondents = 0.00 which is less than the critical value for F0.05;2,28 (=3.34) and so, Ho [there is no significant difference between the motif liked cartoonized motif among the respondents] is accepted and Ha [there is a significant difference between the motif liked cartoonized motif among the respondents] is rejected. Again, the F value for cartoonized motifs = 3.65 which is greater than the critical value for F0.05;14,28 (=2.06). This shows that Ho is rejected and Ha is accepted.

Thus, is may be concluded from the observations that, the three categories of respondents, namely mother, student and designer, have similar preferences towards their most liked the cartoonized motifs irrespective of their classified categories (animal, bird and other fauna).

Another very interesting inference points out to a same line of preference by all the respondents throughout study indicating lion as the most preferred motif in all forms (as present on the sculpted monument, in its realistic form, in all the styles of modification (natural, geometric and stylized) including its cartoonised version even when printed on a t-shirts. It is a well established fact that lion belongs to the 'cat' family [7] and this big cat ultimately emerged as the first choice of the respondents in all the forms presented (natural, geometrical, stylized and cartoonized). Association probably exists among the preference of most respondents towards cats as motifs for children as is evident from their liking for Doraemon and Tom of Tom and Jerry both belonging to the cat family (as mentioned in Table 3.1), and the lion motif in all modified and ad

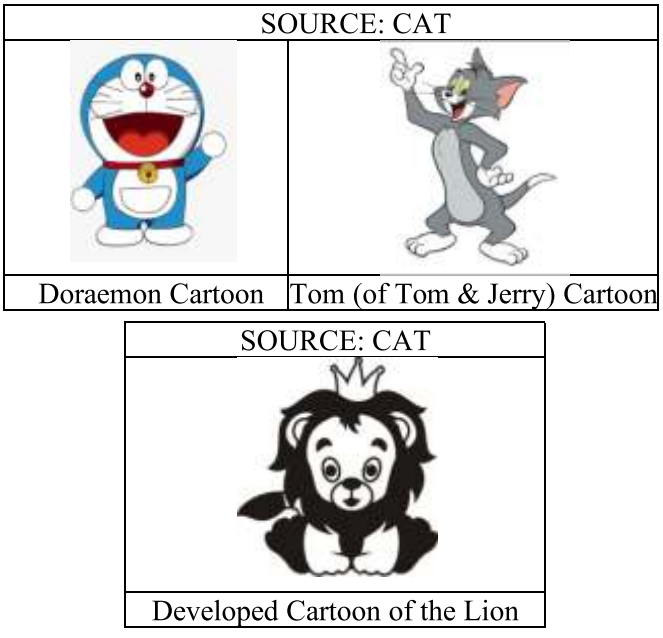


Figure 3.2: Cartoons sourced from the 'cat' family

4. Conclusion

No visible trend of favouritism among the well-known cartoons could be seen among either of the respondents and Shin Chan was the only human-cartoon liked by some respondents. Also only Chota Bheem was the only cartoon of the Indian origin that was liked by the respondents. The cartoonized version and their application as digitized prints on t-shirts evoked same response with respect to the selection of motifs in their modified (naturalized, geometrical and stylized) and adapted (cartoonized) forms. Here again lion (in the animal category), and fish (in the other fauna category) were the most preferred. The only deviation with respect to the choices was with the bird motifs, where parrot cartoon was preferred over the peacock cartoon motif that was ranked highest in its natural realistic and in its sculpted forms. The entire summary of the findings is evident from Figure 4.1.apted versions. This is clearly visible from Figure 3.2.

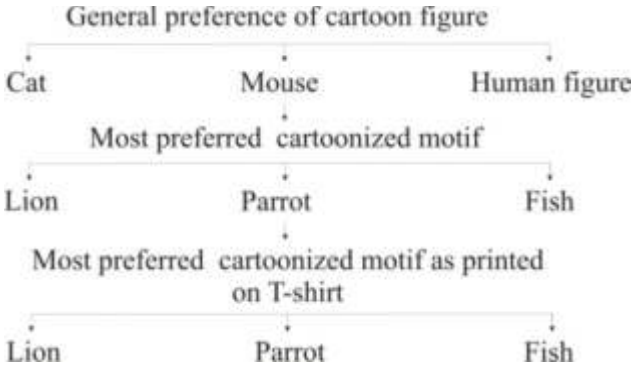


Figure 4.1: Summary of the research findings of the most preferred motif

Thus as evident from the study, motifs from the animal kingdom can be successfully used to develop cartoon figures that can enhance the design palette for childrens' wear and increase the acceptability and marketability of the garments besides promoting appreciation of wildlife among the young children. Also the Indian monuments which are a storehouse of motifs and designs can be explored to source inspiration for designers.

5. Acknowledgement

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Contextualization of Factors Influencing Online Impulse Buying Behavior for Apparel Consumer

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Abstract:
Impulse shopping has drawn significant consideration to the researchers from various disciplines since last decade. This review paper provides the detailed understanding of the online impulse buying (IB) of apparel consumers by analysing numerous researcher's work in the field of Impulse Buying Behavior. This article provides overview and critical analysis of impulse buying behavior (IBB). In this study various research articles related to online impulse buying for apparel are investigated and a research gap has been observed, further based on research gap, a conceptual framework has been developed between the main key elements and numerous factors related to online impulse buying. The study emphasis and identify various factors that affects online impulse buying Behavior for apparel.

Keywords: *Apparel consumer, Consumer behavior, Conceptual framework, Impulse buying behavior, Online impulse buying*

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1. Introduction

Shopping habits of consumers are increasing due to rapid growth in the use of internet, To design and maintain a consumer-friendly website that influence consumers buying behavior can be crucial for retailer's success . In this regard, retailers should understand the characteristics which drive consumers buying and impulse purchasing behavior in online shopping . Impulse buying (IB) is defined as a sudden, unplanned, and complex buying behavior which has been broadly investigated by many academicians and corporate professionals since many years. In the previous studies of the consumer buying behavior , substantial efforts are dedicated to categorizing the aspects (e.g., website features, serviceability of website and payment features etc), which influence online impulse purchasing . Due to the technological development and incredible progress of electronic commerce, web impulse buying has become a widespread. It was projected that around more than 38% of customer's are spending attributable money and time in online shopping .

Many researchers have suggested that online purchasing atmosphere significantly affects impulse buying behavior ——. The e-retail platform provides freedom to the consumers to select, store location, store working hours, to avoid pressure from salesman and staff.

With the rapid progress of internet and its setup across the globe, the online retail market experienced a similar improvement. It was estimated that online retailing market to grasp 350 million consumers by 2021. It was projected that every third consumer is doing shopping online using a mobile phone internet . India's total online retail market is estimated to rise 23% by 2021, and apparel would be the largest category in this segment. Apparel products are major category in online sales. Around 35% of total revenue is generated through online sales comes under apparel category . Amazon, Flipkart, and other fashion centric e-commerce websites like Jabong, Myntra, AJIO, Voonik, Koovs, and Limeroad etc. are the largest key players in this business .
An individual's body shape, type and choices are customized through an apparel e-commerce website for providing better performance of their online apparel store. Clothing has the option to choose your favourite colours and styles, although it represent personality and self-esteem of individuals . The consumer buys apparel products impulsively, to enhance their personality, self-esteem, satisfaction, and emotions. Therefore, apparel is an important product category for impulse buying .

Online impulse purchasing is described as a spontaneous and unexpected purchase with no prior planning. Our preliminary analysis of studies on online impulse buying revealed that the area of study on this phenomenon is broad. The literature review of offline impulse-purchasing studies is common, little effort has been made to consolidate existing information in the context of online impulsive purchase.
According to previous findings the possibility of exploration on this online impulse buying behavior of apparel consumer is extensive. A methodological assessment of past investigations on web impulse purchasing was required to find research gap and prospects imminent research implications. Therefore, this critical review has three objectives:

a) To identify research gap among existing studies of online impulse purchasing behavior for apparel.
b) To consolidate numerous factors related to online impulse purchasing for apparel, and
c) To develop a conceptual framework which represent the interrelationship between numerous factors of online impulse buying behavior for apparel.

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2. Impulse Buying Behavior for Apparel

Impulse buying is defined for purchasing which is made without any prior goal of shopping for a specific type of product to suit specific demands . Engagement of customers in this conduct take place when they are overcome by a strong desire to buy and forced to make an impulsive purchase without proper thought . The desire to make impulsive purchases is a multidimensional hedonic feature that commonly triggers emotive conflict, which might originate from psychological and emotional (internal) factors as well as marketing influence (external) [13, 14, 15] explained a thorough review of the impulse purchase literature and proposed a more specific and complete impulse purchasing model with four components: unplanned, the consequence of exposure to a stimulus, on-the-spot choice, and emotional involvement. Most of the popular impulsive purchase research has historically focused on physical (Brick and Mortar) stores [16, 17]. Traditional brick-and-mortar establishments have witnessed a significant decline because of the internet revolution, with many businesses migrating to online platforms. Many studies are investigated consumer's impulsive online buying behavior, where the virtual environment played an important role in enticing customers , as well as pricing, discounts and rewards offers [11, 14, 21]. The study of Chen et al. and Vinish et al. also indicates that unplanned and impulsive purchasing are similar in nature, since both occur when a purchase is made without previous planning or thought [21, 22]. Table 1 shows impulse buying behavior between online and offline shopping environment.

Table 1- Impulse buying behavior between offline and online shopping environment

IBB Parameters	Offline Shopping	Online Shopping
Shopping Environment	The encounter of specific cues, such as layout design, lighting, music, and product assortments, might trigger a buying impulse [23].	When discounts and promotions are offered online, it triggers a buying instinct. Consumers are also attracted by visual appeal, such as website design and color scheme and serviceability [14, 24].
Types	Traditional "brick-and-mortar" retailers, where customers look around and ask questions, and if they are pleased with the answers, they purchase the product [22].	Products are shown on many internet platforms with accurate pricing, promotions, and payment options [11, 25, 26].
Convenience	Consumers may hold the goods in their hands and check its quality against industry standards [16].	Consumers may buy from anywhere in the globe whenever they believe they need that product the most [25].

Prior research studies defined impulse buying and found some common definition like: Any Purchase with very little planning or wothout planning in advance . According to Rook & Hoch Sudden and Spontaneous desire to act. Impulse buying is an immediate decision making and fairly biased in favour of immediate procurement . According to Piron impulse buying (IB) is spontaneous, unexpected and a result of emotion.

These findings emphasized on the assessment of the genuine outcome with the proposed target . In an online impulse buying, many researchers focusing the effect of atmospheric cues, which is an effect of exposure to in-store inducements . Advantages associated with impulse buying force researchers to include various features in their websites.

Most research studies related to impulse buying were conducted in the USA , followed by Asia and relatively few in Europe . Previous findings used sample of college student to authenticate the conceptual model. According to Kim & Eastin the usage of college student sample was suitable because young consumers are the leading cluster of online retailers. Some types of consumer products are more likely to be impulse buying than others like apparel, jewellery and other fashion item are closely link to self -image and appearance . According to Zhang et al. four categories of IB is identified which associated with the shopping of apparel products: pure or novelty, reminder, fashion oriented and planned impulse buying. Various studies showed that impulse shopping occurs irrespective of merchandise types: once the study defendants were uncovered to internal and external stimulus —. According to past studies, various theoretical foundations have been given in case of impulse buying. The summery of theoretical foundation with esteemed author name is mentioned in table 2.

Table 2 - Summery of theoretical foundation.

Theoretical Foundation	Explanation	Author
Cognitive reaction theory	This system suggests that sentiments are resulted from the observations of media and society, personality development enhances sentiments.	Dawson & Kim [37]
Elaboration likelihood theory	The theory proposes the central and the peripheral path to encouragement. Person reacts in a different way while proceeding stimulus received from the atmosphere.	Phau & Lo [38]
Heuristics information processing	This theory recommends that shoppers affected with lucrative deals for increasing rare products because of afraid. They concern the amount will increase again when the stock is exhausted.	Bellini et al. [39]

Theoretical Foundation	Explanation	Author
S-O-R Model	The model suggests that exciting cues (stimulus) apparent from atmospheric internal valuation (organis m), which leads to a tactic and escaping behavior (response).	Liu et al. ; Kim & Eastin [4,34]
Technology Acceptance Model	It describes that access to the latest technology affects the decision making:	Duarte et al. [43]
The consumption impulse formation enactment model	It explains shoppers impulse shopping phenomenon. The phenomenon includes utilization urges. Compelling factors that evaluate online impulse buying.	Park et al. [47]

Table 2 representing S-O-R model, which is widely preferred in the studies of online IBB, possibly because this model has traditionally provided the foundation for consumer behavior studies. Furthermore, most research studies have emphasized the role of atmospheric cues in online impulse purchasing behavior. Regardless of their adopted theoretical model, existing studies on online impulse buying have consistently evaluated the relationships between atmospheric cues, consumers' cognitive and affective reactions, and the resulting behavior, and have largely drawn on the environmental psychology paradigm, which can be reconciled with the S–O–R model. Therefore, we adopted the S–O–R model to guide the classification of variables in online impulse-buying studies.

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3. S-O-R Model

Three keys' dimensions of the S-O-R model are as follows:

- Stimulus (S), It is a activate that evokes customers,
- Organism (O), It is an inner assessment of customers, and
- Response (R), It is a result of customer's reactions toward the IBB and their inner assessment.

Fig. 1 Represent the S-O-R model for online impulse buying behavior for apparel consumer, that shows various formats of online impulse buying.

3.1 Online impulse buying stimulus

There are two kinds of online IB stimulus: External and Internal factors. The internal factors of stimulus are consumer characteristics and external factors of stimulus are features of product, website, and varied situations.

3.1.1 Website Characteristics

According to Narayana et al. , internet permits customer to shop any time, offering 24x7 days convenient shopping . Researchers are now identifying the numerous facets of impulse shopping and creating different tactics to encourage buyer. Apparel shopping website characteristics are very important during a progression of impulse shopping as online consumer have to deal with it, these features can enhance the purchasing . According to Lo et al., store design of a website can be described as which individual shopper can consider the online store visually appeal [41].

The usability of website can be demonstrated as the level to which a probable consumer assumes, shopping website should be effort free, such as easy functions and movement between pages by scrolling down and easy access with the internet, so individual can access easily through server . Presentation of product in a visual attractive way: like, displaying several images, information and videos with customized view and numerous varieties available of product in e-store content specially in case of clothing, which will help the individual gets involved in purchase of the products . The feedback system and usability of the website should be very simple and responsive, so that consumers can get exact amount spent during each individual purchase .

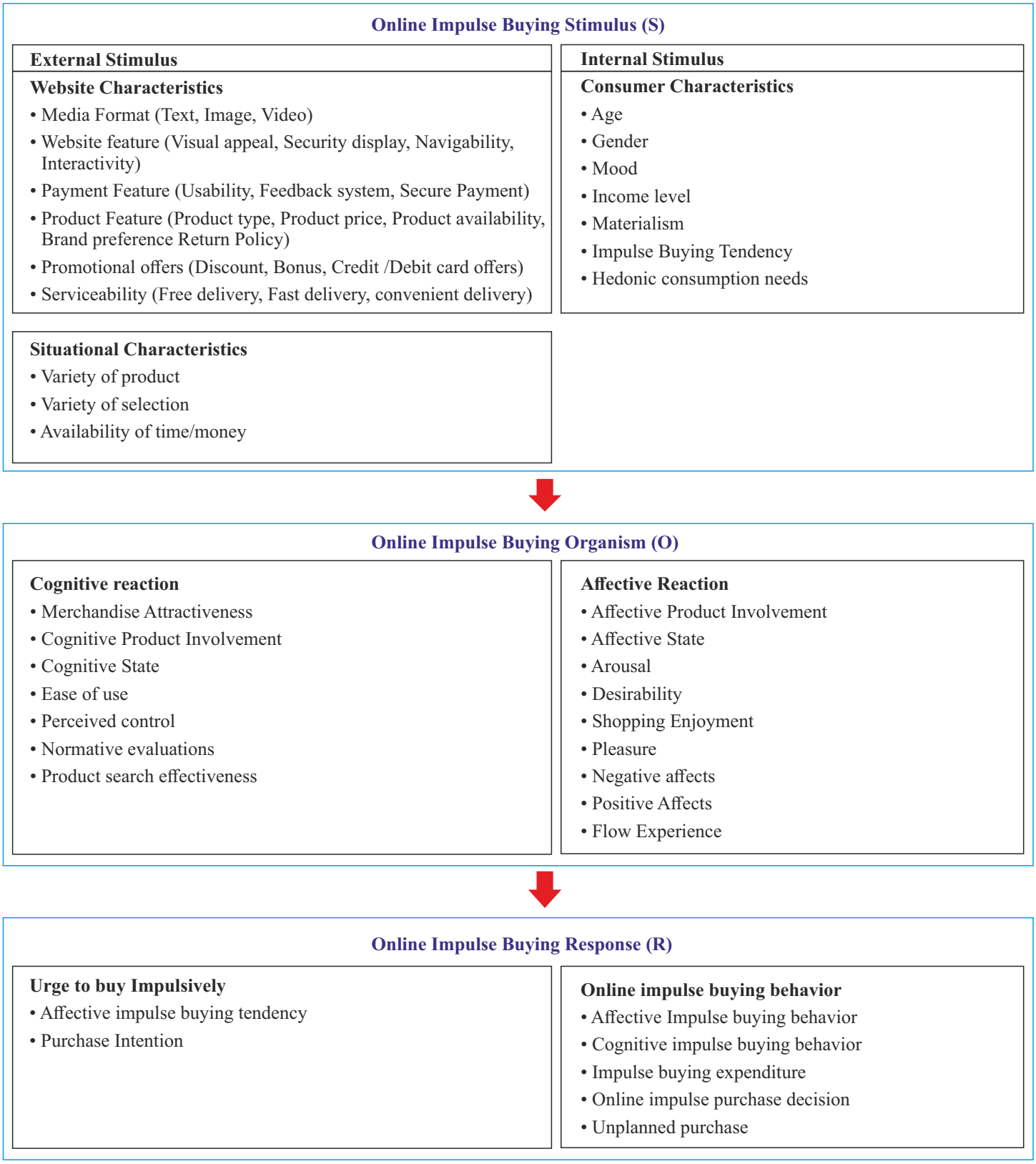

Figure 1- S-O-R Model for impulse shopping behavior for apparel [4,34].

3.1.1 Website Characteristics

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Online impulse buying behavior is influenced by product characteristics such as physical appearance and others functional features . According to Park et al. clothing are the most likely shopper for impulse buying and clothing are "fashionable goods which give the impression to have potential for self-expressive, mood transformation, and entertainment".
Product type and price play important role in impulse buying[45]. Akram et al[46] find that shoppers are buying impulsively, when there are sales available, and products are on discount prices. Items which are procured during impulse are generally less expensive. Moreover, past findings showed that goods are bought as per their appearance which enhance impulse buying based on their appearances .

According to Applebaum [30] suggested that impulse buying behavior of consumer may be affected by special discounts and promotional offers, these activities fulfil the psychological requirement of consumers. Offering bonus packs and discount prices during promotional offer, consumers get benefits during shopping, and it encourages impulse buying . Offers on debit and credit cards also motivate the consumers to do more shopping impulsively ' . Serviceability of website in terms of product delivery like faster delivery, free delivery, and convenient delivery, also encourages to consumers to buy product online impulsively [33].

3.1.2 Situational Characteristics

Situational stimuli or characteristics consist of individual and atmospheric aspects that inspire consumer towards impulse shopping. Situational factors comprise availability of time/ money, sales promotion, and existence of others . Availability of time and money are important situational factors and main key element in a progression of impulse shopping . During shopping, availability of time governs whether a buyer will be affected by impulse shopping or not. Shortage of time throughout purchasing has negative impact on impulse buying as it creates irritation. Therefore, if shopper's have additional time, then they will utilize it in shopping efficiently . Availability of money boosts the consumer's buying capability and limited money may reduce the chances of impulse purchasing .

According to Khan et al.,[45] during apparel browsing, if different styles and numerous varieties are available for selection, consumers can choose any one according to their requirements. In apparel shopping, brands play an important role. During promotional offers, the availability of various styles with different brands categories encourage the impulse buying[4] .

3.1.3 Consumer Characteristics

Consumer's characteristics consist of age, gender, mood, income level, materialism, shopping pleasure and impulse buying tendency. Previous studies on consumer characteristics have found that young purchasers do more impulse buying then elder shoppers [36]. According to Kollat & Willet age of shopper and impulse shopping have adverse relationship between each other; that means young shoppers have less willpower over their shopping behavior rather than elder shoppers. Another characteristic is gender which also affects the impulsiveness. Koufaris [35] found that the preferences of men and women do not have similar type, when they do purchase. Men consider shopping as identity which lead to buy products with practical and instrumental application while women do shopping with their emotions and social identity[38] . Previous studies also found that consumer's mood also influences the impulse buying behavior of shopper. Sudden shopping can support the shopper to transform their mood from negative to positive side.

Impulse buying is avoided by those customers who gave value the product with its material. They mainly prefer to economize instead of pocket money on impulse buying[39] . These consumers usually do not affect by impulse buying. Another important characteristic is impulse buying tendency (IBT), which is associated with the lifestyle of consumers[40] . Consumer with high amount of IBT are more probable to possess desire to get various sorts of products impulsively . Purchasing is fun for a few customers, but they do not purchase any product, vendors may encourage these kinds of customer to spend longer time in shops and stimulate them to undertake to IB.

Consumer can satisfy due to hedonic consumption needs, customers do fun and get pleasure during online shopping [32, 43]. During online browsing, if consumer do value shopping, exploring during shopping, social shopping, idea shopping and relaxation shopping, that motivate to them for impulse purchasing [20]. According to Liu et al.[4] suggested that, if consumer found a good deal (in terms of discounted prices, EMI offer, and exchange offer) during impulse shopping, the consumer's gratification is very high at that moment.

3.2 Online impulse buying organism

In the S-O-R framework online impulse shopping organism refers to consumers inner valuations. Two kinds of IB organism are: cognitive and affective.

3.2.1 Cognitive reaction

Cognitive reactions are the intellectual processes which occur when buyer interact with stimulus, and it happens when consumers become aware during the web IB . Positive and negative cognitive reactions determine the consumer purchasing responses. Various aspects related to cognitive reactions in impulse shopping are merchandise attractiveness, cognitive state, ease of use, satisfaction, perceived control, and website communication styles etc.

According to Dawson & Kim merchandise attractiveness plays a big role throughout online IB, positive perception of the dimensions and attractiveness of the merchandise results in impulse buying. Cognitive product involvement is tempted by functional and utilitarian aspects of products . Its energies shopper to search product related information and intentions. Cognitive state of consumers means, how individual understand, think and interprets the information about the product . According to Xu & Huang perceived control is a consumer perception being in a control over what to see and do in e-store. The ease of use or usability means, consumer trusts that employing a specific web system would be free from effort . The normative evaluations of customer are the decisions of consumer regarding the constructive appropriateness of impulse shopping behaviour [4, 32, 45, 46, 48]. Product search effectiveness is the capability of website to accomplish shopper needs for exploration and product acknowledge . The consumer satisfaction depends on the services provided by the website, whether they are enjoyable or not [33]. The communication styles of website mean, how the website communicates with their services to its consumers .

3.2.2 Affective reaction

Affective reactions are the sensitive responses that came when shopper interrelate with an atmosphere of the online store. Customers enjoy web purchasing responses once they experience positive affective reactions, like pleasure and arousal [42]. The desire encourages impulse buying and arousal initiates the progression. The previous studies examined that most commonly affective reactions were shopping enjoyment, impulsiveness, pleasure, and arousal associated with web impulse shopping responses [41, 42].
Affective product involvement is an inner response resulting from affective motives . Affective state is an individual's mental state and self- emotions . Arousal is a state of feeling that varies from feelings of eagerness, activeness, excitement, or stimulation to the feeling of being exhausted, sleepy or boredom [42]. Desirability of consumer is an attractive deal; individual's has desire to find attractive deal during their shopping situation [39]. Shopping enjoyment is a pleasure that obtained an individual's during their shopping experience [31, 41, 44]. Flow of experience is psychological experience, when a consumer emphasized on his or her action during shopping and senses shopping fun and loss of self- realization . Pleasure is a shopping enjoyment, in which individual shopper feels happy, thrilled, or gratified during shopping time [42]. Positive effects are a situation, in which a person feels happy, thrilled, and encouraged. On the other hand, a person feels frustration, disturbance and irritation during shopping situation is a negative affect [22, 24].

3.3 Online impulse buying response

A shopper's feedback to web impulse shopping stimulus and organism is called response. The two online IB responses are: urge to by impulsively and IBB.

3.3.1 Urge to buy impulsively

According to previous studies, urge to buy impulsively is common factor which is used as a substitute for assessing online IB [4, 40]. According to Ozen & Engizek , affective IB tendency is a situation in which individual shopper is expected to make unplanned, instantaneous, and unreflective buy. An individual's intent to make an online shopping is a buying intention [45, 46].

3.3.2 Online impulse buying behavior

Measuring online IBB has been described as a complex and challenging phenomenon [34, 40] due to respondents attended act during a socially desirable manner once they were being observed in an experimentation.

Affective IBB is an unplanned buying that relates to a feeling of enthusiasm and uncontrollable urges to buy [50]. IB expenditure is an actual amount of cash consumed during online impulse shopping. Any alternative purchase decision made by consumer during online impulse shopping is known as impulse purchase decision. Any sudden and spontaneous shopping during online is an unplanned purchase.

4. A conceptual framework of online impulse buying for apparel

After a critical analysis of various research papers, this article proposed a conceptual framework in order to provide a more complete picture of existing information on an online IBB for apparel consumer. In this review paper S-O-R model is used because it was the foremost theory. Past literature described that this relationship among the main three key elements of S-O-R model using other different theoretical foundation. Developing a new conceptual framework by the help of S-O-R model, it deliberates the relationship between online IB factors and their perspectives. Fig 2 portrays the conceptual framework of online IBB for apparel.

Based on the prevailing literature analysis, authors have developed interrelationship between main key elements of online impulse buying behavior for apparel consumer that would increase the knowledge of impulse buying. Our proposed conceptual framework of online IB captures the various aspects of IB of the shopper during online purchase situation.

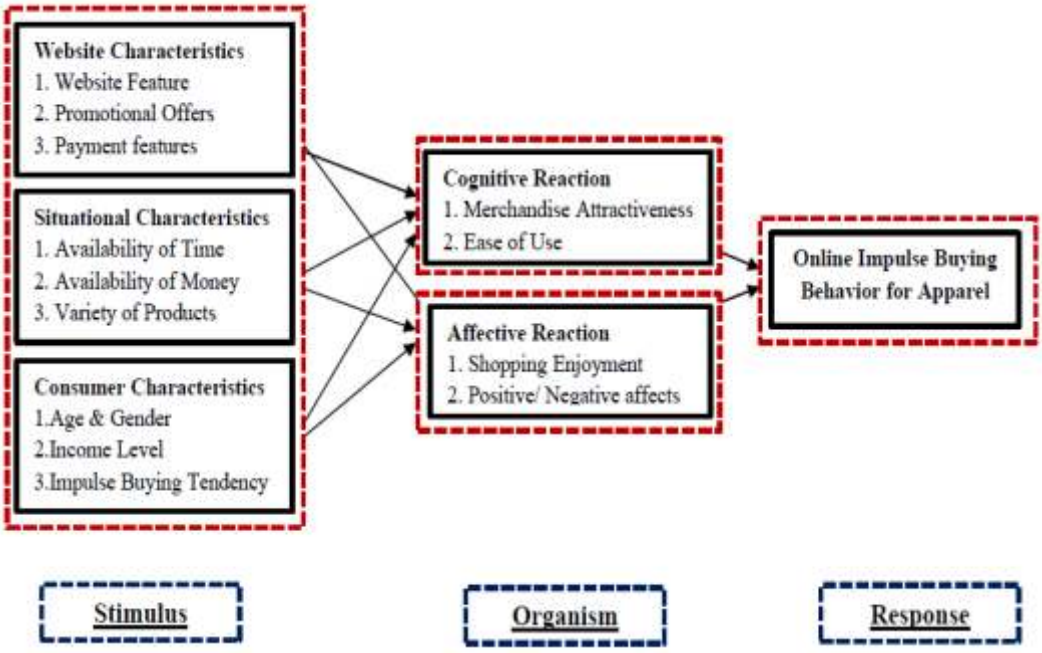

Figure 2 - Conceptual framework of online IBB for apparel

Further hypothesis and research can be attempted between these key elements and online impulse buying behavior for apparel. Among these implications of research, the most challenging implication are the effect of the online store characteristics and situational factors on the consumer's IB.

Due to technological advancements only website related aspects are fully under control of marketers. External stimuli or factors might be leveraged by the e-retailers by enclosing suitable strategies to tap the probable shopper during online shopping. Forthcoming studies might be protracted during this area by analysing the collaborative belongings of the varied factors and therefore the shopper's personal traits.

5. Conclusions

Online impulse buying is complex phenomenon, which is a challenge for apparel e-retailer. In this article we have identified S-O-R model and proposed a conceptual framework to summarize the various aspects related to online IBB for apparel. Increase in personal income have made an online impulse buying ubiquitous, across the various e-commerce platform. Creating an attractive visual display of merchandise in the form of media format and availability of apparel products in different styles at e-commerce platform is an important to increase the sales through unexpected IB. Promotional offers including discounts, rewards and credit/debit card cash back offers also influence the individual shoppers buying attention. Sufficient money and time boost the individual's buying tendency during the impulse buying. Online retailers need to understand this phenomenon and make a suitable retail strategy, by which they can induce shoppers at the online platform.

Online impulse buying has various attributes such as website features, characteristics of consumer, situational factors, and cognitive and affective reactions of apparel consumer. We highlighted these attributes as a research gap and proposed a relationship between numerous influencing factors for future investigation.

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Application of Box-Behnken Design for Modeling Pore Size of Nonwoven Air Filter

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Abstract:
Air Filtration means the separation of particles from gas by passing through a permeable medium. A nonwoven textile material exhibits good filtration property due to three-dimension network of fibers enclosing small pocket of void spaces. In the present work, Pore Size property is chosen for study and to access optimal conditions required for air filters. The experiment was carried out with three levels and variables using Box-Behnken design combined with response surface methodology [RSM]. Denier of fiber, density of fiber and gram per square meter of fabric were independent variables selected to get desired Pore Size of needle punched nonwoven fabric. Data were fitted to a Cubical model, model fitness was evaluated by the analysis of variance, which indicates P < 0.0005, R2 = 0.9849 and coefficient of variance [CV] = 2.52, SD = 13.35. Individual and interactive effects of the independent variables on Pore Size were interpreted using the proposed mathematical model.

Keywords : *Box–Behnken, Denier, Density, GSM of fabric, Pore Size*

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1. Introduction

Industrialization makes polluted environment in and around area of industrialized cities. As a result of these, the issue of sustainable and healthy environment has received increasing attention. Air filtration method removes air pollutants and effectively improves air quality. Quality of filtration depends upon thickness, air permeability, size of pores, bursting strength and porosity of filtering media. [1,2]. In 1940 use of Glass fibre in air filter in the United States opened new chapter for the global manufacturing industry to develop air filter rapidly. Activated carbon fibre [ACF] developed by Japanese recently is considered to be one of the best air purification materials due to its advantages of uniform pore size distribution, large adsorptive capacity and easy regeneration [5]. In the present work, Pore Size property is chosen for study and to access optimal conditions required for air filters [3, 4, 1].

2 Experimental procedure

2.1 Materials

Polyester and polypropylene fibers were used as raw material. The details of properties of fibers are listed in table [1] below.

Table 1 Details of fiber parameters

Sr. No	Material	Denier	Denier	Staple length[mm]
1	Polyester	6D	3D	64
2	Polypropylene	6D	3D	64

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2.2Methodology

2.2.1 Design of Experiment

A literature survey shows air filter fabrics are produced in the range of 120 to 200 GSM. To produce needle punched fabric we have used polyester and Polypropylene fiber with 3D & 6D. In present trials we have used Response Surface-Box-Behnken Design with three center points and 15 runs. [6] The aim of the experimental design was to optimize the response variables [Y]. The empirical equation which explains the behavior of the system is represented as;

$$Y = \beta_0 + \sum \beta_i X_i + \sum \beta_{ii} X_i^2 + \sum\sum \beta_{ij} X_i X_j \quad [1]$$

Where β0 the constant coeficient; βi the linear coefficients and Xi is the independent variable of action called factors. [6].

Table 2 Box-Behnken experimental design with the independent variables

STD	RUN	DENIER OF FIBER	DENSITY OF FIBER	GSM
4	1	3	1.155	200
14	2	3	1.38	160
1	3	4.5	0.93	200
8	4	6	0.93	160
2	5	4.5	1.155	160
11	6	4.5	1.38	200
15	7	6	1.155	120
12	8	6	1.155	200
3	9	3	0.93	160
13	10	4.5	1.38	120
10	11	4.5	1.155	160
7	12	6	1.38	160
5	13	4.5	1.155	160
9	14	3	1.155	120
6	15	4.5	0.93	120

2.2.2 Production of Fabric

As per run order fibres were used for manufacturing the needle punch nonwoven fabric on Trutzschler nonwoven machine shown in figure 1with constant process parameters to avoid variation due to machine parameter.

Figure 1 Needle punching machine [Courtesy – DKTE CoE Nonwoven]

2.2.3 Testing of material

The pore size test carried out as per ASTM E 1294 Test method by using capillary flow porometer [PMI] [figure 3.7]. For evaluation of pore size in nonwoven fabric we are using the liquid extrusion technique. In this technique, wetting liquid water [surface tension 72 dynes/cm2] fills the pores of the sample and pressurized gas pressure removes the liquid from the pores. There are find out differential gas pressure and flow rates through dry and wet samples were measured to calculate pore diameters.

Figure 3 Pore size testers

3 Results and Discussion

The Bursting strength of nonwoven fabric was measured by AUTOBURST tester and is presented in Table 4.

The empirical relationship between Pore Size [Y2] and the three process variables was obtained given in Eq. [2].

$Y2= 571.83-6.02 \times A -19.97 \times B -21.04 \times C-45.98 X AC+ 35.18 X A^2- 54.62 X B^2 -57.62 X C^2 -39.34 X A^2B + 49.59 X A^2C$ [2]

Table 4 Box-Behnken experimental design with the independent variables and the response values for Bursting strength

RUN	DENIER OF FIBER	DENSITY OF FIBER	GSM	Pore Size Observed	Pore Size Predicted
1	3	1.155	200	624.09	629.65
2	3	1.38	160	509.86	499.11
3	4.5	0.93	200	454.06	458.23
4	6	0.93	160	605.3	605.68
5	4.5	1.155	160	558.5	571.83
6	4.5	1.38	200	422.45	418.29
7	6	1.155	120	566.08	560.52
8	6	1.155	200	531.2	525.64
9	3	0.93	160	618.1	617.73
10	4.5	1.38	120	456.21	460.38
11	4.5	1.155	160	568.5	571.83
12	6	1.38	160	476.32	487.07
13	4.5	1.155	160	588.5	571.83
14	3	1.155	120	475.05	480.61
15	4.5	0.93	120	504.48	500.32

Table 5 Analysis of variance [ANOVA] for response surface Linear model for Pore Size

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	58144.42	9	6460.49	36.26	0.0005	significant
A-Denier of fiber	290.37	1	290.37	1.63	0.2578	Not significant
B-Density of fiber	1595.2	1	1595.2	8.95	0.0304	significant
C-GSM of Fabric	1771.57	1	1771.57	9.94	0.0253	significant
AC	8455.91	1	8455.91	47.46	0.001	significant
A^2	4570.36	1	4570.36	25.65	0.0039	significant
B^2	11015.24	1	11015.24	61.83	0.0005	significant
C^2	12382.96	1	12382.96	69.51	0.0004	significant
A^2B	3094.68	1	3094.68	17.37	0.0088	significant
A^2C	4917.74	1	4917.74	27.6	0.0033	significant
Residual	890.79	5	178.16			
Lack of Fit	424.13	3	141.38	0.6059	0.6715	not significant
Pure Error	466.67	2	233.33			
Cor Total	59035.21	14				

Table 5 shows F-value of 36.26 indicates that the model is significant. Additionally, the model terms are A & C are significant as "Prob. > P" are less than 0.05. The "Lack of fit F-value" of 0.6715 implies that the "Lack of fit" is not significant and, adequacy precision ratio is 19.39 which is greater than 4 indicates that developed model can be used to guide the design space [6]. es and the response values for Bursting strength.

For pore Size, the predicted R2 value for Eq. [2] was 0.8016, which was close to R2 value which revealed that the experimental data for Pore Size fitted well with predicted value of the model.

Table 6 Statistical parameters obtained from the analysis of variance [ANOVA] for the models for Pore Size

Std. Dev.	13.35
Mean	530.58
C.V. %	2.52
R^2	0.9849
Adjusted R^2	0.9578
Predicted R^2	0.8016
Adeq Precision	19.3941

The experimental data were also analyzed to check the correlation between experimental and predicted values of Bursting Strength. It can be seen from figure 4 that data points on plot were reasonably distributed near to the straight line, indicating selected Linear model was adequate in predicting response variables for experimental data [6, 8].

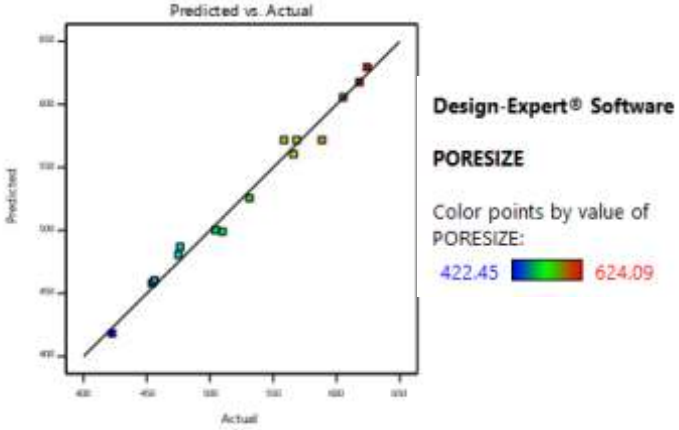

Figure 4 Actual and predicted plot of Fabric Pore Size

Effect of Fiber Denier, Fiber Density and Fabric GSM on Pore Size Properties of Needle punched Nonwoven Fabric.

Effect of Denier of Fiber, Density of Fiber and GSM of Fabric on Pore Size Property of Needle punched Nonwoven Fabric

Based on ANOVA, the results were obtained, the effects of experimental factors on Pore Size, corresponding plots were shown in Figures 7–15 and the response model were represented in Eq. [2]. Density of Fiber, GSM of Fabric and their interaction has significant effects on Pore size.

A graph shown below shows a effect of denier on pore Size which is not significant at its individual state but in combination with GSM of fabric it has significant effect. Denier doesn't 'shows any particular trend with pore size [7, 8]

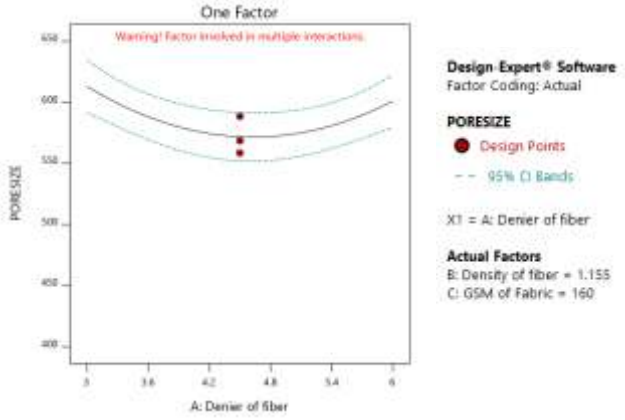

Figure 5 Effect of Fiber Denier on Pore Size

A density of Fiber shows a significant effect on pore size of fabric. The cure has exponential nature. Less density of fiber has finer pores and as density increases it increases up to 1.15 densities and start descending with further increase in density of fibers.

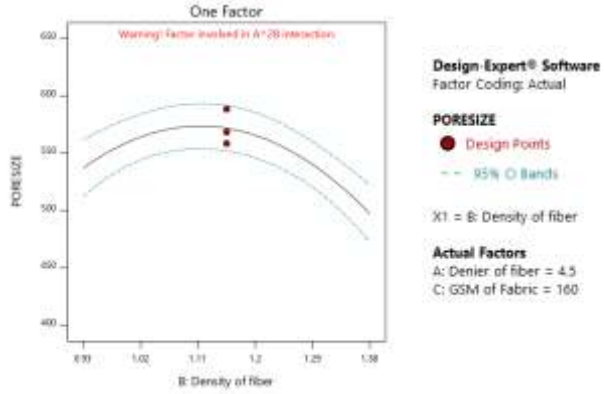

Figure 6 Effect of Fiber Density on Pore Size

A Fabric GSM shows a significant effect on pore size of fabric. The cure has exponential nature. Less Fabric GSM has finer pores and as Fabric GSM increases it increases up to 160 GSM and start descending with further increase in Fabric GSM.

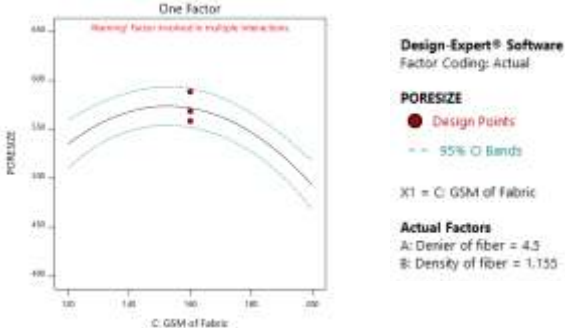

Figure 7 Effect of GSM of Fabric on Pore Size

Figure 10 and 11 counter plot and surface plot of interactive effect of denier of fiber and GSM of fabric on pore size. The response surface better visualizes the tendency of each factor to influence the pore size. The shape of the contour plot shows the natures and extents of the interactions between factors. Statistical analysis shows a significant effect of interaction factor on output variable pore size. As GSM decreases pore size decreases and increase in fiber denier pore size increases if we keep density of fiber constant i.e., Density =1.15[7, 8].

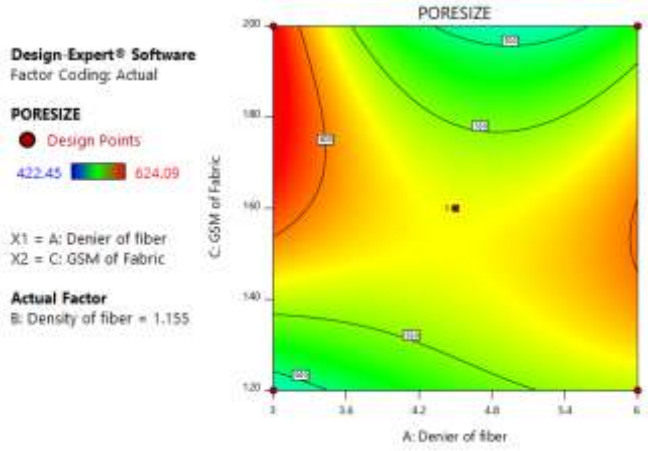

Figure 8 A counter plots of GSM of Fabric and Denier of Fiber on Pore Size at optimum condition

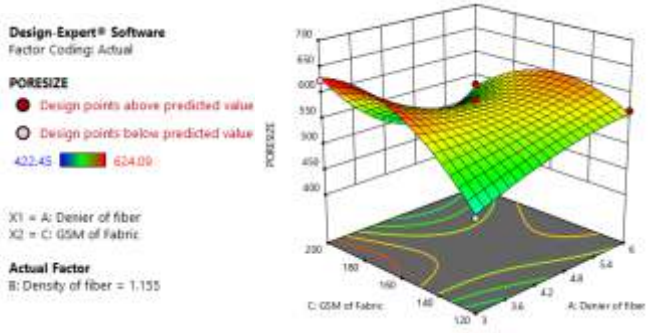

Figure 9 Combined Effects of GSM of Fabric and Denier of Fiber on Pore Size

Figure 8 and 9 counter plot and surface plot of interactive effect of denier of fiber and density of fiber on pore size. Statistical analysis shows a significant effect of interaction factor on output variable pore size. The nature of interacting effect of density of fiber and denier of fiber is exponential type if we keep GSM of Fabric constant at 160 GSM. In case of density finer pores are formed when 0.93 density fiber used and pore size increases up to fiber density 1.15 and again star reducing with increase in density up to 1.38. Exactly reverse trend is observed with denier of fiber. A fine size pore is formed when two fibers of 3D and 6D are mixed to get average 4.5 Denier [7, 8]

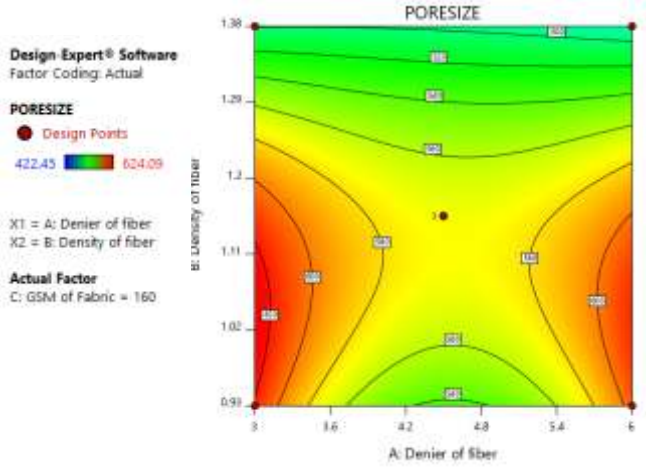

Figure 10 A counter plots of Density of Fiber and Denier of Fiber on Pore Size at optimum condition

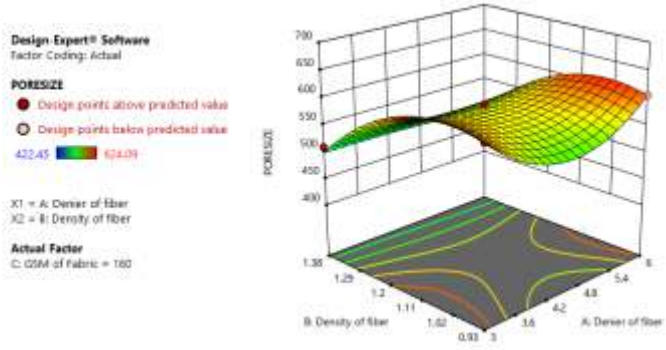

Figure 11 A Combined Effects of Density of Fiber and Denier of Fiber on Pore Size

Figure 10 and 11 counter plot and surface plot interactive effect of square of denier of fiber and GSM of Fabric on pore size. Statistical analysis shows a significant effect of interaction factor on output variable pore size. As GSM reduces pores becomes finer in nature and as denier of fiber increases pores become larger in size if we keep density of

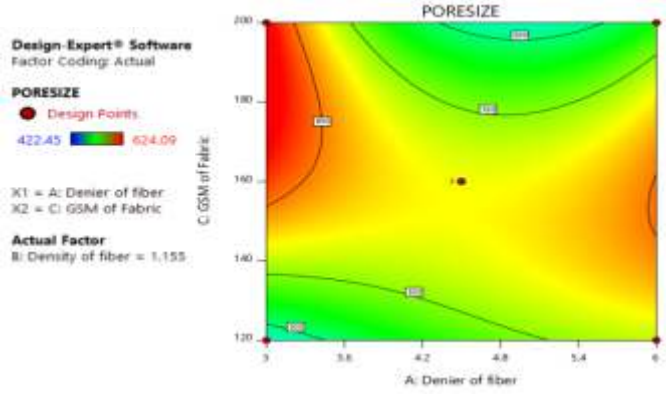

Figure 12 A counter plots of GSM of Fabric and Denier of Fiber on Pore Size at optimum condition

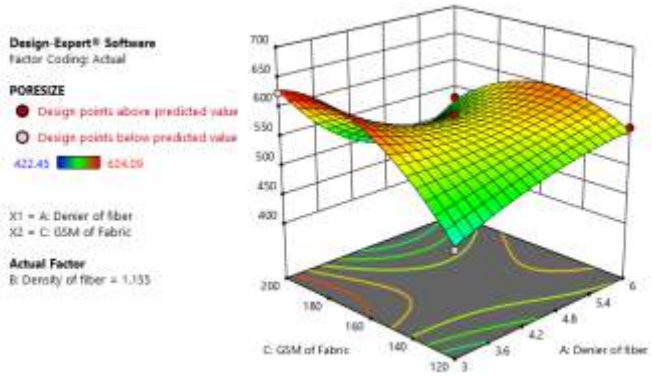

Figure 13 A Combined Effects of GSM of Fabric and Density of Fiber on Pore Size

4 Conclusions

1. A Third-order polynomial mathematical model appropriately described the relationship between the parameters studied and output variables – Pore Size.
2. Density of fiber and GSM shows statistically significant effect of exponential nature relation with Pore size.
3. A statistically significant effect of interaction between Square of denier & Density and Square of denier & GSM was observed on pore size

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Extraction and Dyeing of Natural Dye from Tung Leaves on Cotton Fabrics: Gamma Ray Assisted Changes in Colour Strength and

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Abstract

The present study was conducted to explore the colouring potential of tung (Rhus parviflora Roxb.) leaves and to improve colour strength of dye using gamma radiations followed by natural and chemical mordanting process. The results showed that tung plant leaves could be an excellent source of natural dyes for textile sector. Ferrous sulphate (1%) and lemon juice (1%) were the best pre- and meta-mordants, respectively to improve the colour strength and colour fastness properties. The results from dyeing indicated that gamma ray treatment of 15 kGy was the effective absorbed dose for extraction of dye and surface modification of cotton fabric. Dyeing of cotton fabric with tung leaves extract at 60 oC for 60 min using dye bath of pH 7.0 and salt concentration of 6 g/L produced good colour strength. Gamma ray treatment of cotton reduced the amount of mordants and improved the colour fastness properties.

Keywords: *Colour fastness, Irradiation, Mordanting, Natural colourant, Rhus parviflora, Spectra flash*

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1. Introduction

In the recent years, there has been more focus on use of natural dyes due to ecological and environmental problems associated with the use of synthetic dyes. Moreover, many synthetic dyes have been found to be potentially carcinogenic. Although, natural dyes are manufactured through eco-friendly processes [30] based on abundantly available natural products like plants, animals and minerals, many textile manufacturers have not yet seen an incentive to switch to natural dyes due to its exorbitant rates. The technology of utilizing natural dyes in the modern clothing industry is also relatively new and is still being improved upon. India has a rich biodiversity and it is not only one of the world's twelve mega diverse countries, but also one of the eight major centers of origin and diversification of domesticated taxa. It has approximately 490,000 plant species of which about 17,600 are angiosperms; more than 400 are domesticated crop species and almost an equal number of their wild relatives one. Thus, India harbours a wealth of useful germplasm resources and there is no doubt that the plant kingdom is a treasure-house of diverse natural products. The District Chamoli, Uttarkashi and Pithoragarh of Uttarakhand, India use wool and woolen products dyed traditionally by using natural dyes. Natural dyes have the ability to produce wide range of tints and shades, with the same dyeing material. Certain problems with the use of natural dyes in textile dyeing are color yield, complexibility of dyeing process, reproducibility results, limited shades, blending problems and inadequate fastness properties. In the current scenario, the use of non-allergic, antimicrobial, ecological and eco-friendly dyes in textiles has attracted the attention of people throughout the world [1]. In India, there are more than 450 plants that can yield dyes [12]. In addition to their dye-yielding characteristics, some of these plants also possess medicinal value. Though there is a large plant resource base, little has been exploited so far. Due to lack of availability of precise technical knowledge on the extracting and dyeing technique, it has not commercial ly succeeded like the synthetic dyes. Although indigenous knowledge system has been practiced over the years in the past, the use of natural dyes has diminished over generations due to lack of documentation. Also there is not much information available on databases of either dye-yielding plants or their products. Natural dyes extracted from plants, animals or minerals without chemical processing show better compatibility with environment [2] due to their non-toxic nature and renewability potential [3]. Despite so many benefits associated with the use of natural colourants textile industries, particularly in developing or underdeveloped countries hesitate to use natural dyes due to their low colour strength, limited availability and high cost in these regions. Most of the natural colourants are commonly obtained from floral parts of plants. Thus, there is need to explore the colourant potential of non-flowering parts of commonly grown, evergreen and less expensive plants. Tung (Rhus parviflora Roxb.), is ubiquitous in presence, fast growing, can withstand harsh environmental conditions particularly, soil salinity and its leaves are regularly subjected to cutting and trimming when used as ornamental. Scientists working in the field of natural colourant technology are now focusing to improve extraction of colourant from plant material and its application onto surface modified fabric. Different techniques like UV, microwave or ultrasonic treatment; bio polishing, cationization and mercerization are being implied for surface modification of fabric [4], [5]. The utilization of gamma radiations in surface modification of fabric has been the subject of many recent studies [6], [7], [8]. Gamma radiations treatment can improve the shrinking and wrinkling resistance of the fabric and enhance the shades of

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dyed fabric. It also increases the ability to uptake dye onto fabrics at low temperature without affecting the morphology of colourant as well as the physical structure of fabrics [9], [10].

Exploration of natural colourant sources has been the subject of many studies from last few decades. Despite all the efforts, scientist have been able to explore about more than 600 plants out of hundred of thousand species found on the earth [11], [12]. Keeping in view above mentioned facts; we have selected gamma radiations for the alertness in extraction of colourant from leaves of tung plant and surface modification of cotton fabric. The objective of study is to get a cheap and easily available natural colourant for textile industry as well as to alter colour strength and colour fastness of fabric. The structures of pre-isolated colourants from this species have been mentioned in the below Figure 1.

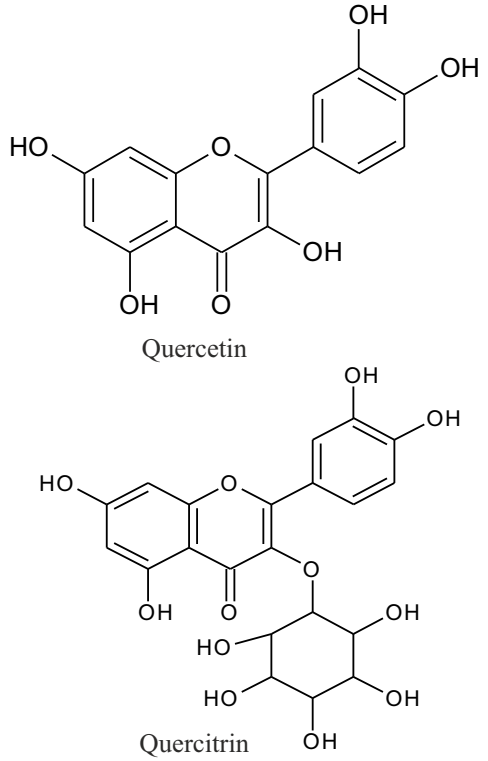

Figure 1. Chemical structures of pre-isolated two dyes bearing yellow colourants from the leaves of Rhus parviflora

2. Materials and Methods

2.1 Sample preparation, irradiation and extraction process

Fresh leaves of tung plant were collected from Pauri, Pauri Garhwal, Uttarakhand, India. The leaves were washed with distilled water and shade dried at room temperature. Dry leaves were ground into fine powder. Cotton was purchased from the local market of Gopeshwar, District Chamoli, Uttarakhand. The cotton was bleached and mercerized. Cotton fabrics and tung leaves (shade dried) powder were exposed to different absorbed doses of gamma radiations, such as 5, 10, 15, 20 and 25 kGy using Cs-137 gamma irradiator at Indian Institute of Technology, Roorkee, Haridwar, Uttarakhand, India [13]. After the gamma ray treatment, three different types of media (aqueous, alcoholic and alkaline) were used for the extraction of natural colourant from the leaves of tung plant. Dyeing process was carried out using NRP/NRC (non radiated powder/non radiated cotton), RP/RC (radiated powder/radiated cotton) & NRP/RC (non-radiated powder/radiated cotton). Extraction of colourant was carried out by boiling irradiated (RP) and un-irradiated (NRP) dye powder using the aqueous, alcoholic and alkaline media with material liquor ratio of 1:30 for 1 hr [14]. After boiling, the liquor mixture was filtered and filtrate was used in further studies. Colour strength of dyed cotton fabrics was determined by measuring surface reflectance of the samples using a computer-aided Macbeth 2020 plus reflectance spectrophotometer.

2.2 Optimization of dyeing and mordanting conditions

To optimize dyeing conditions, irradiated cotton (RC) was treated with extract of tung leaves using varying values of time interval, temperature, pH, salt concentration and material: liquor ratio. Dyeing time was optimized by dyeing irradiated cotton (RC) fabric to dye for different time intervals of 30, 40, 60, 70 and 80 min. To study the effect of salt concentration, different concentrations of NaCl were added in the dyeing medium (2, 4, 6, 8 and 10 g/L). The tung leaves extract was used to dye irradiated cotton at 60 oC keeping the ratio of M: L 1:30 for 60 min. Varying concentration of NaCl salt (2, 4, 6, 8 or 10 g/100 ml) were added in the dye solution and cotton fabric was treated separately with each dye solution. The pH was optimized at 5, 6, 7, 8, 9 and 10. For the improvement of colour fastness and colour strength properties pre and meta-mordanting was performed. Alum, iron sulphate, Ferrous sulphate and lemon juice were used as pre- or meta-mordanting agents. The cotton fabrics were treated separately with various concentrations (1, 3, 5, 7 or 9%) of each of above mentioned chemicals [15]. The fabric was dried and then dyed at optimum conditions. On completing dyeing process, the fabric was washed with water and dried.

2.3 Evaluation of quality characteristics of dyed fabrics

The colour strength values of un-irradiated and irradiated dyed fabrics were investigated by CIE lab system using the Spectra flash (SF 660) at Chemistry Division, FRI, Dehradun, India. Colour fastness to washing of the dyed fabric samples was determined as per IS: 764 – 1984 methods using a Sasmira launder-O-meter following IS-3 wash fastness method. The wash fastness rating was assessed using grey scale as per ISO-05-A02 (loss of shade depth) and colour fastness to exposure to light was determined as per IS: 2454- 1984 method. The sample was exposed to UV light in a Shirley MBTF Microsal fade-O-meter (having 600 watt Philips mercury bulb tungsten filament lamp simulating day light) along with the eight blue cotton standards (BS1006: BOI: 1978). The fading of each sample was observed against the fading of blue cotton standards (1-8). Colour fastness to perspiration [16] assessed according to IS 971-1983 composite specimen was prepared by placing the test specimen between two adjacent pieces of cotton fabric and stitched all among four sides.

3. Results and discussion

Exposure of tung leaf powder and cotton fabrics to different doses of gamma radiations (5, 10, 15, 20 and 25 kGy) had varying effects on colour strength of cotton fabrics (Fig. 2). Gamma ray treatment of 15 kGy proved to be most effective in improving colour strength of cotton fabrics dyed with tung leaf extract compared with other doses. Gamma ray treatment of 15 kGy produced significant modifications on surface of fabric. That upon dyeing showed firm interaction with dye molecules and this interaction was confirmed by investigation of fabric in CIE Lab system. It seemed that below 15 kGy, the surface of fabric cellulose units were not properly activated for dyeing, while at higher doses of gamma radiations, fabric might be either degraded or its fibres might face dislocation [17]. Due to this degradation of actual colourant, molecules might show less absorbance on fabric and upon investigation showed low colour depth. During extraction process gamma ray caused more interaction with colourant in alkaline media as compared to aqueous or alcoholic [18], [19]. Previously, it was found that gamma ray treatment of dye powder improved colour extraction without harming its physiological characteristics [20], [21]. The same effects of gamma radiations were observed in our studies. The values given in Figs. 2-4 showed that an absorbed dose of 15 kGy produced darker shades.

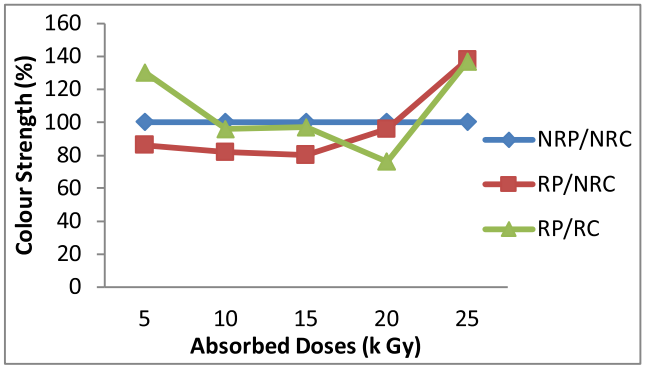

Figure 2. Effect of gamma radiations on colour strength of cotton fabric dyed with aqueous extract of tung leaves (NRP/NRC ¼ Non-radiated powder/Non-radiated cotton; RP/NRC ¼ Radiated powder/Non-radiated cotton; RP/RC ¼ Radiated powder/ Radiated cotton)

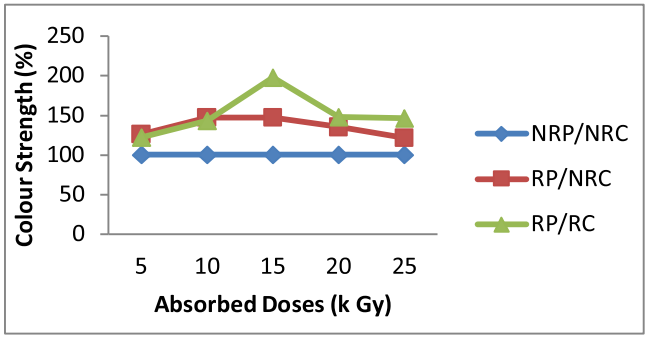

Figure 3. Effect of gamma radiations on colour strength of cotton fabric dyed with alkali solubilized extract of tung leaves (NRP/NRC ¼ Non-radiated powder/Non-radiated cotton; RP/NRC ¼ Radiated powder/Non-radiated cotton; RP/RC ¼ Radiated powder/ Radiated cotton)

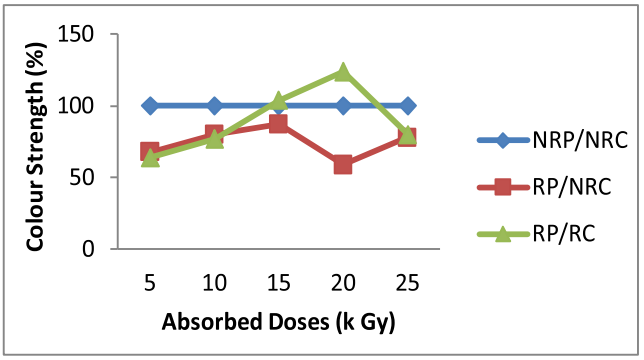

Fig. 4. Effect of gamma radiations on colour strength of cotton fabric dyed with alcohol solubilized extract of tung leaves (NRP/NRC ¼ Non-radiated powder/Non-radiated cotton; RP/NRC ¼ Radiated powder/Non-radiated cotton; RP/RC ¼ Radiated powder/ Radiated cotton)

At this dose, the fabric surface might be evenly modified and sorbed dye molecules. Hence, 15 kGy was the optimum absorbed dose for extraction of the colourant and surface modification of fabrics. Dyeing of irradiated fabric (RC, 15 kGy) using alkali extracts of irradiated red calico leaves powder (RP) was found to be temperature dependant (Fig. 4). The data revealed that colour strength values were different at temperatures like, 30, 40, 50, 60, 70 and 80 oC, respectively. The dyeing uptake ability evaluation of irradiated fabric (RC, 15 kGy) using alkali solubilized extract showed that at 60 oC, the dye molecules rapidly rushed onto modified fabric, while, at low temperature, dye molecule might sorbed slowly, which upon investigation by spectra flash showed dull shades [22]. Above 60 oC, the colourant might face hydrolytic degradation and other impurities got a chance to sorb at surface of fabric causing unevenness and dull shades. Hence, 60 oC was the optimum temperature of dyeing of cotton fabric with tung leaves extract.

The data given in Fig. 6 revealed that less colour strength was produced when cotton fabrics were dyed for shorter time (less than 60 min). Maximum colour strength was obtained at 60 oC, when dyed for 60 min. Initially in the start, dye rate was low, while after increasing dyeing time, surface modified fabric showed better uptake of dye. Dyeing for longer time might have shifted more colourant from irradiated cotton fabric to dye bath. So the rate of desorption became high and low strength was observed. The study also indicated that gamma ray treatment of fabric as well as dye powder was time effective. The pH of dye solution had varying effects on colour strength of cotton fabric dyed with alkali extract of tung leaves powder (Fig. 7). The data revealed that in alkaline media, the colourant might be sorbed more onto irradiated cotton (RC, 15 kGy) which was also confirmed by extraction process. Hence, the dyeing was significantly and evenly found onto irradiated fabric (RC) using the dye bath of neutral pH (7.0). The low colour strength in the acidic medium can be explained by the fact that, at acidic pH, the colourant might be in ketonic form. In basic media, the enolic form of colourant might have favoured interaction with gamma treated fabric resulting good colour strength. Also

under alkaline conditions, it might be possible that the dissociation of hydroxyl group lowered the exhaustion resulting in less colour strength [23]. At neutral pH (7.0), extract gave maximum colour strength and upon investigation in spectra flash showed darker shades. Exhausting agents (salts) had been reported to play a vital role in improving colour strength of fabric dyed with natural colourants [24], [25]. Using appropriate amount of exhausting agent, leveled dyeing could be achieved as showed in Fig. 7. The data showed that 6 g/L of table salt gave deeper and darker shades. Hence, optimum amount of salt for dyeing cotton fabric with colourant extracted from tung leaves was 6 g/L. Gamma radiation treatment reduced the amount of exhausting agent used in dyeing. Results displayed in Fig. 8 showed that irradiated fabric required less amount of pre-mordant to produce good colour strength and acceptable fastness properties.

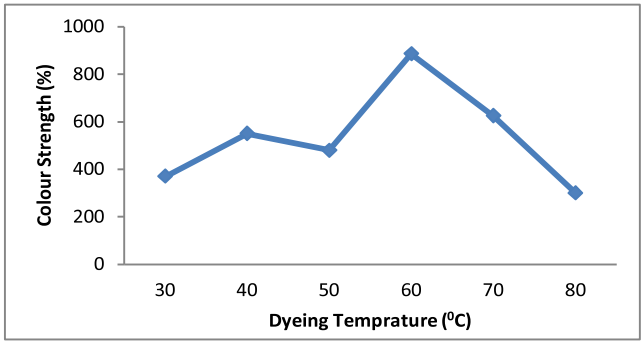

Figure 5. Effect of dyeing temperatures on colour strength value of irradiated cotton fabric dyed with alkali solublized extract of tung leaves

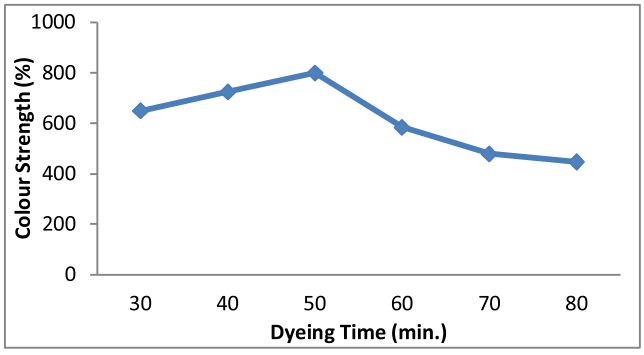

Figure 6. Effect of varying dyeing time on colour strength value of irradiated cotton fabric dyed with alkali solublized extract of tung leaves

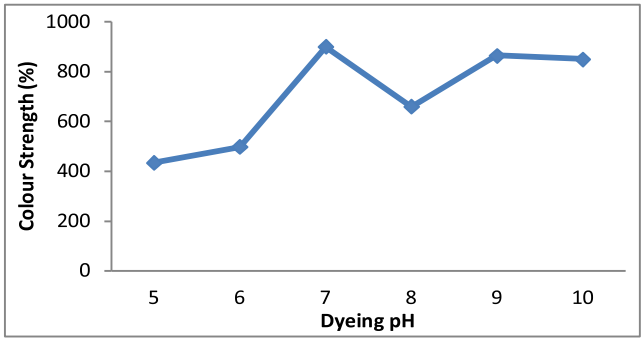

Figure 7. Effect of dyeing on colour strength value of irradiated cotton fabric dyed with alkali solublized extract of tung leaves

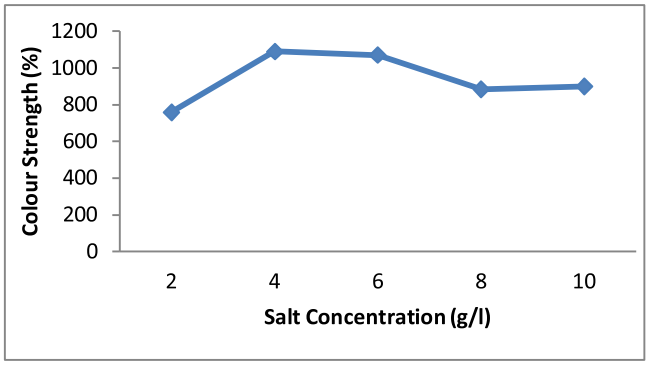

Figure 8. Effect of salt concentration on colour strength of irradiated cotton fabric dyed with alkali solubilized extract of tung leaves

The pre mordanting experiments revealed that cotton fabric mordanted with 1% ferrous solution showed better effects on colour fastness compared with other pre mordanting agents. The more colour strength might be due to stable dye complex formed on the fabrics [26]. In meta-mordanting, 1% lemon juice proved to be more effective in improving colour shade of cotton fabrics than that of other meta-mordants used (Fig. 10). Hence post mordanting with 1% lemon juice was the best mordant for improving colour strength and colour fastness properties.

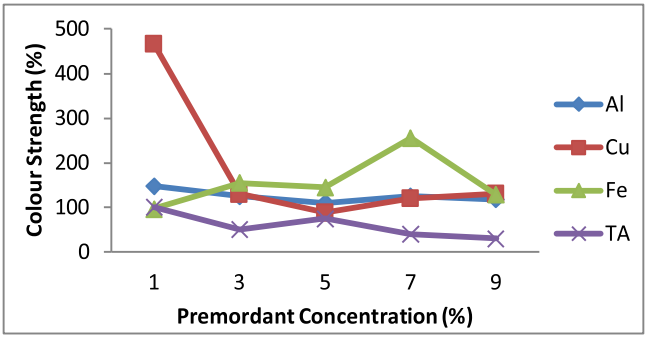

Figure 9. Effect of pre-mordants on colour strength value of cotton fabric dyed with tung leaves

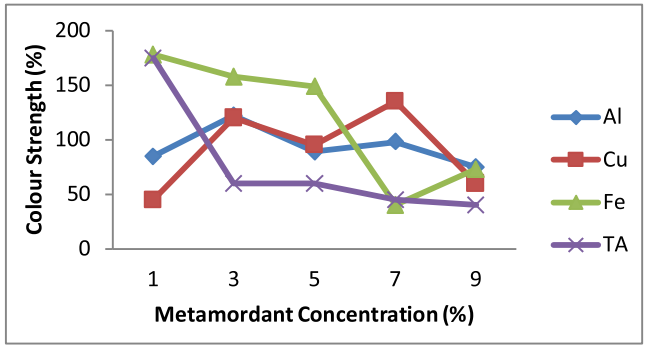

Figure 10. Effect Meta-mordants on colour strength of cotton fabric dyed with tung leaves extract

The rating results of colour fastness given in Table 1 showed that these properties has been improved by dyeing followed by mordanting the irradiated fabric using extract of irradiated powder at optimum conditions. The washing fastness of dyed irradiated fabric showed that mordanting improved the rating

from poor to good. This was attributed to metal dye complex formation onto irradiated fabric through covalent bond formation, when these mordanted fabrics were exposed to detergents did not detach. It was the case observed during rubbing fastness and light fastness. The good rating also attributed to process of conjugated system found in colourant.

Table1. Effects of gamma radiation on colour fastness properties of irradiated fabric using optimum extract

Optimum dyeing conditions	Washing fastness	Light fastness	Rubbing fastness	
			Dry	Wet
NRP/NRC (Control)	2-3	3	3	3
Extraction (RP/RC, 15 k Gy)	4	3-4	4	4-5
Dyeing Temperature (60^0C)	4	4	4	4-5
Dyeing Time (min.)	4	4	4	4
Dyeing pH (7.0)	4	4	3-4	4
Salt Concentration (4 g/l)	3-4	3-4	4	4
Pre-mordant (1% Fe)	3-4	4	4	4
Meta-mordant (1% lemon juice)	3-4	3-4	3-4	4

Finally, through bonding those agencies, no or little effect on shade permanency was observed [27], [28]. At optimum conditions, gamma ray treatment improved the rating of colour fastness from poor to good for light [29], better for washing and excellent for rubbing.

4. Conclusions

On the basis of the results of the present studies it can be concluded that,

(1) The dye can be best extracted from irradiated powder of tung leaves (RP, 15 kGy) using alkaline medium.

(2) Good colour strength is obtained by dyeing irradiated fabric (RC,15 kGy) with tung leaf extract at 60 oC for 60 min by maintaining pH of the dye bath at 7.0 using electrolyte concentration of 6 g/L as exhausting agent.

(3) Ferrous sulphate (1%) and lemon juice (1%) are the best pre and meta-mordanting agents respectively to improve the colour strength as well as colour fastness properties of irradiated cotton fabric using dye extracted from tung leaves.

(4) Use of gamma radiations particularly, 15 kGy dose can be helpful in improving colour fastness by inducing surface modification of cotton fabric.

5. Acknowledgement

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Structure and Properties of Vortex-Spun Yarns & Fabrics- A Review

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Abstract
Murata Vortex Spinning (MVS) system, which is a modified version of air-jet spinning technology, gathers attractions as a promising system in the new spinning systems. This system is claimed to be capable of producing yarns which have a ring-spun like appearance and higher tenacity due to higher number of wrapping fibres when compared with the previous air-jet spinning systems. The first vortex spinning machine the Murata MVS 810 was exhibited at Osaka International Textile Machinery Show in OTEMAS. Subsequently, Murata introduced its third generation vortex spinning machine, Vortex III 870. In this machine, Spinning Tension Stabilization (STS) System is used to obtain consistent and reliable yarn quality. With continuous developments, they have achieved a maximum speed of 550 m/min. with the VORTEX 870 EX. In this article, the general evaluation of MVS system along with information about MVS yarns and fabrics has been presented.

Keywords: *Air jet, Delivery speed, MVS yarns, Nozzle air pressure, Vortex spinning*

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1. Introduction

The latest development in air-jet spinning systems, vortex spinning seems to be a promising technology due to its high productivity, low production cost and especially its suitability for the spinning of 100% cotton yarns. This system is claimed to be capable of producing yarns which have a ring spun-like appearance and higher tenacity due to higher number of wrapping fibres when compared with the previous air-jet spinning systems [1-2]. The low yarn hairiness is the most outstanding feature of vortex-spun yarns. Fabrics produced from vortex-spun yarns have advantages in terms of abrasion resistance and pilling propensity over those made from ring-spun or open-end rotor-spun yarns.

The first vortex spinning machine the Murata MVS 810 was exhibited at Osaka International Textile Machinery Show at OTEMAS'97. The machine had a delivery speed of up to 400 m/min. The modified version of this machine, MVS 81T, was developed to produce twin vortex-spun yarns. After that, Murata exhibited a new version of vortex spinning machine, the MVS 861. This version allowed the spinning of core yarns and achieved higher delivery speeds of up to 450 m/min. Murata introduced its third generation vortex spinning machine, Vortex III 870. In this machine, Spinning Tension Stabilization (STS) system is used to obtain consistent and reliable yarn quality with a maximum production speed of 500 m/min. Subsequently, Murata introduced a new model VORTEX 870 EX, realizes high-speed spinning at 550 m/min (max.) & wider count range of about 10s-80s Ne as shown in Figure 1. In this machine, Murata has improved its splicing & doffing capacity by developing splicer carriage & auto doffer respectively, which contributes to the high speed production.

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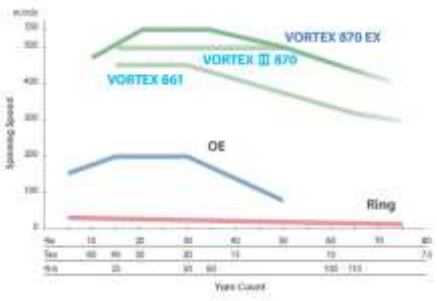

Figure 1 Productivity of spinning technologies [1]

2. Vortex spinning system

2.1 Principle of yarn formation mechanism

The spinning unit of MVS is shown in Figure 2 [2]. In MVS, a drawn sliver is fed to a four-line drafting system. The drafted fibres delivered from the drafting unit then pass through the nozzle block. The nozzles in the nozzle block induce swirling air currents to twist the fibre bundle. The nozzle block also contains a needle holder with a twisting guide surface which gently twists around the longitudinal axis of the needle holder. The nozzle block is followed by a hollow spindle through the inlet of which the guide member is projecting. The fibre bundle is converted into yarn while passing through the hollow spindle. The finished yarn is wound onto a package after the yarn cleaner has removed any defects. The principle of vortex spinning and the nozzle block in MVS are illustrated in Figure 3 & Figure 4 respectively [3].

When the fibre bundle leaves the front rollers of the drafting zone, the fibres are sucked into the passage through the air stream created by the nozzles. As the cross sectional area of the fibre bundle passage gradually decreases, fibres are held together more firmly as they move towards the needle-like guide member. Subsequently, the fibre bundle is caused to turn around the guide member as the bundle moves towards the hollow spindle and is twisted by the swirling air current provided by the nozzle.

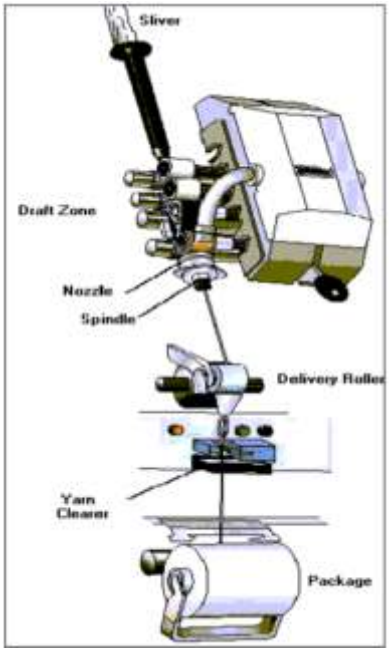

Figure 2 Spinning unit of Murata Vortex Spinner [2]

This twisting motion tends to flow upwards towards front rollers of the drafting unit; however, the guide member protruding from fibre bundle passage prevents this upward motion. Therefore, the upper parts of some fibres are kept open as they depart from the nip line of front rollers. At this stage, while the leading ends of most of the component fibres of the fibre bundle are drawn into the hollow spindle by the preceding portion of the fibre bundle being formed into the yarn, trailing ends of some fibres exposed to the swirling air current are separated from fibre bundle and thereby twine over the spindle. They are then caused to wrap around core fibres to form a yarn like a real twisted spun yarn as they are drawn into the spindle. The finished yarn is wound onto a package after any defects present are removed [3-4].

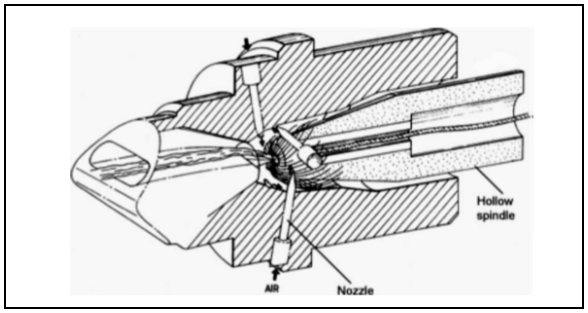

Figure 3 Principle of vortex spinning [3]

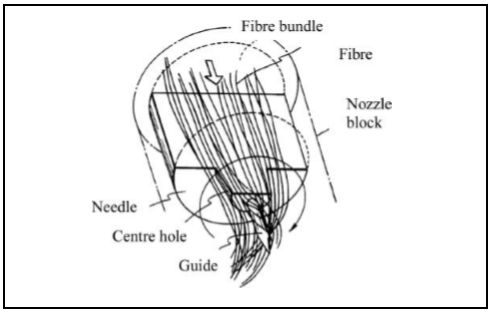

Figure 4 Nozzle block [3]

2.2 Structure of vortex-spun yarn

As a fasciated yarn, vortex-spun yarn is composed of an untwisted core of parallel fibres held together by wrapper fibres. The yarns obtained in MVS, which uses only one modified air jet is stated to differ from jet-spun yarns produced on the Murata Jet Spinner with respect to the number of wrapper fibres. Since fibre separation occurs everywhere in the outer periphery of the fibre bundle, a higher number of wrapper fibres are obtained with the vortex-spun compared with jet-spun yarns as shown in Figure 5 and Figure 6. This leads to the production of a spun yarn with more of a ring-spun-type appearance and also with higher tenacity [5-6].

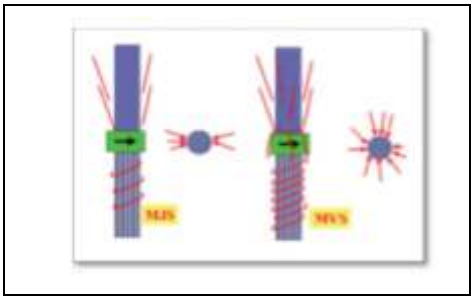

Figure 5 Wrapping fibres in MJS and MVS [5]

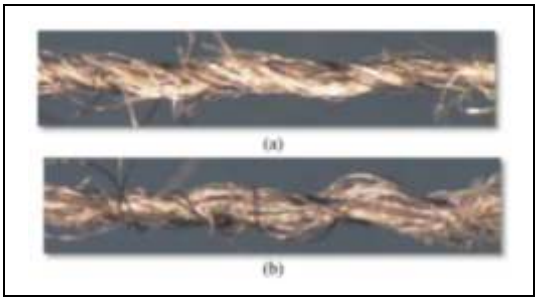

Figure 6 (a) MVS yarn; (b) MJS yarn [6]

Fibre alignment and migration behaviour examined in 100% carded cotton vortex-spun yarns by using a tracer fibre technique combined with image analysis [7]. According to the results of fibre configuration classification, the percentage of straight fibres, trailing hooked fibres and the fibres hooked in both ends were found to be similar and higher than that of the leading hooked, entangled and looped fibres in vortex-spun yarns as shown in Table 1.

Table 1 Fibre configuration in vortex-spun yarn

Class	% of fibres
Straight	20.50
Hooked(leading)	23.00
Looped	10.25
Straight	20.50
Hooked(leading)	23.00
Looped	10.25

After using tracer fibre technique for structural analysis of polyester–cotton yarn samples and observing the fibre configuration in vortex-spun yarns, four types of structural classes of MVS yarns was observed, as shown in Figure 7 and

concluded that vortex-spun yarns have about 50–60% core fibres and the remaining is wrapper or wild fibres [8].

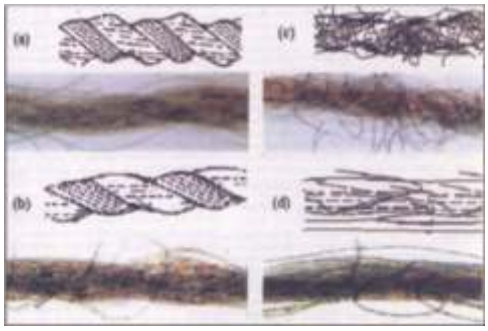

Figure 7 Four types of structural classes of MVS yarns: (a) Class 1, (b) Class 2, (c) Class 3,(d) Class 4[8]

The structure of vortex-spun yarns is classified into four main categories as:

Class1: It has a core of parallel fibres, which is tightly wrapped by a ribbon of fibres. Many sections of this class include crimped core, as the yarn structure consists of almost 50% core fibres and 50% wrapper fibres, and they form troughs and crests along yarn length.

Class 2: It is similar to the Class I structure, but with long regular wrappings. The core and wrapper fibres form troughs and crests alternately.

Class3: It has a core of parallel fibres wrapped by fibres at varying angles. In this class, yarn sections with very low proportions of wrapper fibres or loose wrappings also exist.

Class 4: It has no wrapper fibres. In this class, core fibres are generally untwisted but yarn sections with some residual twist are observed.

Vortex-spun yarn structure was also studied in comparison with ring and open-end rotor-spun yarns by using a tracing fibre technique [9-10]. Apart from core and wrapper fibers, the fibre arrangements were classified as wild, wrapper-wild and belly-band as illustrated in Figure 8.

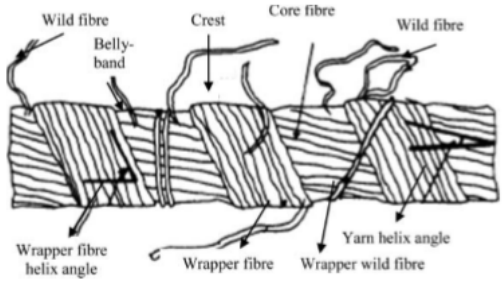

Figure 8 Schematic diagrams of fibre types in yarn structure [9]

3. Properties of vortex-spun yarns

3.1 Tensile properties & breaking elongation

It was reported by many researchers [9-11] that the tenacity of vortex-spun yarns is almost equal to 88% of the tenacity of ring-spun yarns, while the tenacity of open-end rotor-spun yarns is around 75%. The results of other studies also revealed that the tenacity of vortex spun yarns is lower than that of conventional and compact ring-spun yarns, and higher than that of open-end rotor-spun yarns [12-13].

Vortex-spun yarns is expected to exhibit higher tenacity values than jet-spun yarns for every blend ratio of cotton and polyester but not for 100% polyester, where yarns spun on both systems have the same tenacity. As the cotton content increases in the blend, the difference between tenacity values of yarns also increases. With regard to breaking elongation, it is observed that vortex-spun yarns have lower breaking elongation and this off sets the gains in tenacity and results in insignificant differences in their work-to-break values. The higher tenacity of vortex-spun yarns was attributed to the higher number of wrapper fibres compared with jet-spun yarns by researchers. The number of wrapper fibres was stated to be critical for yarn tenacity, since they hold the internal parallel fibre bundle tightly together, and this effect was stated to be more critical for cotton fibres. According to researchers, the number of wrapper fibres depends on the fibres at the edge of yarn in jet spinning. However, in the vortex spinning system, fibre separation from the bundle occurs everywhere in the outer periphery of the bundle, and therefore a higher number of wrapper fibres are obtained in vortex-spun yarns [3].

It was also confirmed that breaking force of vortex-spun yarns is lower than that of conventional ring-spun and compact yarns. The breaking elongation values of spun yarns obtained by different systems also varies due to their unique structures [14]. Although the breaking elongation of vortex-spun yarns is expected to be lower due to the presence of wrapper fibres that prevent fibre slippage, it was found to be higher [11] than conventional ring-spun, compact and open-end rotor-spun yarns in some of the studies [12]. The lower breaking elongation of vortex-spun yarns was attributed to decrease in fibre slippage due to better grip by wrapper fibres.

3.2 Yarn evenness and imperfections

The comparative studies on different spinning systems generally revealed that more even yarns are obtained in the vortex spinning system compared with jet-spinning and open-end rotor-spinning systems; however, vortex-spun yarns are worse than the conventional ring-spun and compact yarns in terms of yarn evenness [6, 11 & 14].

It was concluded in earlier studies that the number of thin places in vortex-spun yarns is lower than for open-end rotor-spun yarns and higher than for conventional and compact ring-spun yarns [9, 11–14].

In terms of the number of thick places and neps, the results obtained in earlier studies are not consistent. Vortex-spun yarns are better than open-end rotor-spun yarns and worse than ring-spun yarns in terms of the number of thick places and neps [11]. On the other hand, a higher frequency of thick places and neps was observed in 100% cotton vortex-spun yarns when compared with ring and open-end rotor-spun yarns [9, 12]. The number of thick places in 100% cotton vortex-spun yarns is lower, and the number of neps is higher

when compared with conventional ring and compact ring yarns. On the other hand, some researchers [11–14] reported that the number of thick places in 100% viscose rayon vortex-spun yarn is lower than for open-end rotor-spun and compact ring-spun yarns, and the lowest level of neps is observed in vortex-spun yarns.

In addition, vortex-spun yarns have fewer thick places than jet-spun yarns, whereas no significant difference between jet-spun yarns and vortex-spun yarns with regard to the number of thin places and neps. Others reported that the difference between the number of thin places and thick places between the ring-spun and vortex-spun yarn samples in counts of 30s Ne was not statistically significant, but that significant differences did occur in finer yarn counts.

3.3 Yarn hairiness

The most outstanding feature of vortex-spun yarns is claimed to be their low hairiness in comparison with yarns spun on other systems. Vortex-spun yarns have lower hairiness compared with jet-spun yarns [6]. When compared with conventional ring, compact and open-end rotor spinning systems, the yarns spun on the vortex spinning system were observed to exhibit lower hairiness due to uniformly distributed layer of wrapper fibres [9, 11-14].

3.4 Yarn bulk & rigidity

The diameter of vortex-spun yarn is generally higher and the density is lower when compared with those of compact-spun yarns for 100% cotton, 100% regenerated cellulose fibres and their blends. Due to the untwisted core fibres, the bending rigidity of vortex-spun yarn is also higher than ring-spun and rotor-spun yarns. Moreover, the bulkiness and higher resistance of wrapper fibres make vortex-spun yarns less compressible [9, 14].

4. Properties of fabrics made from vortex-spun yarns

4.1 Fabric strength

The performance of 100% viscose rayon vortex-spun was compared with conventional ring-spun, compact and open-end rotor-spun yarns in knitted fabrics. The results revealed that the lowest bursting strength is obtained from the fabrics knitted from open-end rotor-spun yarns in both undyed and dyed forms, whereas the fabric knitted from ring-spun yarns has the highest bursting strength in undyed condition and the fabric knitted from compact ring-spun yarns has the highest bursting strength in the dyed condition. These results are consistent with the tenacities of the related yarns, where compact ring spun and conventional ring-spun yarns have higher tenacities than vortex-spun yarns, since most of the fibres are axially positioned along the axis of yarn by means of real twist and this improves the tenacity of the yarn. Some researchers also found that the fabrics knitted from ring-spun yarn have the highest bursting strength due to its high tenacity and uniformity, and the bursting strength of the fabrics knitted from vortex-spun and open-end rotor-spun yarns were ranked in order of the tenacity values of the yarns. Fabric knitted from vortex-spun yarn had lower bursting strength than its conventional and compact ring-spun counterparts at all tightness levels; the tenacity of the yarns used in the fabrics was directly reflected in their bursting strength behaviour [11-13].

4.2 Abrasion resistance

Fabrics knitted from ring-spun yarns have low abrasion resistance where as the fabrics knitted from vortex-spun and open-end rotor-spun yarns have higher abrasion resistance. The fabric samples knitted from vortex-spun yarns generally have the highest abrasion resistance in both undyed and dyed forms. In both studies, high abrasion resistance of the fabrics made from vortex-spun yarns was attributed to the existence of wrapper fibres, which resist the movement of tightly packed parallel core fibres in yarn structure during abrasion. In accordance with these findings, the average mass loss values in abrasion of both grey and dyed fabrics knitted from vortex-spun yarns are generally lower than that of the fabrics knitted from ring-spun and open-end rotor-spun yarns [11, 13].

On the other hand, cotton fabrics knitted from compact ring-spun yarns are more abrasion-resistant when compared with ring-spun and vortex-spun yarns, and the fabrics made of vortex-spun yarns have the worst abrasion resistance, although the hairiness of vortex-spun yarns was found to be the lowest during yarn tests. The possible reason for this result was explained by the fact that the grip of wrapper fibres in vortex-spun yarn may not be strong enough to resist abrasive forces during testing [12].

4.3 Pilling propensity

A comparative analysis revealed that the fabrics knitted from vortex-spun yarns exhibit less pilling tendency than the fabrics knitted from conventional and compact ring-spun yarns. Moreover, the fabrics knitted from open-end rotor-spun yarns are usually considered to have lower pilling tendency due to belt fibres in its structure; however, these fabrics cannot achieve the results obtained by the ones knitted from vortex-spun yarns. Fabrics knitted from open-end rotor-spun yarn have higher pilling rate than its vortex counterpart, since vortex-spun yarn has longer wrapped fibre zones along the yarn with less protruding fibres. Consequently, pilling test results obtained by others confirmed that pilling propensity decreases with decrease in hairiness of yarns [11-13].

4.4 Fabric thickness, compressional properties and fabric handle

Wool–polyester woven fabrics made from vortex-spun yarns are relatively heavier and thicker than fabrics made from ring-spun and open-end rotor-spun yarns due to higher bulkiness and this is reflected in greater fabric weight and thickness. In addition, fabrics woven from vortex-spun yarns were found to have higher shear rigidity when compared with the fabrics woven from ring-spun yarns [9].

The effect of spinning systems and twist direction of folded cotton yarns on the handle properties of woven fabrics. Yarn liveliness, bending properties, stiffness and drape angle were

measured and surface properties, such as friction co-efficient of fabrics, as the components of the fabric handle. The results revealed that applying twist in opposite direction in folded yarns resulted in lower yarn liveliness for all yarn samples. In addition, folded vortex-spun yarns were found to have the highest twist liveliness in both directions; however, the differences were not statistically significant.

Fabrics produced with folded vortex-spun yarns were observed to have the highest value of bending rigidity and the highest value of stiffness in all types of fabrics regardless of the plying twist direction. The high bending rigidity of fabrics woven from vortex-spun yarns was attributed to high bending rigidity of vortex-spun yarns. The high stiffness of fabrics woven from vortex-spun yarns was correlated with high twist liveliness of yarns. In addition to yarn liveliness, a high correlation between bending rigidity and stiffness was also found [9, 15].

With regard to surface properties, it was observed that fabrics produced with rotor spun yarns gave the lowest values in tests and this may be due to the fact that rotor-spun yarns are bulkier than ring-spun and vortex-spun yarns [15].

5. Effects of processing parameters on the structure and properties of vortex-spun yarns

Effects of some spinning parameters like Nozzle air pressure, Yarn delivery speed, Distance between front roller nip point and spindle & Draft, that affect the structure and properties of vortex-spun yarns are also considered in this article [7, 8, 16 & 26]:

5.1 Effect of nozzle air pressure

There are many studies concerning the effect of nozzle pressure to the vortex spun yarn. These studies reveal that the nozzle air pressure directly influences the fiber configuration and hence yarn structure, which in turn affects yarn properties in the vortex spinning system [7, 8, 16–23]. Increasing velocity inside the nozzle block is stated to enhance the expanding effect on fibre bundle that results in more wrapper fibres. On the other hand, when the nozzle pressure is too high, the separated fibres are easily taken out of the fibre bundle by high-speed airflow, which produces more wild fibres and causes more fibre loss, and reduces the uniformity of the vortex-spun yarn [16-17].

Some researchers observed that an increase in nozzle air pressure results in an increase in tight wrappings, which were classified as Class 1 structure, while the long wrappings (Class 2 structure) and the proportion of unwrapped sections (Class 4 structure) decrease with increase in nozzle air pressure. However, these structures were observed to change into irregular wrappings (Class 3 structure) and wild fibres at a very high nozzle air pressure of 6kgf/cm2 [8].

The influence of nozzle air pressure on fibre configuration was also observed in vortex spun yarns and found that the mean migration intensity, which is defined as the rate of change in radial position of a fibre in yarns, is higher at higher nozzle air pressure. This results in the decreased diameter of yarn and the yarn becomes more compact due to an increase in the incidence of wrapper fibres and tight regular wrappings, and consequently the flexural rigidity of the yarn increases; in other words, the yarn becomes stiffer as the free movement of core fibres is prevented when higher nozzle air pressure is used in yarn preparation [7, 17, 19].

With regard to yarn hairiness, influence of increase in nozzle air pressure from 4 to 5kgf/cm2 on the structural classes of vortex-spun yarns results in obtaining lower hairiness up to a certain limit; however, hairiness increases due to increase in wild fibres at further increase in nozzle air pressure to the level of 6kgf /cm2. On the other hand, it was also found that hairiness of 100% carded cotton vortex-spun yarns shows a decreasing trend with increased nozzle pressure as a result of better wrapping due to the fact that whirling force of the nozzle air stream increases with increasing nozzle air pressure [20].

Some researchers observed continuously increasing trend in tenacity along with the increasing nozzle air pressure [20]. But according to others, despite the fact that the number of core fibres decreases with increase in nozzle air pressure, the increased tight wrappings and reduction in proportion of unwrapped sections result in improvement in tenacity; however, it was found that tenacity decreases at the nozzle air pressure of 6kgf/cm2 [18].

With regard to breaking elongation, increased tight wrappings with increase in nozzle air pressure caused lower breaking elongation, but the changes in the yarn structure with further increase in nozzle air pressure caused increase in breaking elongation.

The studies on vortex-spun yarns also revealed that yarn evenness and imperfections are affected significantly by the nozzle air pressure. The yarn evenness deteriorates, and the number of thin places, thick places and neps increases with increase in nozzle air pressure, which is mainly attributed to increase in fibre loss at higher pressure [18].

As far as the low-stress characteristics of polyester–cotton vortex-spun yarns are concerned, it was reported that increase in nozzle air pressure leads to improvement in structural integrity, increase in abrasion resistance, tensile energy, tensile and compressional resilience of vortex-spun yarns; however; they all deteriorate when the nozzle air pressure reaches 6kgf/cm2 [19].

5.2 Effect of yarn delivery speed

According to the theoretical analysis conducted by some researchers, higher delivery speed increases the width of migration wrapper fibre, and decreases the number of wrappings created by regular wrapper fibres. In addition, it was also observed that a smaller yarn diameter is obtained at lower delivery speeds, since the fibre bundle is exposed to the whirling force for a longer period and hence receives more twist. As a result of higher twist and more tight regular

wrappings, it was found that hairiness decreases as the yarn delivery speed is reduced. Moreover, all values regarding tensile properties of vortex-spun yarn decrease with increased delivery speed [3, 7, 13, 18, 20 & 27].

It was also observed that, yarn evenness deteriorates and the number of thin and thick places increases when a certain delivery speed is exceeded. On the other hand, it is found that the number of neps decreases as the delivery speed increases. Lower yarn delivery speed causes lower number of thick places and higher delivery speed deteriorates yarn physical properties in terms of yarn evenness, number of thin places and tenacity in viscose rayon vortex-spun yarns. The lower the delivery speed, the better the stated yarn properties [13, 18 & 20].

5.3 Effect of distance between front roller nip point and spindle

The distance between front roller nip point and spindle in the vortex spinning system was found to have impact on the amount of fibre loss and the number of wrapping fibres [8, 16, 17, 18, 21 & 27].

Some scientists reported that the fibre length and the distance between the front roller nip point and the inlet of the hollow spindle has a significant impact on the length of fibre situated in the yarn core. The core fibre length increases along with the increasing fibre length and shorter distance between the front roller nip point and the spindle. If this distance increases, the length of the fibre embodied into the vortex-spun yarn tail is expected to decrease so does the critical angular velocity of the fibre with open trailing end. Therefore, the leading ends of the fibres are more easily pulled out from the vortex-spun yarn tail, which results in increased fibre loss and more thin places in yarn.

Moreover, it was observed that increase in the L distance results in an increase of negative pressure at the inlet of the nozzle block, which allows the drafted fibre bundle to successfully enter the twisting chamber. On the other hand, while increase in L distance increases the number of open-trail-end fibres, it causes a decrease in the tangential velocity inside the nozzle block, which results in the weakening of the twisting effect of open trail-end fibres. Furthermore, the fibre bundle entering the twisting chamber can be easily disturbed by high-speed airflow when L distance is excessive [16-17].

5.4 Effect of Draft

The role of draft ratios on vortex-spun yarn properties was also investigated. Two levels of intermediate draft ratio, 2.3 and 2.5, and three levels of total draft ratio, 182, 216 and 267, were selected [26]. It was found that while working with high levels of total draft, i.e. using a heavy sliver, lower the intermediate draft, better are yarn evenness and thin place values obtained. Regarding tensile properties, the breaking elongation and work-to-break values were observed to be higher at an intermediate draft level of 2.5 in the case of the highest total draft (267); however, no significant difference was observed in terms of tenacity.

6. Summary

Vortex spinning technology produces a yarn with high function and fashion applicability. As a result of the higher number of wrapper fibres and a decrease in unwrapped sections, vortex-spun yarns have significantly better tensile properties, better evenness and lower hairiness than jet-spun yarns. The low yarn hairiness is the most outstanding feature of vortex-spun yarns. Fabrics produced from vortex-spun yarns have advantages in terms of abrasion resistance and pilling propensity over those made from ring-spun or open-end rotor-spun yarns; however fabrics from vortex yarn is attributed with higher air permeability and water vapour permeability and lower wicking values and spirality compared to fabrics from ring spun yarn.The system offers an alternative to ring spinning system in medium-fine count yarns in terms of productivity and total production cost.

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Designing Jacquard Woven Saree by Extracting and Synthesizing Elements of alpona Motifs

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Abstract:

Alpona which is basically an ephemeral art form practiced by the womenfolk from time immemorial, in almost every corner of our country. This painting style is very much popular in Bengali culture and is an integral component of every auspicious occasion or festival. Santiniketani style of alpona design have reached, over the years, with the different dimension in terms of contemporary style, types, measurements and placement of motifs, and use of vibrant colours. Although, alpona motifs are very much common in sarees printed with block, screen, batik or digital printing, jacquard woven sarees with alpona motifs are very scarce. In this work, a sincere effort has been made to work with alpona motifs of Bengal, in general and Santiniketan, in particular. The elements of Santiniketani alpona motifs have been extracted, modified as per need, and synthesized with the help of CAD software to develop feasible jacquard designs and layout for woven saree. After dyeing the cotton yarns with desired colours for warp and weft, the final saree was woven in a 200-hook handloom jacquard using the developed designs and layout. Jacquard woven sarees designed innovatively from alpona motifs, especially of Santiniketani style, can cater to the need of the people who are contemporary in style and traditional, too, and possess a great veneration to Tagore's Santiniketan.

Keywords: *Alpona, CAD, Handloom, Jacquard, Saree*

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1. Introduction

Alpona, the ephemeral drawings or ritual painting, is a sort of folk art which is a spontaneous expression of the artistic sensibility of people. It is an art form which conveys the past experience of the community and, at the same time, is very much contemporary in feeling. Mainly the womenfolk were involved in this folk art and have kept the art alive in this part of the subcontinent. Being conscious of the changing moods of the season, the changing cycle of the year is thus marked through their creativity.

Alpana, alpona or alimpan refers to traditional, sacred art form or painting done with hands and paint using white or colourful motifs. The paint used is mainly in the form of a paste of rice, flour or chalk. The word 'alpona' is derived from the Sanskrit word 'alimpana', meaning 'to plaster' or 'to coat with'. Traditionally, it was drawn before sunset by the women of the house [1, 2]. Alpona is also a traditional folk art of Bengal, which is mainly practised on various auspicious occasions as an integral part of Bengali culture and rituals. In Bengal, these finger-painted ephemeral drawings/motifs in the name of 'alpona' are intrinsically associated with religious austerity or rituals commonly called as brata or brotos or vrat performed by the women of rural Bengal during festival times for the well-being of the family [1, 3, 4].

Alpona art is an adornment or decoration having different names in different states of India: e.g., Alpona in Bengal, Murja in Odisha, Chaookpurna in Chhattisgarh, Aripan in Bihar, Rangoli in Karnataka, Mandana in Rajasthan, Sanskar Bharti in Maharashtra, Kolam in Tamil Nadu, Muggu in Andhra Pradesh, Aipan in Kumaon, Golam in Kerala, and Saathiya in Gujarat. Apart from the name, the designs, elements and colours also vary as per the region.

Figure 1.1.1: Typical motifs of traditional alpona of Bengal [3]

In Bengali culture, especially in Santiniketan there is huge practice of Alpona. Abanindranath Tagore was the pioneer of introducing this graphic tradition in Santiniketan with contemporary style. Santiniketani alpona drawings are quite

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different from those of other parts of Bengal and the subcontinent in terms of both elements of motifs and colours.

Figure 1.1.2: Some typical alpona motifs used in Bengali festivals and their elements [3]

Converting these hand-painted motifs into woven motifs and producing them in the hand-woven fabric is really a challenging job. The motifs being larger and more intricate, ordinary handlooms do not suffice due to their inherent limitation of figuring capacity. The same is true for the dobby operated handlooms. The only option is the handloom jacquards which are intended for weaving intricate designs with larger repeat size.

The main objectives of the present work were as under:

1. To study various alpona motifs of Bengal with special emphasis on Santiniketani alpona.
2. To extract various key elements/motifs of the alpona designs, and explore the possibilities of incorporating them in the jacquard woven design.
3. To synthesize the final designs for a jacquard saree by selecting some feasible elements of alpona designs and converting them into feasible jacquard designs with the help of CAD tools.
4. To develop the final jacquard saree with the synthesized alpona designs by choosing appropriate coloured threads for both the warp and weft to give the final product a gorgeous-yet-ethnic look.

1.1 Key elements in traditional alpona

In the composition of alpona design, various types of traditional objects are present as a motif or elements of motif. The motif can be derived from fish, flower, cutter, leaf, geometrical shapes etc. In traditional circular alpona various household and farming tools are found as the key elements such as bucket, pot, ladles, basket, hoe, wooden rack, sickles, ladder, dheki (a tool to de-husk rice), bonti (a curved blade made of iron attached to a wooden block used to cut vegetables and fish), etc. Various geometric shapes like triangles, squares, rectangles, circles or ovals are also used alone or in combination to represent houses, stables or kitchens. These are often grouped together along with pictograms of human or animal figures inside. Some of the typical motifs of the traditional alpona designs are presented in Fig. 1.1.1

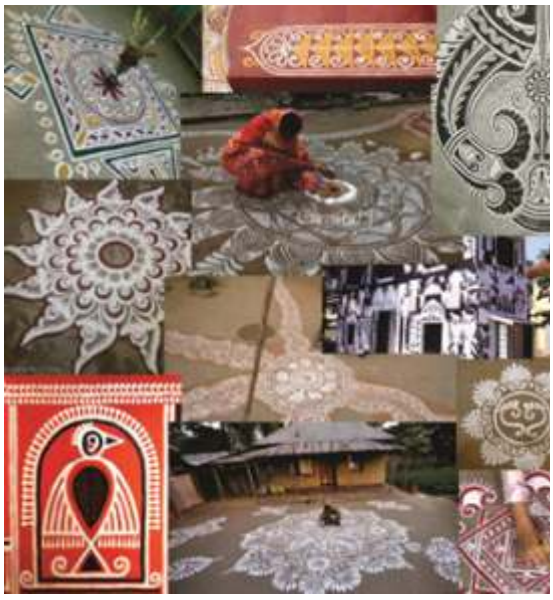

Figure 1.1.3: Some typical Santiniketani alpona designs [3]

Circular alpona is used as a holy pedestal during various festivals of Bengal namely Saraswati puja (Vasant Panchami), Durga puja, Diwali (the Festival of Lights). The typical elements include the sun, swastika, rice stem, owl, ladder, plough, footprints of the goddess Lakshmi, fish, betel, lotus, Shankhalata (snake), and sometimes just some abstract elements [3], which are shown in Fig. 1.1.2.

Santinikatani alpona designs, on the other hand, are contemporary in style and different from other varieties in terms of both nature of elements, their placements, often use of scale or measurements and use of different colours/hues. Fig. 1.1.3 shows some of the typical alpona designs of this genre.

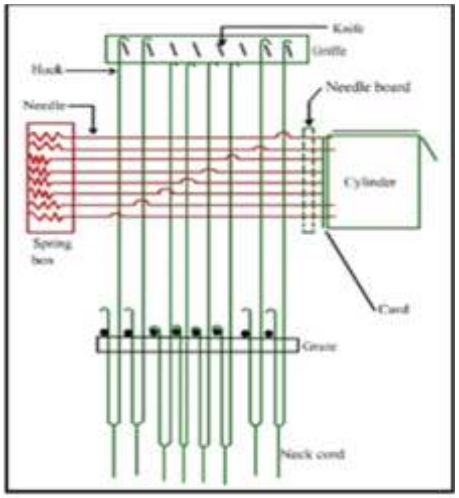

Figure 1.3.1: Side view of handloom jacquard (single-lift-single-cylinder) [6]

1.2 Overview of handloom jacquard

According to shedding devices, handlooms are classified into three categories: i) ordinary peddle/treadle operated handloom, ii) dobby (operated) handloom, and iii) jacquard (operated) handloom. Jacquard is a system or mechanism or a special attachment on the top of handloom/power loom to control individual warp threads to form the shed. It enables the looms to weave fabrics having intricate patterns with very large repeat size, such as damask, brocade, tapestry, home furnishings, blankets, quilts, towels, etc. The jacquard system was developed by Joseph Marie Jacquard of France in the year 1804-1805. This system utilizes the interchangeable punched cards to control the movement of the individual healds thereby controlling the weaving of cloth in such a fashion that any desired pattern can be obtained automatically [5, 6].

Figure 2.1.1: Inspiration motifs

Unlike other two categories, jacquard loom with the help of pattern cylinder and pattern/punched cards controls each and every warp thread individually by means of individual healds which in turn are controlled by the corresponding hooks, needles and knives. Only the upward movement of the warp threads/healds is controlled by the hooks, the downward movement is imparted by the reversing/under motion in the form of dead weights (commonly known as 'lingoes') attached at the bottom of each heald.

1.3 Working principle of handloom jacquard

A simplified handloom jacquard system is shown schematically in Fig. 1.3.1. For each pick of the design repeat, a pattern card is punched, and all such punched cards are laced serially to form a pattern chain which is placed over a pattern cylinder. In a particular punched card, a whole represents that the corresponding hook (and thus warp) will be selected (or lifted), and a blank represents deselection of corresponding hook (i.e., warp will be down) with respect to the corresponding pick. Vertical movement of the hooks are controlled by griffe knives which are, in turn, controlled by leg of the weaver through a paddle/treadle. When the griffe begins to move upward, the punched card along with the perforated cylinder is pressed against the needles. If there is a hole in the card, the needle directly opposite the hole will pass through it and in to the perforation of the pattern cylinder. The needle will not be depressed and the corresponding hook will be in original vertical position. The hook will thus be selected to be lifted by the griffe knife during its upward journey. The corresponding warp thread will also be lifted to form the top line of shed. On the contrary, if in the card there is blank opposite any needle, the needle will be depressed by the inward movement of the cylinder, which will deflect the associated hook to be disengaged with (deselected by) the knife and to be left down. The corresponding warp thread will also be left down and form the bottom line of shed.

1.4 Bengal sarees

The weaving of jacquard sarees is usually practiced at various places of West Bengal such as Santipur, Phulia, Nabadeep, to name a few. Presently, many thousand active weavers are found to involve in this business along with other stakeholders like active dealers, dyers, designers and supplementary support providers. Saree, Gamcha and Lungi are the primary products of Bengal handloom cluster and the predominance of these products still continues. Bengal Tant Saree is, needless to say, a significant wardrobe for Bengali women. Tangail, Jamdani, Korial, Baluchori, etc. are some of the age-old famous sarees of Bengal [7].

2. Methodology

There are two major steps of saree making, namely i) design development, and ii) product development.

Figure 2.2.1: Main design element created/synthesized

2.1 Inspiration and motif extraction/selection

In this study, Santinikatani alpona designs have been taken as the inspiration. After studying various designs of this genre, a typical design as shown in Fig. 2.1.1 has been chosen as the feasible design of inspiration, and its major element has been extracted or selected for further process.

Various sub-steps of design development process are as under:

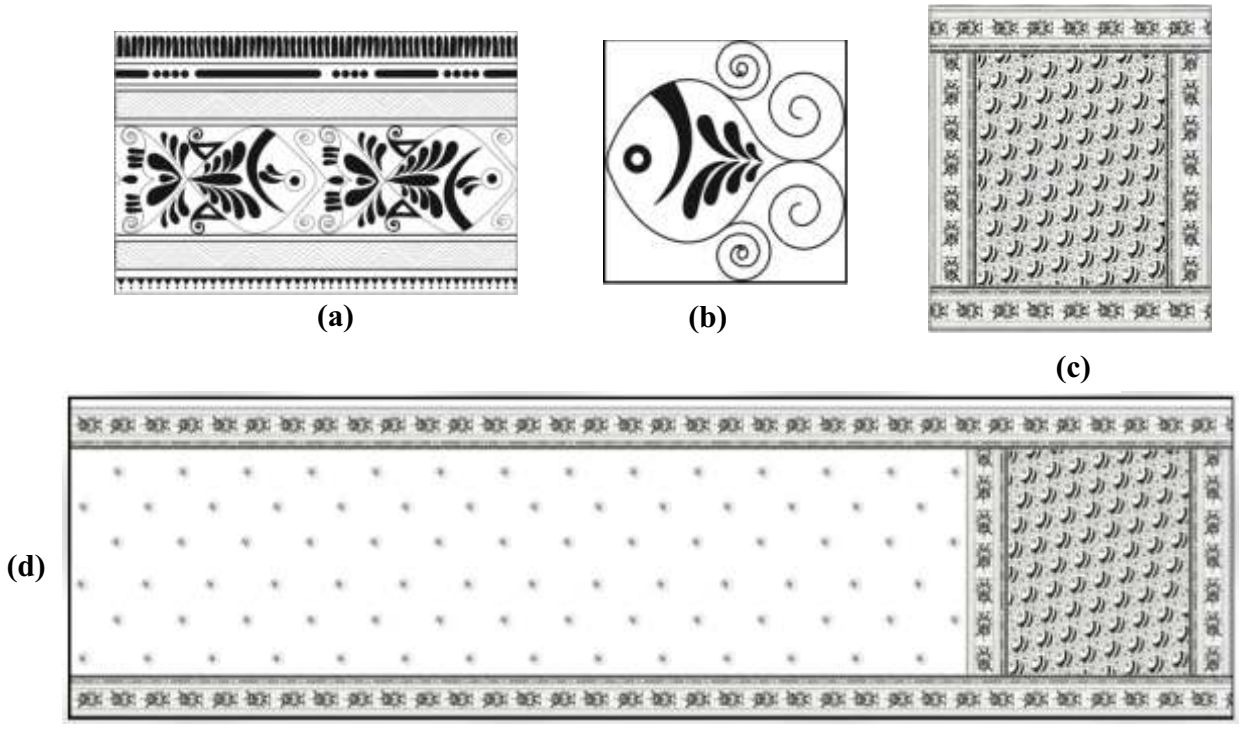

Figure 2.3.1: Concept drawings for (a) running border, (b) ground motif, c) anchal, (d) overall layout of the saree

2.2 Design modification

Taking the extracted motif as the inspiration, it has been modified a little bit and also other elements have been added to create the final designs feasible to be woven using 200-hook handloom jacquard. The key element of the motif that has been modified is given in Fig. 2.2.1.

2.3 Concept drawing

The concept drawings for the running border, ground motif (or buti), and anchal are shown in Fig. 2.3.1(a), 2.3.1(b), and 2.3.1(c), respectively, whereas Fig. 2.3.1(d) represents the overall view/layout of the saree. Concept drawings have been done using Corel Draw Graphic Suite X8 software. The dimensions of the three drawings were as follows:

Running border : width = 10.34 in, and height = 6.5 in
Ground motif/buti : width = 1.5 in, and height = 1.5 in

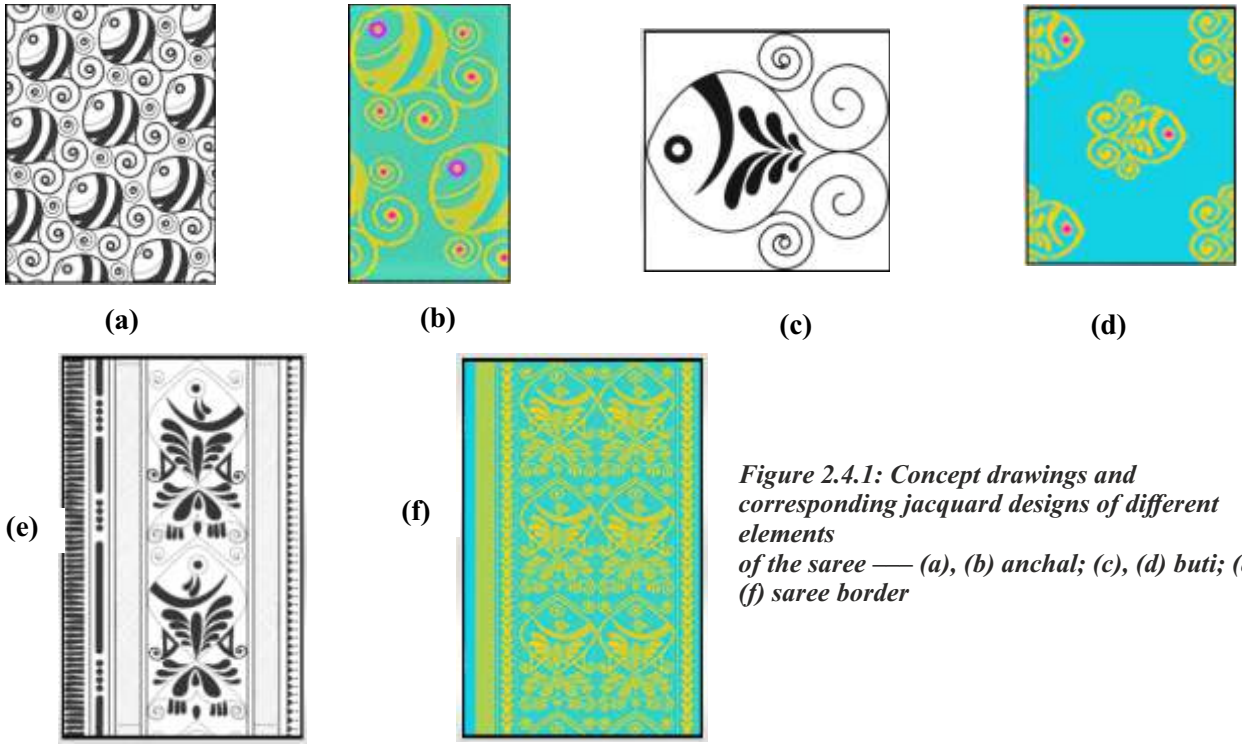

Figure 2.4.1: Concept drawings and corresponding jacquard designs of different elements of the saree —— (a), (b) anchal; (c), (d) buti; (e), (f) saree border

2.4 Development of textile design

The conversion of various concept drawings into corresponding jacquard designs has been performed with the help of Graph Master Software.

For anchal

Primarily, the concept was drawn in Corel Draw and it has been converted to jacquard design using Graph Master Software suitable for weaving using 100-hook capacity. The repeat size was kept as 100 x 186. For the binding, 7-end sateen was used for the ground of anchal, whereas 5-end sateen was chosen for the buti. Fig. 2.4.1(a) and 2.4.1(b) represent the concept drawing and the jacquard design of the anchal, respectively.

For buti

The concept drawing of buti to be used in the ground of the saree and the corresponding jacquard design are shown in Fig. 2.4.1(c) and 2.4.1(d), respectively. Here, the 5-end sateen weave has been chosen as the binding weave of the buti.

For border

The concept drawing for the saree border is given in Fig. 2.4.1(e), which has been manipulated a little bit as per the technical specification of the jacquard loom used. Fig. 2.4.1(f) shows the modified jacquard design for the saree border.

2.5 Conversion of textile design from concept

The component designs drawn using Corel Draw are converted into corresponding textile designs with the help of Graph Master keeping in mind the restriction of hook capacity/figuring capacity of the jacquard (maximum 200 hooks, in this case). The mono-chrome and the coloured textile designs are presented in Fig. 2.5.1 and Fig. 2.5.2.

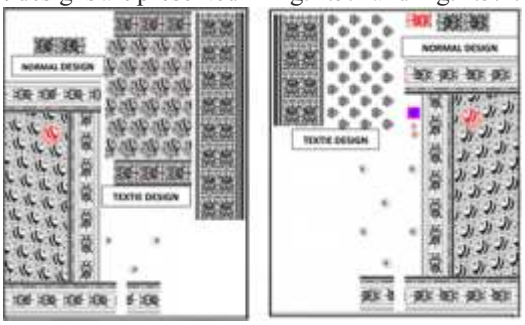

Figure 2.5.1: Final textile design of the saree from concept drawings in mono-chrome

Figure 2.5.2: Final textile design of the saree from concept drawings in multi-colour

3. Results and discussion

3.1 The making process of saree

For producing the saree in the jacquard, the below mentioned steps were followed, which are more or less common for making any kind of jacquard saree:

- Collection of grey yarns
- Dying of yarn as per the colour combination of the final product
- Winding of yarns - i.e., transferring of yarns from hank form to bobbins or pirns.
- Reeling of bobbins
- Warping - to form warp sheet from bobbins with the help of horizontal/sectional warping machine.
- Beaming - to form weavers' beam to be fed to the loom for weaving
- Drawing & denting as per the weaving plan of the designs to be produced
- Harness mounting for jacquard (each for body and border)
- Card Punching as per jacquard designs, and lacing to form chain of pattern cards
- Weaving
- On-loom finishing with indigenously prepared size paste/mixture

Figure 3.1.1: The saree is being woven in a pit loom with jacquard attachment

The saree as per the developed designs was woven in a traditional fly shuttle pit loom with single-cylinder-single-lift 200-hook jacquard shedding device (Fig. 3.1.1) at Nabadeep, Nadia District, West Bengal. The details of the loom specification are given in Table 3.1.1. The grey yarns as per requirement were collected from the local market of Nabadeep. After collecting the yarns, they were dyed in the tints of Tuntey, Golden, and Navy Blue using appropriate reactive dyes. Dyed yarns which were used as warp threads were subjected to sizing in hank form using indigenously prepared starch solution with sago, boiled rice and Khoi. The purpose was to form a thin film/coating of starch around the fine warp threads in order to make the yarn surface smooth thereby improving abrasion resistance and also imparting strength.

Table 3.1.1: Loom specification

Items	Description
Loom used	Handloom with jacquard attachment
Loom type	Pit loom
Shedding device	Jacquard
Mechanical jacquard system	Single cylinder single lift
Reed count	72^s Stockport
Total no. of hooks used	200
Total no. of heald shafts used	2 (for plain ground of saree)

Two types of packages were formed in the pre-loom activity using Charkha winding device: bobbins for the purpose of warping from dyed and sized yarns, and Noli (i.e., pirn) as weft packages from the unsized dyed yarns. Warping was done using wooden horizontal/sectional drum warping m/c and a wooden peg creel. After getting the weaver's beam, it was fed to the specified handloom with jacquard attachment with 200-hook capacity. In the drawing/drafting operation, warp yarns for the body of the saree were drawn 2 ends per heald eyes. Since, ground of the sarees is always woven using plain weave, so warp threads were drawn in straight pattern. The extra figuring warp threads meant for the designs in saree border and body were drawn through the harness cords of the jacquard. The denting pattern was 2 ends per dent. For the borders/selvedges, the drawing-in pattern and the denting were kept double. This was followed by harness mounting for the jacquard along with binding of lingoes (dead weights for heald reversing), which being a time consuming and tedious job, took a very long time. In the meantime, card punching and lacing were done as per the developed designs. Once harness mounting was ready, the chain of punched cards (mala, in local term) was fitted to pattern cylinder, and after a few trials, the actual weaving started. It took around 4 days to weave the complete saree. The technical specification of the saree is given in Table 3.1.2, whereas Table 3.1.3 shows the final costing with break-ups.

Table 3.1.2: Technical specification of the saree

Items	Description
Dimension of saree	216 in X 48 in
Width of border	5.70 in
No. of ends per inch (grey state)	88 (for body)
No. of picks per inch (grey state)	68 (for body)
Cotton yarn count	100^s Ne (both warp & weft)
Colours of the saree	Ground colour – *Tuntey* Zari – golden border and *mina* – navy blue

3.2 Finishing and packaging

The finishing of the saree was done on-loom alike other Bengal Tant Sarees. While weaving, an indigenously prepared size mixture in the form of paste consisting of natural adhesives, primarily boiled rice and parched-rice (Khoi) was applied directly on the surface of the saree with hand as soon as one metre cloth was woven. Before applying the size paste, the saree was wetted first with the help of a wet fabric, then it was wiped with a dry piece of fabric to absorb extra amount of water from the loom-state saree. The loom-state fabric/saree was then rubbed with the size material by hand to apply the sizing material evenly on the fabric surface. This process was repeated after every metre.

Due to the application of size paste in the above manner, the final saree became stiff like paper. After weaving the full-length saree, it was folded in a characteristic manner and tied with a piece of cloth, which is commonly known as "Swatch ½ width". Finally, it was dried in sunlight and then packed with paper.

The 3D draping of the final saree is presented in Fig. 3.2.1.

Table 3.1.3: Approximate costing of the saree

Items/head of charges	Amount (in Rs.)
Lingoes binding charge	3000/-
Dram charges	15/- per saree
Bobbin making or winding charge	30 (½ kg @ Rs. 60/- per kg)
Drawing and denting charge	450/-
Card punching cost	3/- per card (including punching & lacing)
Card and design conversion charge	4000/-
Warping cost per saree	120/-
Zari cost	135/- (3 reels @ Rs. 45/- per reel)
Wages of the weaver	600/-
Designer's charge	3000/-
Total cost of saree (including designer's cost)	11350/- (approx.)

4. Conclusion

Alpona is a traditional painting style mainly practised by the womenfolk as an ephemeral form of folk art which is used to apply on interior and exterior of the houses. Alpona art is very much popular in various parts of our country, and mainly linked with culture and rituals of the regions/states. In Santiniketan of West Bengal, there is a huge practice of alpona art introduced by famous artist Abanindanath Tagore as a graphic art with contemporary style. Santiniketani alpona drawings are quite different in terms of elements of motifs, their measurements and colours from those of other parts of Bengal and the Indian subcontinent.

Application of alpona motif is very much common in various forms in sarees printed with block printing, screen printing, batik printing, and digital printing. Alpona motifs in Santiniketani Batik printed sarees are extremely popular and well accepted in India and abroad.

Figure 3.2.1: 3D draping or texture mapping of the developed saree

However, there is scarcity of jacquard woven sarees using alpona motifs. Consequently, in this study an effort has been made to explore the opportunity to work with alpona motifs, especially of Santiniketani style, extracting various elements and synthesizing them in jacquard designing using CAD tools. Due to the inherent limitations of handloom jacquards, the selected motifs and/or their elements have been manipulated as much as possible to make them feasible for jacquard textile design. During this journey, it has been realized that there is ample scope of creating innumerable innovative jacquard designs simply manipulating the alpona motifs a little bit and incorporating a few simple design elements using CAD software.

In this era, people usually believe in change of taste, wants to try many innovative things like combination of traditional and contemporary designs in garments, home furnishings, lifestyle products and many other things. Hence, jacquard woven sarees designed innovatively from alpona motifs through exploration, extraction, and manipulation of various elements can, obviously, cater to the people with different tastes and also to the niche market.

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Problems and Prospects of Marketing of Khadi with Special Reference to Haryana and Punjab

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Abstract:

Khadi is a versatile fashion fabric and has been used as a tool to navigate India through its hard-won independence. When it comes to marketing of khadi, it has a restricted market which reach to a very few customers. In current market scenario, khadi has not witnessed much change in terms of design, colour and readymade khadi apparel. Punjab and Haryana have rich potential and tradition to promote khadi as it is linked with the freedom movement of India and has immensely contributed to the khadi movement. In the present market scenario it has become very important to do marketing and selling of khadi through proper channels to reach to the masses. Clearance of unsold stocks, adopting correct marketing strategies to promote khadi to reach to its target customer are some of the major problems which sale outlets of Punjab and Haryana are dealing with. The current study aims to find out the problems and give suggestions to enhance the marketing strategies to promote khadi.

Keywords: *Khadi, Marketing, Promotion, Strategies, Sale outlets*

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1. Introduction

In India, khadi is not just a cloth, it is a movement started by the father of the nation "Mohandas Karamchand Gandhi". "Revival of the hand spinning and hand weaving makes the largest contribution to the economic and moral regeneration of India" (Gandhi, 2009). The words of the Mahatma Gandhi still have the same significance in the current Indian scenario. In the 1920s, for improving the Indian economy, Mahatma Gandhi began to encourage and promote the spinning of khadi for rural freelance and self-sufficiency, creating khadi an essential division and idol of the Swadeshi movement. To save the future of India, it was important to re-organize the handicrafts and being hand spun and hand woven cloth, khadi was chief among them.

The khadi movement encourages beliefs, a purpose that Indians could be self-sufficient and independent. The khadi development focuses at rejecting foreign products which were produced by buying cotton from India in cheaper rates, exported to Britain where they were manufactured and brought back to India for sale with the huge hike in price. The movement started by Mahatma Gandhi was not only a call to generate self-sufficiency but a call to wear own manufactured cloth that could show the integration of our country.

Khadi is a versatile fashion fabric and has been used as a tool to navigate India through its hard-won independence. From the past 72 years, khadi fabric contributes to form a remarkable inspiration for creative minds across all International borders. Known as the "Fabric of India", khadi has proven to be a culture in itself, one that precisely speaks the pride of our country's achievements. On one side, the whole world proceeds towards industrial fashion, but another side "Khadi" the fabric of independence constantly generates income for the rural poor prompting the country of its heritage of sustainable living and self-sufficiency.

The whole process of making khadi involves the use of hands only, thus the imperfection in the texture of khadi becomes a structural part and enhances the beauty of fabric (Bose, 2018).

2. Market analysis of Khadi

Khadi has a very restricted market, serving few customers who either believe in wearing good quality cotton clothes or are emotionally attached to the khadi ideology. Design, colour, and type of readymade khadi have not witnessed much change. A few attempts are being made by the khadi institutions which are focusing on understanding the current market scenario and make an attempt to make products that are more 'in' with the consumer(Gopinath, 2008). Extensive branding and popularization of other private brands like Fab-India and Khaddar have changed the growth of the khadi industry in the Indian market. According to the recent published report in The Economic Times, the sales of khadi decreased by 16 per cent year-on-year to Rs 3,527.71 crore in 2020-2021. According to another report, a growth of 179 percent has been recorded in the sales of khadi fabric from Rs. 1,510 crore in 2015-16 to a massive Rs 4,211.26 crore in 2019-20. Whereas, the production of village industries products witnessed an increase of 96 percent from Rs, 33,425 crore in the year 2015-16 to Rs 65,393.40 crore in 2019-20. As per the report shared by KVIC, during the financial year 2017-18, sales of khadi including solar and poly vastra, grew 24.71 percent to Rs 2,503 crores. According to a recently published report, the sale of khadi and village industry hiked by 14 percent to reach 37935 crores during the financial year 2015-2016. For the first time, growth of 29 percent was witnessed by khadi fabric and garments, which has crossed Rs 1,500 crore mark. While the government is enhancing khadi, a difference can be seen in the sales mix with the

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readymade garments accounting 45 percent compared to 30 percent two years ago (Sidhartha, 2016). A growth of 168.24 percent has been recorded for the average khadi sale of 120.09 crores by departmental sale outlets in the financial year 2015-18 as compared to 44.77 crores in the 2004-14 decade. During the period of 2004-14, only 110 khadi institutions were established whereas after 2015 more than 375 new khadi institutions were established in two odd years.

Current scenario of Khadi in Haryana and Punjab

Punjab and Haryana have rich potential and tradition to promote khadi as it is linked with the freedom movement of India and has immensely contributed to the khadi movement. In the present scenario, Punjab seems to have failed to match the economics of khadi with politics. As a result, more than 20 of the 28 khadi trusts running in the Punjab state are reeling under huge debts. The reason behind this is due to lack of interest of state government as well as the Khadi and Village Industries Commission (KVIC). After the year 2000, the production of blanket and hosiery garments dented the khadi market and the demand continued to slide. The spinners and weavers started moving to other parts of the country, leaving the impact on the production capabilities of the khadi production centres.

Most of the khadi institutions are facing problems like shortage of working capital, financial help for improvement of retail outlets. The khadi sales outlets of Haryana and Punjab are filled with unsold stocks of durries, blankets, khes, towels etc. Only very few manufacturing centres of Haryana and Punjab are producing thick and coarse khadi fabrics which are acceptable in rural areas only. Fine khadi fabrics are brought from other states like Bengal, Rajasthan; Madhya Pradesh etc. which are limited to the reach of urban cities. Readymade apparel like male jackets, shirts, kurta, etc. which are being made in khadi are very limited and manufactured by only very few khadi organizations.

3. Review of literature

Agrawal and Nair (2016) conducted a study in Ahmadabad city to identify social media as a marketing tool for the growth of Indian Khadi industry. Conceptual research was done on a sample size of 101 respondents and questionnaire was used to collect the data. Data analysis was done on the basis of age, occupation, preference, types of khadi, online shopping sites, etc. Chi-square tests and frequency table was used to calculate the results. The results show that the majority of people constantly use online shopping portals for purchasing apparels. Seventy-six percent of people use social media and they get attracted and influenced by social media advertisements to buy their apparels. It was also suggested that Khadi should not be limited to Khadi.

The change in marketing and promotion strategies of khadi has two different elements, i.e., Khadi Mark and Khadi Organization. To provide a distinct identity of khadi, the requirement of the program from KVIC is to evolve the Khadi Mark which should include logo for the genuineness of khadi and khadi products and under the Trade Mark Act, the registration of Khadi Mark should be done. Khadi Mark Regulation was formed by Ministry of Micro, Medium and Small Enterprises (MMSME) in 2013 with powers taken from KVIC Act 1956. The logo along with the regulations was published in July 2013. As of 28 February 2016, a total number of 1,468 active khadi institutions were registered for the Khadi Mark. In the second element, KVIC is required to do the identification of independent partners and establish a marketing organization with the maximum number of stake-holding by independent partners and to separate from the marketing function. In addition, KVIC is also required to undertake the market analysis survey to figure out the initiatives taken for the marketing of khadi with the help from marketing organization (ADB, 2016).

Choudhury and Ghosh (2016) in their study investigated the performance of khadi in economic growth and development of India from 2007 to 2014 in terms of sales, production, employment generation and earning generated by khadi textiles. To get the related data exploratory and descriptive research methods was used and correlation analysis was done. It was observed that by providing employment, earnings and livelihood to their workers khadi textile industry not only contributes in the economic growth and development, but also to the GDP of the country. It also reveals that over the period of time from 2007 to 2014, the production sales and employment earnings generated by khadi textile industry is increased with a decreasing rate in terms of production, sales, employment generation and earning provided to the khadi workers. A strong correlation between the production and sales of khadi textile industry and production and employment generated by khadi textile industry was found. The paper also suggested that khadi textile industry needs to improve their marketing strategies and provide sufficient training to their existing khadi workers in order to meet to the present market scenario.

Goel and Jain (2015) made an attempt to identify the problems related to demand and supply of the khadi industry in India and recommended an action plan for the same. They found the reasons for limited growth of the khadi industry, the workings of KVIC - Khadi and village industry commission and current marketing strategies of Rajasthan Khadi and Village Industry board. A literature review was done to reach the effective outcomes. The study reveals that major problem encountered with KVIC products is regarding marketing and sales as the KVIC products are being sold through their own network thus finding it difficult to market their products and facing demand and supply side problems like less awareness of the khadi brand, limited working hours of the khadi bhandars, uneven quality and limited design patterns, poor marketing linkages, obsolete weaving technology leading to more preference given to foreign brands. It has been suggested that by improving the quality and building an effective marketing plan can spread more awareness of khadi brand in the masses.

From the literature review it was found that the current marketing strategies adopted by KVIC do not meet the requirement of present market and khadi is still lacking behind in the race of reaching to its target customer.

4. Objectives of the study

1. To identify the current market scenario of khadi in Haryana and Punjab.

2. To study the marketing strategies adopted by khadi sale outlets in the study area.
3. To suggest measures to promote khadi.

5. Materials and Methods

The current study is mainly based on primary data and is descriptive in nature. To carry out the research fifty khadi sale outlets were selected purposively (twenty-five each from Punjab and Haryana respectively) and the owner of khadi sale outlet from each store was selected as respondent. Interview schedule with open and close ended questions was prepared and required information was collected and expressed through frequency and percentage. Secondary data required for the study was gathered from research articles, magazines, books, newspapers and online websites.

Table 1 Level of satisfaction towards the marketing of khadi (N=50)

Opinion	Haryana		Punjab	
	N	%	N	%
Yes	16	64	17	68
No	9	36	8	32

From the above table, it is witnessed that the majority (64%) of respondents belong to Haryana and 68% of respondents belong to Punjab views that KVIC lacks in marketing of khadi; whereas, 36% of respondents from Haryana and 32% of respondents from Punjab, are satisfied with the marketing of khadi.

Marketing of khadi is one of the very important elements. As shown in the results depicted in the above table, it is evident that the percentage of respondents who thinks that KVIC lacks in doing the marketing of khadi is more in Punjab as compared to Haryana. At present khadi have a very limited market and a few customers who are willing to buy and wear khadi. Regular and focused marketing strategies adopted by KVIC can lead in the growth of khadi sales. The marketing strategies adopted by KVIC such as opening of new khadi sales outlets, advertising and distribution of pamphlets is limited to the rebate period only. Yadav (2015), mentions that advertisement of khadi should be done through all wire mediums with modern and appealing approach which could help in increasing the customers.

Table 3 Khadi reaching to its target customer with the present marketing strategies (n=50)

Opinion	Haryana		Punjab	
	N	%	N	%
Yes	13	52	9	36
No	12	48	16	64

From the above table, it is observed that present marketing strategies adopted by the sale outlets of Haryana (52%) are sufficient to reach to its target customer as compared to the strategies adopted by the sale outlets of Punjab (36%). On the other hand, 48% of the respondents from Haryana and 64% of respondents from Punjab believes that the khadi is not reaching to its target customer with the present marketing strategies.

It can be concluded from the above results that the current marketing strategies adopted by KVIC or the khadi sale outlets are not sufficient to reach to its target customer in both the states of Haryana as well as Punjab. P. Gopinath (2008) stated that, no attempt has been made to find out the needs, requirements and preferences of the customers who buys khadi to identify the target customer.

Table 4 Measures taken by the sale outlets for attracting more customers towards khadi (N=50)

Measures	Haryana		Punjab	
	N	%	N	%
New designs	7	28	6	24
Improved quality	11	44	11	44
Swadeshi/patriotic sentiments	5	20	6	24
Eco-friendliness	8	32	3	12
Any other	3	12	6	24

The above table reveals that, the majority (44%) of the respondents from Haryana as well Punjab, improved quality of khadi was taken as a measure to attract more customers towards khadi. According to 32% of respondents from Haryana and 12% of respondents from Punjab, eco-friendliness of khadi was taken as a measure for attracting more customers towards khadi, according to 28% of respondents from Haryana and 24% of respondents from Punjab, new designs of khadi was taken as a measure for attracting more customers towards khadi. From Haryana 20% of respondents and 24% of respondents from Punjab, swadeshi or patriotic sentiments towards khadi was taken as a measure for attracting more customers towards khadi and according to a few of 12% of respondents from Haryana and 24% of respondents from Punjab, other methods such as discounts on certain occasions or advertisement through putting banners outside the sales outlets was taken a measure for attracting more customers towards khadi.

From the above results it is evident that, improved quality of khadi is considered as an effective measure to attract more customers towards khadi in the sale outlets of Haryana as well as Punjab. In sale outlets of Haryana, eco-friendliness of khadi and introduction of new designs of khadi apparel was considered more as a measure to attract customers towards khadi than in the sale outlets of Punjab. However, swadeshi or patriotic sentiments and other measures such as discounts on certain occasions, advertisement through putting banners outside the sale outlets etc., was done more in the sale outlets of Punjab to attract more customers towards khadi when compared to the sale outlets of Haryana.

From the previous studies it was observed that, there is a need for attracting customers towards khadi, as at present, only

few people are willing to buy and wear khadi. Consumer preferences and fashion forecast for the upcoming year should be kept on priority while deciding on designing of the product range. There is a need to attract more customers towards khadi in order to increase the sales of khadi readymade apparel. Proper advertisements and improved marketing techniques should be adopted by KVIC to promote khadi and make it reach to the target customer. Kulhar (2019) stated that, in order to meet the demand of the present market, there is a need for adopting design inventions and modern technologies. Traditional khadi products are unable to compete with the present market to fulfil the demand of modern generation.

Table 5 Methods of promotion undertaken by sale outlets for marketing of khadi (N=50)

Methods of Promotion	Haryana		Punjab	
	N	%	N	%
Radio advertisement	2	8	0	0
Newspaper advertisement	2	8	10	40
Banners	15	60	13	52
Pamphlets	10	40	8	32
Television	5	20	5	20
Loud speaker	1	4	8	32
Any other	0	0	2	8

The above table exhibits that the majority of 60% of respondents from Haryana and 52% of respondents from Punjab uses banners as a method of promotion for doing marketing of khadi, however; 40% of respondents from Haryana and 32% of respondents from Punjab uses pamphlets as a method of promotion for marketing of khadi. From both Haryana and Punjab 20% respondents uses television advertisements as a method of promotion for marketing of khadi, 8% of respondents from Haryana and 40% of respondents from Punjab uses newspaper advertisement as a method of promotion for marketing of khadi, and only 4% of respondents from Haryana and 32% of respondents from Punjab uses loudspeaker announcements as a method of promotion for marketing of khadi. Only 8%of respondents from Haryana used radio advertisement as a method of promotion for marketing of khadi and 8% of respondents belong to Punjab uses other methods such as word of mouth etc. as a method of promotion for marketing of khadi.

It can be concluded from the above results that, putting banners outside the sale outlets and distribution of pamphlets is majorly used as a method of promotion for marketing of khadi in the sale outlets of both Haryana and Punjab. Newspaper advertisements and loudspeaker announcement was also used more in the sale outlets of Punjab as compared to Haryana. Walia (2017) stated that integrated marketing channels such as Facebook, Instagram, YouTube and all type of social media should be considered for doing promotion and advertisement of khadi.

Further it was found that, promotion of khadi is done through various methods in which putting banners outside the sale outlets and distributing of pamphlets in nearby areas of the store location is mostly used. The impact of these promotion techniques adopted by the khadi sales outlets is not much effective as it does not reach the masses. Selling of products what customer wants is not the correct explanation of marketing, but to make a customer to buy products which are sold under a brand name. In this globalized world, where modernity and technology has reached its heights the marketing strategies adopted by khadi sales outlets and KVIC should also be improved.

Table 6 Khadi Should Sell Through E-Marketing Techniques (N=50)

Opinion	Haryana		Punjab	
	N	%	N	%
Yes	23	92	17	68
No	2	8	8	32

From table 6 it is witnessed that as compared to Punjab (68%), more respondent from Haryana (92%) believes that the selling of khadi should be done through e-marketing techniques. Whereas, the respondents from Punjab (32%) are more in comparison with Haryana (8%) who does not want to sell khadi through e-marketing techniques.

It can be concluded from the above results that according to the majority of respondents from both Haryana and Punjab, selling of khadi through e-marketing techniques should be done. Kulhar (2019) in her study stated that, in the present market scenario it has become very important to do marketing and selling of khadi through online channels as the whole retail business is going online.

Table 7 Selling khadi through e-marketing attract more customers (N=50)

Opinion	Haryana		Punjab	
	N	%	N	%
Yes	24	96	19	76
No	1	4	6	24

The above table exhibits that the majority (96%) of respondents from Haryana and 76% of respondents from Punjab thinks that e-marketing will help khadi in attracting more customers. Whereas, according to 4% of respondents from Haryana and 24% of respondents from Punjab, selling of khadi through e-marketing will not help in attracting more customers. The overall result of the above table indicates that selling khadi through e-marketing can help in attracting more customers in both the states of Haryana and Punjab. Agrawal and Nair (2016), stated that, well planned and nicely integrated marketing activities on social media can help to generate a impactful effect for the khadi industry in India. Goel and Jain (2015), stated that the customers who shop on online websites are increasing day by day, thus setting up of online khadi stores on certain websites such as Flipkart, Snapdeal, Ebay etc., can help khadi products to reach and delivered all over India.

Table 8 Difference found in marketing strategies adopted by other brands (N=50)

Difference	Haryana		Punjab	
	N	%	N	%
Yes	23	92	25	100
No	2	8	0	0

From the above table, it is observed that majority of 92% of respondents from Haryana and 100% of the respondents from Punjab found difference in marketing strategies adopted by other brands and only 8% of respondents from Haryana do not found any difference in the marketing strategies adopted by other brands.
It was further observed that, marketing techniques used by khadi sale outlets are displaying banners outside the sale outlets, distributing pamphlets, making loudspeaker announcements and television advertisement etc..

These old methods of promotion are makes zero or very less impact on the consumers. Whereas, marketing strategies such as impactful television advertisements, launching of new designs and products through celebrity brand ambassadors and quick adoption of new techniques and technology are mainly used as the marketing tool by other brands, which is a major drawback for sustainability of khadi in the market. Agrawal and Nair (2016), stated that in comparison with other fabrics, khadi has a very limited or no presence in advertising and marketing of their products. Goel and Jain (2015), in their study reveals that impact of heavy promotional activities adopted by other multinational clothing brands is much more in urban population making those brands as a status symbol for them, thus, letting khadi down in terms of acceptance by the consumers.

Table 9 Selling khadi at stores other than certified organisation will help in boosting sales of khadi

Opinion	Haryana		Punjab	
	N	%	N	%
Yes	14	56	17	68
No	11	44	8	32

Table 9 exhibits that the majority (56%) of respondents from Haryana and 68% of respondents from Punjab thinks that, selling khadi at stores other than certified organizations will help in boosting the sales of khadi. Whereas, 44% of respondents from Haryana and 32% of respondents from Punjab do not think that selling khadi at stores other than certified organisations will help in boosting sales of khadi. Yadav (2015), stated that brands like Fab-India and Raymond have tied up with khadi and devoted a section to khadi apparels in about more than 600 stores all over India to help khadi increase its sales.

Table 10 Satisfaction regarding current set-up of the sales outlet to meet today's demand of the consumer (N=50)

Satisfaction	Haryana		Punjab	
	N	%	N	%
Yes	16	64	12	48
No	9	36	13	52

From the above table, it is observed that according to 64% of the respondents from Haryana and 48% of the respondents from Punjab, current set–up and stock of their store is sufficient to meet today's demand of the customer. Whereas 36% of respondents belong to Haryana and 52% belong to Punjab don't have sufficient stock in their store to meet today's demand.

From the above results, it is evident that the current set-up of the majority of stores located in Haryana is satisfactory when compared to the stores of Punjab. It was further observed that, in this fast-moving world place, where modernization plays an important role in attracting customers most of the khadi retail outlets are still lacking in maintaining the outlook and display of the products in sales outlets as per the needs and demand of the customers. Yadav (2016) in their study stated that in this globalized world, there is a need that KVIC should do the improvisation of khadi sale outlets.

Table 11 Support provided by KVIC (N=50)

Getting support	Haryana		Punjab	
	N	%	N	%
Yes	20	80	17	68
No	5	20	8	32

Table 11 reveals that maximum of the respondents form Haryana (80%) and Punjab (68%) got support from KVIC, whereas, 20% of respondents from Haryana and 32% from Punjab, does not get any support from KVIC. Further it was also found that khadi sale outlets were run by different khadi institutions which work according to the guidelines provided by KVIC. Some institutions do not get any kind of support from KVIC in terms of adequate amount of funds for smooth running of the institutions. Yadav (2015), in her study stated that KVIC undertakes to promote the development of khadi and the village industries in rural areas. It also encourages research in the methods of production techniques and provides training to the persons associated with khadi, helps and support in doing promotion of sales and marketing etc.. Agrawal and Nair (2016), stated that lack of funds and support provided by the government, uncertainty of the policies, over-due and non-payment to the working staff has worsen the functioning of khadi industry further.

6. Conclusion

- From the study we can conclude that khadi has a very restricted market, serving few customers who either believe in wearing good quality cotton clothes or are emotionally attached to the khadi ideology.
- Current marketing strategies adopted by khadi sale outlets and KVIC are not enough to attract more customers towards khadi.
- Innovation in designs and techniques used for production of khadi need to be upgraded as per the need of the hour.
- Marketing strategies and promotion techniques adopted by the khadi sales outlets is not much effective as it does not reach the masses.
- Methods used for promotion of khadi are outdated and do not create much impact on the customer who wants to buy khadi.
- There lies a huge difference in marketing strategies adopted by other brands as compared to that of khadi, which needs a quick action in order to attract more customers towards khadi.
- Online marketing strategies can help in boosting sales of khadi.
- There is an urgent need to adopt new techniques and upgrade the common marketing strategies to attract more customers towards khadi.
- Proper funding and support to khadi institutions from KVIC needs to be encouraged for better working and motivation of the staff.

7. Suggestions

- Marketing of khadi should be considered most important element in promoting khadi to reach to its target consumers. Marketing strategies needs to be improvised and should not be limited to opening up of new stores and doing promotion during the rebate period only. Advanced and modern technologies should be adopted for marketing of khadi for an appealing approach which could help in reaching to its target customers.
- In this globalized world, where modernity and technology has reached its heights the marketing strategies adopted by khadi sales outlets and KVIC should also be improved.
- Consumer preferences and fashion forecast for the upcoming year should also be kept on priority while deciding on designing of the product range. There is a need to attract more customers towards khadi in order to increase the sales of khadi readymade apparel.
- The sale outlets of Punjab and Haryana are filled with unsold stocks of durries, blankets, khes, towels, etc., which needs to be cleared.
- E-marketing of khadi can also play an important role in attracting more customers towards khadi. In the present market scenario it has become very important to do marketing and selling of khadi through online channels as the whole retail business is going online.
- Selling of khadi should be market oriented rather that product oriented. Khadi needs proper branding and marketed by central level channels through which it could reach masses.

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Low-stress Mechanical Properties and Fabric Hand of Soybean & Polyester Fiber Blended Plain Woven Dyed Fabrics

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Abstract:

This study is focused to explore the potential uses of soybean fibers for apparels. The soybean fibers are sustainable fibers as they are manufactured from the by-product of soybean cakes. The compatibility of the blends of soybean fibers and polyester fiber is considered for this study as polyester fibers adds excellent mechanical properties to the blended fabrics whereas the soybean fibers are eco-friendly fibers. In this study, 5 different single yarns were spun of 100% soybean, 100% polyester, 65%–35% soybean/polyester, 50%–50% soybean/polyester and 35%–65% soybean/polyester in conventional ring spinning system. These single yarns are converted into 2 ply yarns using two for one twister machine and these 2 ply yarns are woven into five plain-woven fabrics with similar areal density values. These fabrics are further dyed with 1:2 metal complex dyes after suitable pre-treatment process. Finally, the low stress mechanical properties are measured using KES-FB tester and the THV (Total Hand Value) are estimated for these dyed samples. The results indicate that soybean rich blended fabrics show better THV than the polyester rich fabrics for the use in winter. Therefore, soybean has a great commercial potential in apparels as it exhibits decent low stress mechanical properties, good total hand values for the apparel grade fabrics.

Keywords: *Fabric hand, Low Stress Mechanical Properties, Metal Complex Dyes, Soybean fibers, Total Hand Value*

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1. Introduction :

The global garment consumption is increasing consistently with the rise of population as well as the disposable income which makes the textile industry is one of the leading polluting industries on this earth [1]. The manufacturing process, usage and disposal of these garments cause the pollution. It is stated that the textile industry produced 1715 million tons of carbon dioxide and consumed 79 billion cubic meters of fresh water in the year 2018 [1]. The recent focus on the environmental impacts of textiles is largely due to a surge in public interest in plastic pollution of which a significant proportion is thought to come from textile microfibres, a form of microplastic [2, 3]. It is found that the Polyester fibers controls around 52% of the textile fibers which are manufactured from the petroleum base and 24% of the market is controlled by cotton fibers [4]. The polyester fibers are manufactured from the petroleum base hence has great impact on the environment. The cotton fibers are natural fibers but consume lots of water and pesticides during the cultivation. Because of these cited challenges, there is increasing interest to reduce the use of synthetic fibers in the textile products as well as to include sustainable fibers like soybean for the reduction of environmental pollution level. The soybean fibers are produced from the residual cake after extraction of soybean oil. The soybean protein fibre has decent mechanical properties and environmentally friendly [5].

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The fabric quality can be accessed from design, aesthetic, comfort and fit. The evaluation of fabric quality is mostly subjective, but fabric hand is an objective measurement technique developed by Kawabata and Niwa [6]. The fabric hand is one of the most important parameter of fabric marketing and is based upon the end uses. The fabric hand is affected by many parameters such as fiber characteristics, yarn type, fabric structure and the wet processing methods [7]. The low stress mechanical properties are typically more useful for the study, the daily use garments and it affects on many other properties like fibric drape [8]. These properties are used for the evaluation of fabric total hand values (THV). Many researchers studied the low stress mechanical properties of different fabrics, but no published documents found the study of the blended fabrics produced from eco-friendly soybean fibers and polyester which is the mostly used synthetic fiber for apparels. Hence, an attempt is made to study the effect of different blend ratio of soybean and polyester fibers on the low stress mechanical properties and to evaluate the total hand value of these fabrics. The blending of soybean fibers with polyester fibers will improve the softness, smoothness and moisture content of the blended fabric. The addition of the soybean fibers will reduce the polyester content in the fabric and the resultant fabric will become more sustainable. Hence, the optimum percentage of the soybean fibers to be determined in the polyester and soybean blended fabrics with respect to fabric handle.

2. Materials and Methods

2.1 Materials

The polyester and soybean fibres were sourced from the industry and the specifications of these fibers are shown in

Table 2.1. The polyester and the soybean fibers are mixed at the blow-room stage for the satisfactory blending and five different single yarns are spun by using traditional ring spinning technique. The turns per meter (TPM) of all samples are kept alike. Then, these single yarns are transformed in to 5 different 2-ply yarns with the two for one twister machine (TFO). These 2 ply yarns then converted into 1/1 Plain fabrics by a sample rapier loom. The areal densities (grams/meter2) of all the five fabrics were kept alike for easy comparison as mentioned in Table 2.2.

Table 2.1 Fiber Properties of Soybean and Polyester

Fiber Properties	Polyester	Soybean
Fineness, denier	1.4	1.5
Length, mm (2.5% span length)	44	40
Elongation at Break, %	17.12	19.5
Tenacity, cN/tex	60.2	40.7

Table 2.2 Fabric Constructional Properties

Fabric Type	Warp Ne*	Weft Ne*	EPI**	PPI**	Areal Density, gm/m^2
Polyester (100%)	30/2	30/2	60	54	194
Polyester / Soyabean (65/35)	30/2	30/2	60	54	190
Polyester / Soybean (50/50)	30/2	30/2	62	56	192
Polyester / Soybean (35/65)	30/2	30/2	60	54	193
Soybean (100%)	30/2	30/2	60	56	193

*Ne is English Count, **EPI & PPI are Ends per ich and Picks per inch

These five fabrics were pre-treated with standard conditions and then the ready for dyeing (RFD) fabric samples were prepared. Then these RFD fabric samples were dyed with 1:2 metal complex dyes of Lanaset Blue 2R (commercial dye sourced from Huntsman co-operation). The dyeing was carried out in a roto-dyer. The dye bath of the roto-dyer was set to 400 C and MLR (material to liquor ration with mass) was kept at 1:40. Then fabric was treated with 4% ammonium sulphate and 1% levelling agent (Uniperol SE, BASF) for 10 minutes then required amount of acetic acid was added to get pH a 4.5-5. After that dye was added and dye bath was heated to 900 C and held at this temperature up to 60 minutes. The dyed samples were soaped mildly with non-ionic detergent (2 grams per liter) and then washed with cold water and dried [9].

2.2 Methods

The sixteen low stress mechanical properties of these dyed fabric samples were measured for the five woven fabric samples by using KES-FB (Kawabata Evaluation System) tester [10]. The values of the low stress mechanical properties are tabulated in Table 3.1. This system has the capability to measure Tensile, Shear, Bending, Compression and Surface properties with a sample size of 20×20 cm. The average value of each low stress mechanical properties is estimated from four test results. Al the samples are tested at the standard testing conditions of 20±20C and 65%±2% Relative Humidity (RH%). The objective assessment of the five fabrics was evaluated after the estimation of the Koshi (stiffness), Fukurami (Resilience) and Numeri (softness). These called the Primary Hand Values (PHVs) and normally rated on a scale from 0 (weak) to 10 (strong). The Total Hand Value (THV) of these five fabric samples were obtained automatically with KES-FB tester by using the Primary Hand Values. The THV is rated on a scale from 0 (not useful) to 5 (excellent) [11].

3 Result & Discussion

The results of low stress mechanical properties of the five fabric samples measured by Kawabata Evaluation System are shown in Table 3.1.

3.1 Tensile Properties

The low stress tensile properties measured by KES-FB1 are shown in Table 3.1. Four different low stress tensile properties such as extensibility (EMT), tensile linearity (LT), tensile energy (WT) and tensile resiliency (RT) have been measured. The LT value of fabric represent the linearity of the stress-strain curve and the higher LT values indicate the better fabric extension behaviour during the initial extension range [12]. It is observed that the fabrics with 100% Polyester shows higher LT values than the fabrics with the 100 % soybean fibers. The LT values of the blended fabrics decreases proportionally with the gradual increase of soybean fibers as shown in Table 3.1.

The value of EMT% (tensile strain) represents the de-crimping of yarns during tensile loading. Higher EMT% is better for the fabric comfort. It is observed that the EMT values of the sample fabrics increases proportionally with the increase of soybean fiber content in the blended fabric. Hence, soybean rich fabrics scores better than the polyester rich fabrics in terms of extensibility. This may be attributed to the higher bending rigidity and higher initial modulus of the polyester fibers as compared to the soybean fibers.

The WT values show a decreasing trend with the increase of soybean fiber content in the fabric blend. The higher values of WT indicate the better performance of breakage for polyester rich fabrics than the soybean rich fabrics as the polyester fibers are possess higher values of elongation at break as well as the tenacity as per Table 1.

The RT value indicates the ability of the fabric to recover after the tensile deformation. It is observed that the RT values decreases with the increase of the soybean fiber content in the fabric. This may be attributed to the higher RT value of the polyester fiber as compared to the soybean fibres.

3.2 Shear Properties

Three low stress shear properties such as G (Shear Rigidity), HB (the shear hysteresis of the shear force at 0.50) and 2HB5 (the shear hysteresis of the shear force at 50) measured by KES-FB1. The results of these low stress properties are shown in Table 3.1.

It is observed that the G value decreases with the increase of the soybean fiber content in the blended fabric samples. This may be attributed to the higher flexural rigidity and the coefficient of friction of the polyester fiber as compared to the soybean fibers. The lower value of shear rigidity (G) provides more comfort to the wearer as well as exhibits better drapebility and tailorability of the garments. The lower value of the shear rigidity (G) observed for the soybean rich fabrics due to the lesser resistance to the shear forces and with less wrap angle between the warp and weft [13]. It is also observed that the values of HB and 2HB5 decreases with the increase of soybean content in the blended fabrics as shown in Table 3.1. The soybean rich fabrics are thicker than the polyester rich fabrics. The thicker fabric structures allow the yarn to recover more efficiently after the disengagement of load than the compact structures.

3.3 Bending Properties

The pure bending properties are tested by KES-FB2. The B (bending rigidity) and 2HB (Hysteresis to bending moment) values of the fabric samples are shown in Table 3.1. It is observed that the fabric made up with 100% soybean fibers shows lowest B value in comparison to blended fabrics and the 100% polyester fabrics and the bending rigidity value gradually increases with the increase of polyester fiber percentage in the blended fabric. The bending rigidity (B) depends upon the bending rigidity of the constituent yarns of the fabrics and the interlacement points of warp and weft in the fabric structure. The interlacement points govern the mobility of warp and weft in the fabric structure [12]. The 100% soybean yarn has lower bending rigidity than the 100% polyester yarns which lead the fabric made up with 100% soybean yarns will exhibit lowest bending rigidity value.

The other bending parameter of low stress mechanical properties is the bending hysteresis of the bending moment and is represented by the 2HB. 2HB value indicates the recovery from the induced bending deformation. It is observed that the 2HB value decreases with the increase of soybean fiber content in the blended fabric. The fabric made up with 100% soybean yarns shows lowest value of B and 2HB due to lower yarn rigidity.

3.4 Compression Properties

The compression properties of the sample fabrics are measured by KES FB-3. The Linearity of the compression, compressional energy (WC), compressional resiliency (RC), fabric thickness at pressure 0.5gf/cm2 (T0) and fabric thickness at pressure 50gf/cm2 (Tm) are the low stress compression properties measured for this study and the respective values are shown in Table 3.1. It is observed that the LC value are similar for all types of fabrics but the WC value of 100 % soybean fabric is lowest and this value increases with the decrease of the soybean fiber content in the fabric blend. The low compressibility energy of the fabric made up with 100% soybean fiber is due to the lower rigidity and higher fiber to fiber friction of soybean fibers than the polyester fibers. Higher coefficient fiber to fiber friction leads to the less energy consumption for the compression.

It is also observed that that the RC value is lowest for the 100 % soybean fabric and RC value increases proportionally with the decrease of the soybean fiber content or increase with the polyester fiber content. This trend can be attributed to the lower resilience and higher fiber to fiber friction of soybean fibers than the polyester fibers.

3.5 Surface Properties

The surface properties namely MIU (coefficient of friction), MMD (mean deviation coefficient of friction) and SMD (geometric roughness) of the sample fabrics are measured by KES-FB4. The values of these surface parameters are shown in Table 3.1. It is observed that the MIU and SMD value decreases with the increase of the soybean content as the 100% polyester yarns are relatively bulkier than the 100% soybean yarns. The MIU value mostly increase with increase of the cross-section area of the constituent yarn. MMD values of the fabric samples do not show any significant variation with change of any fiber content.

Table 3.1 Low Stress Mechanical Properties of the Fabric Samples

Property	Polyester (100%)	Polyester/Soyabean (65/35)	Polyester/Soybean (50/50)	Polyester/Soybean (35/65)	Soybean (100%)
Tensile					
LT	0.765	0.722	0.703	0.686	0.654
EMT, %	6.979	7.284	8.83	9.828	11.48
WT, gf.cm/cm^2	17.315	14.98	12.01	10.27	8.312
RT, %	60.727	56.738	50.727	42.054	38.183
Shear					
G, gf/cm	1.226	1.201	1.186	1.128	1.046
2HG, gf/cm	6.866	6.427	6.042	5.754	5.351

Table 3.1 (Cont.) : Low Stress Mechanical Properties of the Fabric Samples

Property	Polyester (100%)	Polyester/Soyabean (65/35)	Polyester/Soybean (50/50)	Polyester/Soybean (35/65)	Soybean (100%)
2HG5, gf/cm	5.842	5.395	5.021	4.851	4.325
Bending					
B, gf.cm^2/cm	0.047	0.038	0.031	0.028	0.022
2HB, gf.cm/cm	0.058	0.047	0.042	0.037	0.034
Compression					
LC, %	0.643	0.606	0.571	0.432	0.401
WC, gf.cm/cm^2	0.068	0.059	0.052	0.044	0.041
RC, %	77.98	70.85	66.03	53.73	47.67
Weight					
W, mg/cm^2	19.4	19.1	19.2	19.3	19.3
Thickness					
To, mm	0.98	0.94	0.95	0.93	0.94
Tm, mm	0.72	0.75	0.76	0.74	0.75

3.6 Fabric Hand Value

Koshi (Stiffness), Fukurami (Fullness and Softness) and Numeri (Smoothness) are the three primary hand values (PHV) considered for the fabric samples as these fabric samples are suitable for the winter garments. The Koshi (Stiffness), Fukurami (Fullness and Softness) and Numeri (Smoothness) are the values are tabulated in Table 3.2.

Table 3.2 Hand Values of the Fabric Samples

	Polyester (100%)	Polyester / Soyabean (65/35)	Polyester / Soybean (50/50)	Polyester / Soybean (35/65)	Soybean (100%)
Koshi	8.99	8.62	8.55	8.44	8.4
Fukurami	4.69	4.82	4.83	4.85	5.74
Numeri	3.46	3.75	4.21	4.64	5.69
THV	3.22	3.33	3.33	3.44	3.54

It is observed that the Koshi, Fukurami and Numeri value decreases with increase of the soybean content in the fabric samples. The lower value of Koshi for soybean rich fabrics can be attributed to the lower value of bending rigidity, shear rigidity (G) and the tensile resilience (RT) of the constituent soybean rich yarns in the blended fabrics. The decreasing trend of the Fukurami value for the soybean rich fabrics can be attributed to the lower value of hysteresis of shear force (2HG) and relatively higher value of compressional resiliency (RC). The downward curve of the Numeri value for the soybean rich fabrics is due to the increase of compressional energy (WC).

The THV (Total Hand Value) of the developed fabric samples are calculated from the inherent Kawabata system of equations [14]. The THV of the developed fabric samples are found to be in the range of 3.33-3.54. The soybean rich fabrics show slightly better THV than the polyester rich fabrics.

4 Conclusion

The investigated fabric with higher soybean fiber content exhibits decent low stress mechanical properties for the use of apparels. The soybean fiber rich blended fabrics show good values of Koshi (Stiffness), Fukurami (Fullness and Softness) and Numeri (Smoothness). It is also observed from the experimental data that the soybean rich fabric blended with polyester fibers shows THV in the range of 3.33 to 3.54. Hence, the investigated fabrics can be used for the apparels especially for the winter garments as per the THV. Hence, it can be concluded that the fabrics blended with higher content of soybean than the polyester fibers have the potential for the applications in sustainable textiles.

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Kapok: A High Potential Natural Fibrous Material in Technical Textile Applications

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Abstract:

The textile industry which is the reason for 5.4% of the world's pollution is considered as the fifth most unsustainable industry proceeded by electricity and heat, agriculture, road transportation, and oil and gas production. It has a considerable impact on sustainability starting from the raw materials to finished goods. The generation of waste occurs at every stage of manufacturing and the term sustainability stands as the need. Whenever the impact on the environment is taken into the study, the major role of polluting the environment is being played by the raw materials that are used. A huge amount of resources is being exploited in the process of obtaining raw materials. The production of cellulosic fibre like cotton requires a large amount of cultivation land and water. For example, to get 1 kg of cotton fibre, the average consumption of water is about 7-29 tons. Also, the synthetic fibres like acrylic, polyester, etc are not environment friendly. Kapok is one such alternative and it has numerous properties. It is a natural cellulosic fibre found in selective regions of the world that was once used for technical application rather than apparel purpose. The researchers have to work on for making this natural fibre back to the textile application. Usually, kapok fibres are used as stuffing materials for pillows, bedding and in the technical application of oil absorbent, sound absorbing material, air filters and so on. This article details the information regarding the structure, properties and applications of kapok fibres in various sectors.

Keywords: *Applications, Kapok fibre, Properties, Sustainabilit*

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1. Introduction :

Kapok is one of the natural cellulosic fibres found in different regions of the world that was used in technical application rather than apparel application. They have limited use to textile market and faded away due to the upper hand of the manmade fibres like polyester, polypropylene and other substituting fibres. The researchers and technicians have to work on this area for making this natural environmental fibre back to the textile and fashion application. Kapok fibres are obtained from the kapok fruit and are available in Asia, Africa and South America [1]. It is a soft silky cellulosic fibre and it is different from other cellulosic fibres. Kapok fibres have significant hollow tube-shaped structure. The fibres are inherently mold free and free from pesticides as they contain large amount of lignin and wax content in it [2]. Individual fibres are 0.8 to 3.2 cm long, averaging 1.8 cm, with diameters of 30 to 36 micrometres and has a density of 0.29g/cm3 [3]. Usually, kapok fibres are used as stuffing materials for pillows, bedding, and some soft toys [1]. Here, the information regarding the kapok fibre in various sectors like harvesting areas, structure of fibre, chemical composition, the various properties that make the fibre suitable for different applications are discussed.

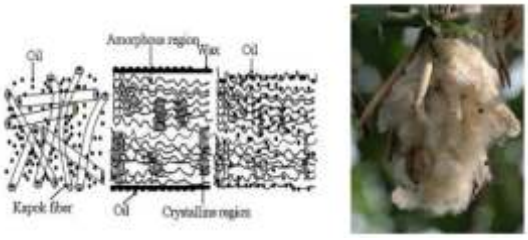

Figure 1 : Nature of kapok fibre [2]

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2. Structure of Kapok fibre

The lateral and longitudinal sections of the kapok fibre are different from that of cotton and the cell wall of kapok fibre is divided into five basic walls or layers such as outer skin (S), primary wall (W1), secondary wall (W2), tertiary wall (W3) and inner skin IS. Inner skin is thin (40–70 nm) and acts as a protective layer for the fibre. Primary wall (W1) is thicker than outer skin (S), but thinner than both secondary wall (W2) and tertiary wall (W3) its thickness varies from 160 to 240 nm, with an average of about 200 nm. The thickness of secondary wall (W2) is about 500 nm, which is similar to that of tertiary wall (W3). Kapok fibres are characterized for having higher level of acetyl groups (13.0%). Usually, cell walls of plants contain about 1%–2% of acetyl groups attached to non-cellulosic polysaccharides. These fibres are super hydrophobic and do not get wet with water [4].

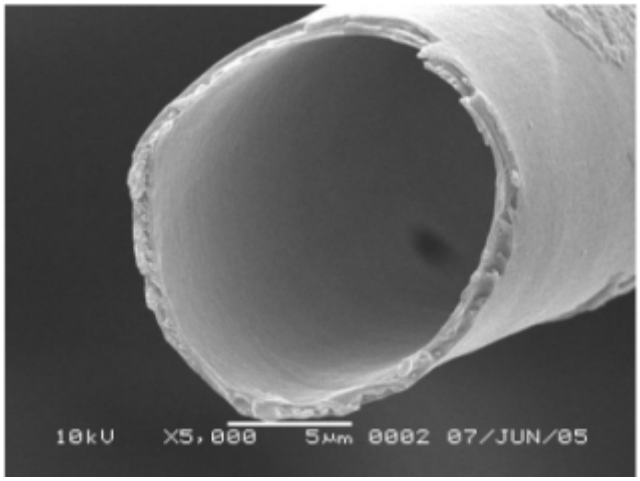

Figure 2 SEM of kapok fibre [2]

The SEM image (Figure 2) of kapok fibre shows homogenous circular cross section with wide air-filled lumen

having wall thickness of about 1-2µm. The average area occupied by lumen contributes around 64% which does not collapse after harsh mechanical action. Kapok fibre requires low energy for production as they have low trash and foreign contaminant and hand opening & cleaning is sufficient enough [5].

3. Chemical composition of kapok fibre

3.1 Cellulose

Cellulose is the most abundant organic polymer on Earth and it is an organic compound with the formula $(C_6H_{10}O_5)_n$. It is a polysaccharide consisting of a linear chain of several hundred to over ten thousand β (1→4) linked D-glucose units and the degree of polymerization varies from 200 to 10000. The degree of polymerization generally lies around 3000 which depends on the method of isolation and purification. Cellulose is being an important structural component of the primary cell wall of green plants. It is used to make water-soluble adhesives and binders such as methyl cellulose and carboxymethyl cellulose. The presence of less amount of hydroxyl group makes the fibre hydrophobic [2].

3.2 Hemicellulose

Hemicellulose is generally found in vegetable fibre other than cellulose and it is the generic term of polysaccharides. The degree of polymerization ranges around 100 [2].

3.3 Lignin

Lignin is a complex chemical compound and it is derived from the integral part of the secondary cell walls of plant. It plays a vital part in conducting water in plant stems. It is more hydrophobic as the crosslinking of polysaccharides by lignin creates an obstacle for water absorption to the cell wall [2].

3.4 Xylan

Xylans are polysaccharides made from the units of pentose sugars called xylose. They are almost as abundant as cellulose in plant cell wall and contain predominantly β-D-xylose units linked as in cellulose. This is found in the cell walls of some green algae, especially macrophyticsiphonous genera, where it replaces cellulose. Similarly, it also replaces the inner fibrillar cell-wall layer of cellulose in some red algae [2]. Table 1 gives the chemical composition of the kapok fibre.

Table 1- Chemical composition of Kapok fibre [2]

Cellulose	35-65%
Hemicellulose	23.0%
Lignin	13.0%
Pectin	23.0%
Extractives	-
Moisture	0.0%

4. Properties of Kapok fibre

4.1 Absorbency

The absorbency of the material is generally based on two factors namely the surface tension and surface energy of the material. Kapok fibre is hydrophobic due to the less amount of cellulosic content present on the wall of the fibre. Kapok fibre becomes hydrophilic due to its very low surface energy and it becomes oil absorbent due to its waxy hollow structure [6]. The cohesion and capillary action are the properties which plays an important role in absorption and retention of the fluid. After 1 hour of dipping, the retentivity value of the kapok fibre is very high as it loses nearly 8 to 12 percent of the absorbed oil-based compounds. The recovery rate of the oil increases with increase in thickness of the oil layer in feed stream [7]. When the thickness of the oil exceeds 60 mm, a constant flux of 3.8–5.0 L/ (m2 min) can be achieved by the kapok wall of 55-, 75- and 95-mm thick respectively under the natural pressure gradient. The hydrophobic/oleophilic characteristics of the kapok fibre are due to its waxy surface though its large percent of lumen contributed to its excellent oil absorbency and retention capacity [3].

4.2 Sound absorption

Due to its hollow structure, kapok fibres have good acoustic property. The sound absorption property is dependent on the thickness and bulkiness of the fabric and the arrangement of fibres but it is less dependent on the length of the fibres [8].

4.3 Thermal characteristics

The properties and the structure of the fibrous materials play an important role in thermal behaviour of the fabric. The heat retention was better in the kapok fibre than that of other fibres due to the static immobile air held in the large lumen region. The conductivity of the kapok fibre ranges between 0.03 and 0.04 W/m.K for the fibre's density which lies between 5 and 40 kg/m3. Therefore, kapok fibre has a good heat insulation property [9].

4.4 Spinning and weaving property

Because of the short length and low elastic nature of the kapok fibre, it is difficult to spin and this limits the application of kapok fibre in apparel [2]. The spinning of kapok blended with cotton fibre is successful and the content of the kapok should not exceed 50% as the yarn regularity and tenacity decreases and it also affects the weaving property [10].

4.5 Dyeing property

As the material is hydrophobic in nature and it contains wax content, it will not allow the water-based dye molecules to colour the fibre. Pre-treatment of kapok textile can be done to remove waxy substances, impurities present on the surface of the fibre and to achieve certain whiteness and the dyeing property can be improved. Then it can be dyed by adding a complexion rare earth mordant into the dye bath and mordant dyeing can be done for the kapok textile [11].

4.6 Microbiological property

Kapok fibre is not easily attacked by ordinary cellulolytic bacteria because of high lignin content and it shows the antibacterial property of the fibre [12]. Liu et al explored the anti-moth, anti-mite and antibacterial properties of kapok battings. They concluded that the results of anti-moth test showed that the mean value of weight loss of kapok batting was smaller than reference sample obviously, and the damage grade of surface of kapok batting was 2A. In the anti-mite test, the anti-mite property of kapok batting was also proved as the mite expelling rate was 87.54 %.For antibacterial test, it was confirmed to possess both the bactericidal effect and bacteriostatic effect on Escherichia coli. But in contrast, it did not have these effects on Staphylococcus aureus [13].

4.7 Mechanical property

Researchers studied the mechanical properties of the kapok fibre and according to the tested result of four types of kapok fibres, the average breaking strength and breakage elongationranges between 1.44–1.71cN and 1.83%–4.23% respectively. By comparing with cotton fibre, kapok fibre has the lower tensile elongation, similar breaking tenacity and initial modulus [14]. The bending rigidity of a single kapok fibre is lower comparing with cotton and some synthetic fibres. However, its relative bending rigidity is much higher compared to other fibres [15]. The compression test is an indirect evaluating method of kapok fibre hollowness and manufacturing technology of kapok products, with the finding that the compression elasticity of dry kapok fibrous assemblies is better than that of wet kapok fibrous assemblies [16]. For the kapok/cotton blended yarns, the mechanical properties can be improved by mercerization process. As the concentration of NaOH increases from 180 to 250 g/L, the strengths of kapok/cotton blended yarns increase and elongations at break decline. And up to 280 g/L, the strengths of yarns exhibit a dramatic drop and elongations at break will have a gradual increase with an increase in kapok fibre content [17].

5. Applications

The various applications of kapok fibre are listed in Figure 3 and they are discussed in detail below.

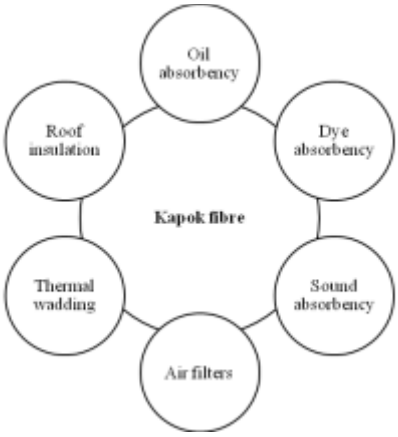

Figure 3 - Applications of Kapok fibre

5.1 Oil absorbency

Kapok fibre's hollow lumen, waxy surface, hydrophobic–oleophilic property makes it unable to sunk in oil or water [18]. Therefore, it is used in deep bed filtration to separate the oil and water. Filter made from kapok helps in reducing COD and turbidity [19]. It has high retaining stability after reusing for 15 times [20]. In fresh water and seawater, kapok fibre can absorb significant amounts of oil (40 g/g of fibre) [4]. The treatment of kapok fibre with water, HCl, NaOH, NaClO2 and chloroform was shown by Jintao Wang et al. The various properties was tested by using FTIR, SEM, XRD and XPS characterization. Kapok fibre's oil sorption capacity is not affected after wax removal. To improve the absorbing property, NaClO2 treatment was preferred. After squeezing, the fibre was found to retain the oil. When compared to conventional oil sorbents, kapok sorbents have high oil absorption, excellent reusability and good biodegradability without water [7]. Using the sol–gel method using TEOS as the precursor followed by the hydrophobization of DTMS, a superhydrophobic surface was fabricated on kapok fibre. Better oil/water selectivity and higher oil sorption capability has been reported after the surface modification of kapok fibre. It can be reused for several times by removing the oil by simple mechanical squeezing. The result shows that the oil sorption capability can be increased by superhydrophobic modification for cellulosic materials. The advantages of this modification lead to replace the organic oil sorbents to remove oil spilled in water in larger quantity [21].

5.2 Metal ion absorbency

Kapok fiber exhibits a less attraction toward metal ions. In metal solvent extraction, it can adsorb an extractant. To get a solvent-impregnated kapok fibre, Higa et al. used 2-ethylhexyl phosphonic acid mono-2-ethylhexyl ester and stated that the kapok fiber has higher impregnation ability (Zhou et al., 2010). Impregnated kapok fibre is used to remove the D2EHPA (Huynh and Tanaka) [22].

5.3 Dye absorbency

Kapok fibre comprises of cellulose and lignin, and these elements exhibits high attraction to dyes in liquid solution. Still, adsorption characteristics of dyes in kapok fibre has not been analysed because presence of waxy layer makes it water resistance. To make it dye absorbent, kapok fibre has to be treated to remove the waxy substances. To convert kapok fibre as hydrophobic to hydrophilic, treat it with sodium chlorite and at the same time, the lignin can be separated from kapok fibre. Wang et al. discovered that a good adsorption capacity for MB is shown by the resulting optimum adsorbent (110.13 mg/g) (Liu et al., 2012) [22].

5.4 Sound absorbency

Kapok fibre's hollow structure, with 16.5 ± 2.4 μm fibre wall, 14.5 ± 2.4 μm lumen diameter and 25 ± 5 μm fibre length (Huang and Lim). Sound waves and fibre's friction makes it suitable for sound absorption. It can be made as sustainable sound absorbing material with the help of its excellent

chemical stability for noise reduction. An earlier study shows that kapok fibre has good acoustical damping performance, and that the sound absorption is due to the bulk density, thickness and arrangement, but less influence on the length of the fibre. Kapok has same thickness with less bulk density compared to the glass wool and degreased cotton fibres (Xiang et al). Combination of polypropylene fibre and kapok fibre for the improvement of sound absorptive nonwoven materials has been found. The test result of the sound absorption coefficient and noise reduction coefficient shows very good sound absorption behavior with frequency range (250–2000 Hz). A 30:70 blend ratio of kapok fibre/polypropylene shows good characteristics in air gap provided (Veerakumar et al) [22].

5.5 Air filters

Using wet laid method, kapok fibres were used in the production of air filtered papers are discussed. The result shows that kapok fibre causes loose paper structure. Increasing the kapok fibre, increases the thickness and the air permeability of the filter papers but it leads to decrease in the filtration efficiency increasing the fibre diameter. In loading test, oil aerosol loading performance is influenced by the content of the kapok fibres. During the first and second stage of pressure drop, the curve becomes flat due to the higher content of kapok fibres which gives long lifetime for the filter papers. The filter paper's cost is around 6000–7500 dollars per ton. However, commercial product's cost is 30,000 dollars per ton which is used for oil gas separation. Therefore, the filter paper made from kapok fibre is an excellent material for the air filtration against oil aerosols [23].

5.6 Thermal wadding

The blend of kapok fibre with PET are used for the production of nonwoven waddings with different combination are discussed in this study. The content of kapok fibre influences the non-woven's thermal resistance property. At higher punch density, increasing the kapok fibre percentage decreases the thermal resistance. To increase the thermal insulation, the light needle punched nonwovens is used because of entrapped air in the structure and high bulkiness. In the case of air permeability, increasing the kapok fibre percentage decreases the air permeability for fabrics with low areal density. It can be seen from the study that blend ratio with less kapok fibre and low needle punch density shows good insulation. This is a step to create sustainable and eco-friendly environment [24].

5.7 Roof insulation

There is a very less study done on using kapok fibre as an insulation material. And also, there is no research about using kapok fibre as a roof insulation material. Since kapok fibre has acoustic and good thermal property, the study has to be carried out. Finding the application of kapok fibre might result in building industry in countries that produces this fibre [25].

6. Conclusion

Nowadays, kapok fiber has received greater attention as an environment friendly material for its intrinsic advantages features. The fibres are inherently mold free and free from pesticides as they contain large amount of lignin and wax content in it. This article highlighted the structure, properties and applications of kapok fibres in various sectors including air filters, oil absorbency, metal ion absorbency, dye absorbency, sound absorbency, air filters, thermal wadding and roof insulation.

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Overview of Regulations in Textile Innovations and Products

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Abstract:

Abstract Antimicrobial textiles are in great demand, and are considered to be more popular and beneficial in preventing the biodeterioration of fabrics. Natural fibers are good substrates and are more susceptible to microbial growth as compared to synthetic fibers since these fibers are composed of cellulose. Fungi growing on such fabrics secrete enzymes and digest the cellulose to glucose. Beside glucose, other nutrients for bacteria are sweat and oil secreted by human skin, dust, soil and finishes. As consumers are aware of the deleterious effect of microorganisms on fabrics and personal hygiene, hence, nowadays antimicrobial fabrics have gained more interest. Textile industries follow different methods to produce antimicrobial fabrics using Synthetic antimicrobial agents comprising of Inorganic and organic finishes. Inorganic finishes include salts and oxides of metals, organic finishes include Quaternary ammonium compounds, Triclosan, and PHMB. Synthetic antimicrobial agents (organic and inorganic agents) are toxic, cause skin irritation and are non-biodegradable, so they are harmful for users and the environment as well. Due to adverse effects and negative impacts of these agents on human health and environment, researchers and users (customers) are discouraging the use of synthetic antimicrobial agents. Natural antimicrobial agents have gained attention and interest of researchers in the last few decades. Several natural agents such as Turmeric, Neem, Basil, Cloves, Pomegranate, Aloe Vera, Chitosan and Onion have effective antimicrobial potential. This review paper focuses on different types of synthetic antimicrobial agents, natural antimicrobial agents, their sources and how they can be used on textiles to introduce antimicrobial properties. This review paper also highlights the applications of nanotechnology in developing antimicrobial finish based on nanoparticles in order to minimize the risk associated with microorganisms [82].

Keywords: *Antimicrobial, Chitosan, Efficiency. Organic agent*

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1. Introduction :

Textile fabrics have important applications in sports equipment, sportswear, food packaging and home furnishing, hotels, restaurants, healthcare and hygiene. Now-a-days the interesting area of research is antimicrobial fabrics. Biodeterioration of textiles is a greater problem, microorganisms such as bacteria, fungi, algae and viruses can grow on the textiles. Bacteria are a unicellular microorganism which grows under specific conditions such as moisture, warmth or temperature, pH and nutrients. Bacteria are subdivided into gram positive and gram negative, spore bearing and non-spore bearing. Molds or mildews are complex organisms with slow growth rate. The presence of microbes on fabrics causes cross infection by pathogens and development of bad odor in the worn fabrics next to skin [1]. The growth of microorganisms on fabrics leads to reduction in mechanical strength and biodeterioration of textiles. Almost all types of fibers are affected by microorganisms but natural fibers are more susceptible to biodeterioration than synthetic. There is increasing concerns about Vancomycin-Resistant Enterococci (VRE) survival on fabrics, the transfer of gram positive bacteria, particularly Multi Resistant Staphylococcus aureus (MRSA) and Vancomycin Resistant Enterococci (VRE) are growing concern in hospitals. The reason for bacterial transfer is the ability of the microorganisms to survive on various common hospital surfaces [2]. Fabric type is also an important factor that influences the duration of bacterial persistence in or on the fiber. McNeil and Greenstein stated that the physical characteristics of the fibers, and surface electrical charge on fiber as well as on bacterial cells may be involved in influencing the attachment of bacteria towards the surface of fabric [3]. Now there is a strong interest and requirement of an antimicrobial agent which must be non toxic to human skin, eco-friendly and have biodegradative properties.

Process of antimicrobial finishing and finishing mechanism

A fabric processed with antimicrobial finish must have the capability to inhibit the growth of bacteria (bacteriostatic finish) or to kill the bacteria (bactericidal finish) inhabited on the skin surface. An antimicrobial agent can kill or inhibit bacteria on the basis of its mode of action; it may act on bacterial cell wall, protein synthesis machinery and can also disrupt the structural and functional integrity of bacterial cell membrane. Plants, spices and herbs are considered to be a good and rich source of phenolic, Sulphur, aldehydes and ester terpenoids containing compounds.

These naturally occurring bioactive compounds commonly found in stem, leaves, roots, flowers, seeds, bulbs and other parts of plants. These bioactive agents are helpful in inhibiting and inactivating the growth of the bacteria, yeast and molds [4]. Large variety of antimicrobial compounds can be obtained from spices and these plant based compounds are biostatic in nature [5]. A few organic antimicrobial agents such as Triclosan, Quaternary ammonium compounds, N-halimanes. PHMB and silver (inorganic antimicrobial agent), are commercially in use and are bactericidal in nature [6, 7, 8, 9]. Natural compounds are increasingly becoming popular as antimicrobial finishing agents [4, 5]. Based on the antimicrobial action performed by the particular finishing agent, there are three finishing mechanisms i.e. control

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release, regeneration and barrier block. There are limitations of control release and regeneration mechanism i.e. durability concerns after washing(laundering) and leaching of the antimicrobial agent from the fabric and in turn reaction with the user's skin surface that result in skin allergies and skin irritation. Fabrics which have undergone regenerate finishing mechanism can also cause such problems; in this method antimicrobial agents require chlorine bleach to enhance wash fastness or to activate antimicrobial properties after washing (laundering). Chlorine bleach is harmful for human skin and damages the cotton fabric as well. Third method, barrier block mechanism has advantages over other two methods. In this method, antimicrobial agents are chemically bonded to the fabric surface and do not release (leach), hence killing microorganisms that come in contact with the fabric [10]. Depending upon the morphology, texture, composition of the fiber and on the antimicrobial agent to be applied, different physical, chemical methods are available and under development to impart antimicrobial properties to the textiles. Antimicrobial agent can be directly incorporated into the polymeric matrix of synthetic fibers [11]. Microencapsulation is a technique by which solid particles or liquid droplets are covered with a continuous thin film of a material, polymeric in nature [12]. These capsules can be applied on the fiber with the help of binder using spraying, padding, impregnation, exhaustion method or screen printing. This technique is more advantageous as compared to other processes as it is energy saving, economic, eco-friendly and there is controlled release of substance [13]. Crosslinking is an effective way to embed an antimicrobial agent into the fiber. Cross Linking occurs when cross linker creates covalent cross linkages between the antibacterial molecule and the polymer chains of the fabric. Examples of crosslinkers are glyoxal, genipap, dextran soleplate, glutaraldehyde, ethylene glycol, diglyceryl ether, 1,1,3,3-tetramethoxypropane, ethylene glycol diglyceryl ether (EGDE), diisocyanato and oxidized cyclodextrins [14,15]. Crosslinking can be introduced by physical [16], chemical [17] and radiation method [18]. In physical method, ionic interactions are required between polymeric chains. So, radiation, chemical methods are more durable as compared to physical method. In order to ensure strong adhesion of antimicrobial agents (finish) to the textiles, surface properties of the fibers are altered. Various surface modification methods are ultrasound technique, surface bridging, oxygen plasma treatment, UV irradiation, enzyme treatment. These are the new and recently investigated methods which are used to enhance durability of antimicrobial finish onto the fabric especially for plant based antimicrobial agents [19]. Antimicrobial agent may act by diffusion and by contact mechanism, depending upon the approach used to apply antimicrobial agent on the fabric. In the diffusion mechanism, an antimicrobial agent diffuses from the fabric to the user's skin and kills the microorganisms. In contact mechanism, antimicrobial agents do not release or leach from the fabric, when bacteria attack the fiber, it will be killed just after coming in contact with the fiber [20]. Antimicrobial finish for textiles must exhibit following characteristics and requirements :durability of antimicrobial activity to washing (laundering), dry-cleaning and leaching and Selective and specific activity towards pathogenic and undesirable microorganisms. The treated fiber must have the property of acceptable moisture transport and must be resistant to discoloration, staining and quality deterioration [84, 85].

2. Types of Antimicrobial agents

2.1 Organic Antimicrobial agents

Synthetic organic antimicrobial agents commonly used as antimicrobial finish are Quaternary Ammonium Compounds (QACs), Triclosan (2, 4, 4'-trichloro-2- hydroxydiphenyl ether), Polyhydroxy methylene biguanide (PHMB) and antimicrobial dyes. These are organic synthetic antimicrobial agents. QACs are cationic in nature; they carry positive charge at the N atom in the solution. They are attached to an anionic surface of the fiber via ionic interactions [11, 21]. Quaternary ammonium compounds are shown with the formula (R N X) they include 191 compounds and refer to linear 4 + - alkyl ammonium compounds containing alkyl chains which are hydrophilic in nature and counterparts which are hydrophobic in nature. QACs containing 12 to 18 carbon atom alkyl chains are preferred in the textile industry, especially for finishing of wool, cotton, nylon and polyester [11, 22, 23]. These compounds show antimicrobial activity against a wide range of microorganisms such as gram positive and gram negative bacteria, fungi, some viruses [21, 24]. Yao 2010 et al developed poly(D,L lactide) (PDLLA) fibrous membrane with its surface altered with domains or moieties of QACs, showed antibacterial efficiency of about 99.99% against both gram negative (and gram positive E.coli) bacteria (It was observed that antibacterial Sauries) activity was dependent upon interaction of positively charged modified PDLLA fibrous membrane with negatively charged bacterial cell membrane, that resulted in leakage and loss of permeability of bacterial cell [25]. Triclosan is an odorless, organic compound used as synthetic antimicrobial agent on the fabrics.

It has antimicrobial efficacy against both gram positive and gram negative bacteria, it also exhibits antiviral and antifungal properties [11, 26, 27, 28]. It is biocidal in nature and acts by blocking and inhibiting the lipid biosynthesis such as lipoprotein, lipopolysaccharides and phospholipids, thereby altering the cell membrane integrity [26, 27]. Triclosan shows toxic effect, dichlorodibenzo-p-dioxin in aqueous solution. Hence, due to its toxicity, use of Triclosan as an antimicrobial agent is also a great concern [29, 30]. PHMB (Poly hydroxy methylene biguanide) ((C H N)), it is a 8 17 5 n polycationic amine in which biguanide groups act as cationic groups, which are interspersed between hexamethylene groups, which are hydrophobic in nature. It exhibits hydrophobic and electrostatic interactions with bacterial cell membrane, causes cell membrane disruption and finally results in cell leakage. It has been observed that antibacterial activity of PHMB depends upon level of polymerization [31]. Reputex and Biozac R ZS, which are

PHMB-based products of textiles, are available in the market as finishing products [32]. Besides yeast and fungi, it is effective against gram positive and gram negative bacteria. It is preferably used in towels and undergarments to obstruct the microbial growth and exhibits good washing durability. At the pH values of 5 and 6, PHMB exhibits effective antimicrobial inhibition action [33,34]. N-Halamines are organic compounds having one or more covalent bonds between nitrogen atom and halogen (N-Cl), generally chlorine is present. N-Halamines can be amine or amide, imide, depending upon the covalent bond formed. N-Halamines are broad spectrum as they show biocidal action against bacteria, viruses and fungi by interacting with the acceptor region of microorganisms and inhibiting their metabolic and enzymatic activities, and consequently, destruction of target microorganisms [35]. Inorganic Antimicrobial Agents A number of oxides and salts of metals like copper, zinc, silver, gold, titanium, magnesium are used as antimicrobial finish. Three different types of Zeolites such as chabazite, mordenite and faujasite are considered to be antimicrobial i.e. against bacteria and fungi. chabazite has lowest silicon to aluminum ratio(Si/Al). This Zeolite was solution exchanged with metal cations with different combinations of [86]. These zeolites are applied on fabric to create novel, sustainable polymers with improved characteristics like stiffness, hardness and high antimicrobial potential [86]. Complexing metallic compounds based on metals like cadmium, silver, copper and mercury cause inhibition of the microbial metabolism. Silver acts as an effective antimicrobial agent by targeting the microbial proteins. Silver releases slowly from the fiber surface and shows toxic effects [36, 37, 38, 39]. Silver particles show broad spectrum antimicrobial properties, on biomedical textiles, particularly in hospital acquired infections which result in polymicrobial colonization [11, 40]. Silver shows bactericidal activity against gram positive and Gram negative bacteria such as Staphylococcus aureus, Staphylococcus epidermidis, Pseudomonas aeruginosa, Klebsiella pneumoniae and E.coli [41]. According to a manufacturer survey in Europe, market data reflected that 79% of silver is used as silver salts, 13% is used as metallic silver and 8% as silver ion exchange in textile industries [40, 11, 22]. It has been observed that bacteria develops resistance against silver-based products [40, 42].They are attached to the fiber surface, so their bactericidal activity decreases day by day. In order to achieve effective control of bacterial growth, a large amount of these antimicrobial agents need to be applied on the fabrics [43].

2.2 Natural Antimicrobial Agents

Natural antimicrobial agents are those which are obtained from plants and animals. These agents have gained more attention due to their characteristics such as they are eco-friendly (biodegradable), human skin friendly, so they are used in textiles, Pharmaceuticals, biomedical and healthcare fields. It has been observed that some specific species of herbs exhibit antimicrobial activity are considered for textile application [45]. Researchers have investigated that different parts of the plants such as leaves, stem, roots, flowers and bark can be used to get extracts which are rich in phenolic compounds, alkaloids, tannins, saponins, quinoids,, flavonoids and terpenoids which exhibit strong antimicrobial properties [46, 47].Researchers have observed that carvacrol and hydrocarbons monoterpenes show synergistic effect. Same effects were reported for eugenol/thymol and eugenol/carvacrol against the bacteria Eugenol and carvacrol disrupt E.coli, the outer cell membrane of E.coli and allow eugenol to enter in the cytoplasm of bacterial cells. Due to this synergistic effect, it has been noticed that there is reduction of concentration required to yield antimicrobial effect as compared to sum of concentrations of purified components [48, 49]. Aloevera (Aloe barbadensis), it is plant-based source and belongs to the family Liliaceae. The extract from its leaves have antifungal and antibacterial properties. It has been used in sutures, dressing gauzes and also in other medical textiles applications [50, 51]. Aloe Vera extract is used for antibacterial finish on cellulose fibers and cotton. It is in significant use in biomedical and healthcare textiles [52]. Neem (Azadirachta indica) is another plant based source; it belongs to the family Mediacies. extract from all parts of the plant have an effective antimicrobial potential. The bark extracts of neem have been successfully used on blended fabrics (cotton/polyester) and cotton [53, 54, 55]. Pineapple (Ananas comosus) is a fruit based plant source and its juice has antimicrobial action and is tested against selected enteric pathogens [56]. Papaya (Carica papaya) is also a fruit based plant source. Agar diffusion method was used to evaluate its antibacterial potential. Vitamin A, C and E , the three effective antioxidants, are present in its fleshy fruit tissue. Its juice has an effective antimicrobial activity against gram negative bacteria [56, 57, 58, 59]. (Ginkgo biloba Mantissa plantarum altera) is another plant based source with antimicrobial potential. It belongs to the family Ginkgoaceae. The extract obtained from Ginkgo biloba leaf contains 5 to 7% ginkgolides and bilobalide [60].

Researchers used Ginkgo leaf extract formulation containing crosslinking agent along with silicon softer and investigated its antimicrobial action against Tencel fabric. Ginkgo extract is also used in cotton textile treatment for healthcare. [61]. Standard Extract is considered to be eco friendly and its application also tested on medical and healthcare products. Due to its effective antimicrobial potential, it is used as finish on hospital beddings, surgical gowns, drapes, nurses' uniforms [61]. Standard concentrations of Ginkgo extract are recommended, beyond these concentrations, cytotoxicity observed [62, 63, 64]. Essential oil extracts from plant sources such as Rosemary (Rosmarinus of Ÿicinalis) (Citrus sinensis) and orange was used to evaluate antimicrobial action on blended fabric(56% cotton and 44% polyester), different concentrations (1%, 3%, 5%) of each oil extract were used and tested against pathogenic fungi. It was interpreted that fabric treated with rosemary oil extract showed 56.99% reduction in growth of fungi and fabric treated with citrus peel oil extract showed 92.48% reduction in growth of pathogenic fungi [65]. Different parts of the plants such as Mint clove ((Mentha arvensis), Eugenia

caryophyllata) false daisy and Leadwort (Ecliptic Alba Plumbago Zetlandic) were dried, powdered, grounded and solvents used for extraction. After extraction, antimicrobial finish was applied on the fabric by pad dry cure and microencapsulation technique. The treated fabric with finish showed antimicrobial efficacy till 15 washes [66].

3. Conclusion

Nowadays, varieties of antimicrobial agents are available in the market such as synthetic inorganic agents, synthetic organic agents and natural antimicrobial agents. Synthetic agents are non-biodegradable, show toxicity, cause skin irritation, allergies and have serious bioaccumulation concerns. Natural antimicrobial agents, on the other hand are biodegradable, biocompatible, skin friendly, eco-friendly and non-toxic. They are more promising as they show effective antimicrobial potential. Washing durability is the main disadvantage of these agents, but still these agents are widely accepted and gaining more interest. Nanoparticles which are plant based have advanced properties and provide protection to broad spectrum of pathogens as compared to conventional agents. The textiles finished with natural, plant based sources, can have future applications in biomedical, pharmaceutical and healthcare products.

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Mr. Nilesh Todi
Executive Director

MMP Filtration Pvt. Ltd., established in 2003 is frontrunner in yarn manufacturer, has a cutting- edge infrastructure in Ahmedabad, Gujarat with capabilities and technology to manufacture top-notch quality yarns offering desirable properties in customized variety of blends. Some of our yarns are High Permeable Irregular Slub Yarn, Core and Sheath Yarn, Melange Yarn, and Uni Colour Twisted Yarn. With 18 years of expertise in Technical Textile, MMP Filtration is the first and at presents the only producer of High permeable bulky yarn using DREF technology friction spinning and Ring Spun yarn for technical textile application. Our vision is to change the dynamics of textile world by continuously identifying and implementing innovative potentials and delivering products that enrich lifestyle and technical textiles with the focus on sustainable and inclusive growth.

E-mail: hpyarn-ahmd@mmpfilter.in

DREF Spinning Technology

Mr. Nilesh Todi

DREF spinning which is conventionally known as Friction Spinning operates on the basis of mechanical/aerodynamic spinning system with an internal suction and same direction of drums rotation. Drafted slivers are opened into individual fibres by a rotating carding drum covered with saw tooth type wire clothing. The individualized fibres are stripped off from the carding drum by centrifugal force supported by an air stream from the blower and transported into the nip of two perforated friction drums where they are held by suction. The fibres are sub-sequentially twisted by mechanical friction on the surface of the drums and produced yarns result in high resilience with bulkiness and high air permeability.

The Core-Sheath combination produced offers improved resistance, strength and combination of different yarns like copper, stainless steel in core which can be used for various applications.

APPLICATIONS & REASONS

- 0.6Ne -1.5Ne-filter cartridge
- 7Ne- for filter fabric where the weft of the filter fabric is with friction spun yarn
- Due to high air permeability of the Dref Friction Spun Yarn, the dirt holding capacity of the filter cartridge and the filter fabric increases tremendously. It also helps the filtration process with higher efficiency
- Friction products such as brake lining, brake shoe, clutch lining etc. are in high demand. Yarn produced through this process is in very high demand. After processing the friction spun ,the other yarns are used to combine on TFO to produce yarns which are used for applications using multifilament glass fibre yarn or UHMWPE as core yarn with Para Aramid fibre as sheath
- Cut Resistant gloves
- Apparel

Other areas where core spun through Friction Spinning are used in shoes, ropes and industrial cable manufacturing. Filler cartridge for liquid filtration is also effectively made with these yarns. Secondary Carpet Backing for tufted carpets can be produced with waste fibres in this spinning system. Upholstery, Table cloths, wall coverings, curtains, handmade carpets, bed coverings, and other decorative fabrics can be produced economically by DREF Spinning System. Heavy flame-retardant fabrics, conveyor belts, clutches, brake linings, friction linings for automobile industry, gaskets are some other examples where the DREF yarns can be effectively used.

Filter fabrics:
Polypropylene filter cloth is extensively used in in liquid-solid filtration mainly for its excellent filter cake release and good resistance to most acids and alkalis. Thanks to its super low moisture absorbption, woven polypropylene in weft on filter fabric in twill, plain weaves is a preferred selection for filtration purposes

Advantages of PP Filter Fabric:

- filter life cycle will increase
- Lightest weight among synthetic fabrics
- Excellent gas permeability
- Free of mildew and oxidation
- Good resistance against acids, alkalis and reducing agents
- Available for large to fine particle filtration

PP Filter Fabric is commonly used in:

- Chemical
- Pharmaceuticals
- Sugar
- Non ferrous metal smelting
- Sewage treatment and many more

PP Secondary Carpet Backing:

Colour, texture, type etc. are always things to consider for any carpet purchase. But, if you flip it over, you'll find something else that is important-"The Backing". So, what exactly is carpet backing? The underside of a carpet is also called the backing. It secures the tufts and gives the carpet additional strength and dimensional stability.

Most carpets have a double backing :The Primary Backing- where the yarn is tufted into, and The Secondary Backing- which is the outer material, from polypropylene and is lightweight, strong, dimensionally stable, mildew resistant, economical, has moisture wicking property and is more durable and long lasting than the traditional backing. Polypropylene is being used widely for secondary carpet backing these days.

A Note from Our Executive Director:

"MMP is set out to carve its niche in making Futuristic Fabric for a sustainable and better world. We live by the ideology of 'Dream, Create, Produce' to bring about yarns that will create a world of difference and elevate India ahead of the completion on global map. At MMP, technology, innovation and experience are integral not only to spinning new yarns, but also to spinning a roadmap for the future."

This may increase general awareness of DREF Friction Spinning Technology and its uses and advantages as experienced by MMP itself.

For more information visit:
www.mmpfilter.com
www.mmpglobal.in

Word of Mouth Publicity - Still the Best Marketing Tool

Rajesh Balkrishna Padalkar
Principal Owner, Blkrsna Media Events Hospitality

There is a term which most of us remember fondly – "Friday-First Day First Show." The importance of this term was that it influenced the fortunes of the new films. It swayed the destinies of film stars and producers. New talent was born and many a times established super stars crashed to earth from their stardom. The first reaction of the audience coming out from the theatre after watching the film, decided if it was a hit or a flop. If the people gave a favorable response the news spread in the community, thereby pursuing others to watch the film. Any negative feedback restricted others to come to the theatres. In the absence of social media, the word-of-mouth publicity was the best marketing tool.

He said that, in the presence of the social media too, the Word-of-Mouth publicity is still the best form of marketing tool.

Word-of-mouth marketing is important for every business - big or small, as each customer can bring dozens of others your way. So, the best persons to talk about your products are your existing happy customers. For example, if you want to buy a new car or a new house or even if you want to go for a vacation, the first person you ask for their opinions are your friends and family persons. Recommendations given by them are believed very easily as they are trusted persons to you. Feedback given by them has a definite impact on your decision. If the feedback is negative then it definitely makes you for some other alternatives. Word-of-mouth marketing is important because consumers trust their family members, friends, and colleagues, so hearing they talk positively about a brand or a product makes them want to try it out, too. It's an effective type of marketing because it's based on sharing positive experiences from people who've tried a service or product and are very much happy about sharing their own personal experiences. Hearing a positive first-hand experience from a friend in your close social circle greatly influences the decision to buy.

Whether your business is small or big, following are the best ways to have your own Word-of-Mouth campaigns through modern day social media.

Happy Customer Testimonials:
In the digital world one of the first campaigns to have would be publish an interview with a happy and reputed customer. Simple questions are to be asked to the customer to get favourable replies. This short 4–5-minute video can be uploaded on YouTube and the link can be shared with everybody. Such a video always influences other customers to avail your services or buy your products.

In most businesses, also in the textile field, the owner or a top management person is interviewed for this purpose. It would also make sense if the supervisory level or shop floor level person's interview is also taken and published across the social and print media. Imagine the word-of mouth publicity generated by a technician in his or her friend circle and the message it gives to others who may be in the same field but may not be using this particular service or product. The goodwill generated by this act cannot be measured in terms of direct revenue but it certainly creates a good image of the company. Also in the long term you never know, if the todays technician is tomorrows decision maker, he or she is surely to buy your product/machines first.

Guest Speakers:
Another way to generate word-of-mouth publicity is to have a customer day celebration in your area or city and ask one of the prominent customers in that area to be a guest or key note speaker. This customer is the soft advocate and ambassador of your product. His or her influence can reach and spark conversations and interest in your product/brand. The amount of free publicity generated is more than equal to a big and costly marketing campaign. The potential customer is motivated to make a quick decision. If he or she had multiple options then after hearing from an industry peer the best choice is zeroed on. If someone else has purchased from the brand and says it's worth it, then there is no reason not to trust them.

Make people talk about your service/product:
The more your customers and potential customers talk and discuss about you, the better mileage you get. A very simple way is to have a contest for your sector or industry with attractive prizes as giveaways. As for most of the contests generally there are three prizes, but it would make sense to have 100 consolation prizes as well to have more winners. Circulate the contest details on your social media platforms and also on your WhatsApp groups. Keep the questions very easy to answer. This creates a buzz in the industry and a word-of-mouth campaign is generated by the initial users who influence and talk about your brands to other peers. This also helps you get a genuine data base of other potential customers who enter your contest.

Case studies/success stories:
This is another form of word-of-mouth marketing activity. A case study is generally a short document narrating the before and after events of a particular customer who has brought your service or product. The narrative details the pain the customer had with, perhaps some other product or the lack of that product. It then goes into the details of their journey to buy your product and then finally the benefits he or she had buy using your service/product. The success story almost certainly has a testimony from the buyer. Such customers, in most cases are generally people who are trusted in certain circles and they tend to be more relatable and approachable.

In conclusion we can say that however much you spend on your marketing campaign ultimately it's your service/product and its end users who decide your profits. If the end user is happy and tells it to others, you need not bother about the growth of your business. Just keep your customers happy and they generate good will which brings in new customers.

Interview with Mr. V. V. Gharat

Mr. Vilas V. Gharat
Trustee – TAI Mumbai Unit
Managing Director - Gharat & Associates

Working as a Managing Director, for Gharat & Associates, having over 50 years' experience in manufacturing function in all composite sectors of Textile Industry. Out of which more than a decade in Operations and HR with emphasis in Business Process Consulting.

Mr. J. B. Soma, Hon. Ass. Editor & Publisher of JTA, took the opportunity to have the deliberate with Mr. Gharat on the current issue of sustainable in Textile Value Chain.

In these Pandemic times, increasing focus on the education, the role at the academic institutes with maintaining the standards of their teaching, Mr. J. B. Soma, Hon. Asso. Editor & Publisher of JTA, took the opportunity to have the deliberation with her on the Educational Leadership and the Pandemic.

Q.: Can you highlight on Sustainability in Textiles and Opportunities?
Ans.: The Sustainability in any business is continuity in getting advance orders with better profitability. The Textile Industry is having many products hence there is excellent opportunities provided we continuously carry out product innovation & developments as per market trends and demand.

Q.: How to achieve sustainability across textile value chain, using 3R (Reduce, Reuse and Recycle)?
Ans.: The present pattern of value chain in Textile Industry is segmented & hence it is not cost or quality effective. The Spinner does not know what type of fabric will be woven & what raw material specifications are required. Same are with further chain hence it very important to set product wise value chain.

The highest cost of final product is Raw Material & hence all 3 R (Reduce -Reuse & Recycle) are to be managed skillfully. The waste generated at every processed should be properly segregated to evaluate all R. It is very wide subject & can be discussed in details in any other forum.

Q.; Which are the priorities for the business, who are looking to enhance the sustainability of their products?
Ans.: The priorities of any business are 1) Market 2) Affordable Price. 3) Customer's Satisfaction. 4) Quality 5) Profitability. 6) Product Development as per changing market requirements.

Q.: How to achieve sustainable innovation across the brands?
Ans.: The Brands are having their USP & hence continuous product development according to market intelligence is very essential for sustainability.

The present marketing systems are with return policy without any valid reason & hence all brands have to follow after sales service. They should get feedback system in place to retain sustainability.

Q.: How you utilize of Natural Fibres in Technical Textiles and what will be the future of Technical Textiles?
Ans.: There are many products in Technical Textile made from natural fibers. Especially Medical Textile Products are made from natural fibers. Such as Surgical cotton, Bandages etc. It can be evaluated separately.

Q.: What will be the Export opportunities for MSMEs Textile & Apparel sector?
Ans.: There is great scope for MSMEs to export provided routed through proper channels & maintaining quality standards. We can learn from Bangladesh & Shree Lanka who are major exporter of Garments.

Q.: What is your view on increase in GST on Textiles and Apparel products?
Ans.: The industry cannot survive unless increase of GST is passed to customers. According to me it should be reverted to 5% or even less. We cannot survive with present rising cost of Raw Materials & Power.

Q.: How the industry will react on PLI Scheme announced by GoI. and How the PLI scheme is playing out on the ground and helping the industry?
Ans.: PLI scheme is very good & it is for larger units with technical textiles -manmade fibers. According to me we should also link SMMEs & Natural fibers also.

The scheme is for Production Incentive but what about market for extra production. Hence it should also be linked with market also. There is provision for Large Textile Parks but success rate of Textile Parks is very poor. It should be managed by professionals instead of politicians.

Q.: How the increased prices on Cotton and Yarn will be affected on the Textile Value chain?
Ans.: It has been affecting value chain for many years. No further comments because it is politically managed.

Q.: What will be the new investment opportunities in Textiles and more for Technical Textiles?
Ans.: There is vast scope provided we produce value added

products which we have been importing since long. Proper market research with support of product developments is the key for investment opportunities.

Q.: What is your opinion on adaptation of digitization to channelize its potential?
Ans.: Digitalization is present as well as future for any business & hence it should be properly used. We need to have proper expertise in place.

Q.: What is your view on technology gaps and how to attract foreign technology into India through R&D & other activities?
Ans.: We Indians are capable of adopting modern technology provided it is affordable. It is my firm opinion that Indian Textile Machinery Manufacturers should try to have collaboration to make it in India without any quality compromise. It should be cost effective & affordable to Indian Industry.

Q.: What is your message to the young Textile Business Entrepreneurs?
Ans.: As long as humans are wearing clothes textile industry will flourish provided, we take following precautions.

a) Continues product developments as per changing market demand.

b) As fashion is changing very frequently avoid over engineering of product because no one expects very long life. It will keep the cost also in affordable range.

c) Customer's satisfaction & service is the key for growth of business. Hence be in touch with your customers.

d) Have creative designers with require infrastructure for product development.

e) Avoid Pyramid Management structure which is confusing & costly also. Linear structure is very effective for better communication with shop floor staff & workers.

f) Have proper MIS reports & unbiased review through proper expert.

g) Most important to have daily P/L review system to maintain strong financial health of company. We have been supporting units to do it.

TAI Higanghat Unit

Mr. A. K. Jain elected as President

The Textile Association (India) - Higanghat Unit established in the year 1980 and now having more than 380 memberships. The Textile Association (India) – Higanghat Unit conducted an election and declared the following Office Bearers for the term 2021-2023, in their Annual General Meeting held on 26-12-2021.

A.K. Jain
President

Shanksr S. Kutte
Vice President

Avinash Mehta
Hon. Secretary

Ravikant
Vice Chairman

President	:	Mr. A. K. Jain
Vice President	:	Mr. Shankar S. Kutte
Chairman	:	Mr. Akosh Akade
Vice Chairman	:	Mr. Ravikant
Hon. Secretary	:	Mr. Avinash Mehta
Hon. Jt. Secretary	:	Mr. Subhash Kodande
Hon. Treasurer	:	Mr. B. C. Swarnakar

Also the following Members were elected as Members of the Managing Committee.
G. K. Dhang, Rakesh Chandarana, Anil Singh, Ramesh Dayma, Hemant Kochar & Nikhil Neralwar

Delhi Unit

Mr. Vikas Chachra elected as President of TAI Delhi Unit

The Textile Association (India) – Delhi Unit established in the year 1965 is having more than 2490 Membership.

Following Office Bearers have been elected for the term 2021-2023

Presently he is a Proprietor of his V. K. Associates.
He was Vice President of The Textile Association (India) – Central Office during 2017-2019 and 2019-2021.

Mr. Vikas Chachra
President

Mr. Ritesh Gupta
Vice President

Dr. R. S. Antil
Chairman

Mr. Ashwani Mittal
Vice Chairman

Mr. Yogesh Mahajan
Hon. Secretary

Shiv Kumar Upadhayay
Hon. Jt. Secretary

Mr. K. K. Agarwal
Hon. Treasurer

Following members were elected as Governing Council Members:

Mr. Yogesh Mahajan	Dr. R. S. Antil
Mr. Kamal Mishra	Mr. B. R. Sinha
Mr. Ashish Gupta	Mr. D. K. Singh

Ichalkaranji-Miraj Unit

TAI Ichalkaranji-Miraj Unit Celebrated 75 years of India's Independence

The Textile Association (India) – Ichalkaranji Unit established in the year 1975 having more 840 membership.

In commemoration of "Azadi Ka Amrut Mahotsav" celebration of 75 years of India's independence, Ministry of Heavy Industries and ITAMMA with support from DKTE Society's Textile and Engineering Institute and the Textile Association of (India) Ichalkaranji-Miraj Unit organized half day Seminar on the Schemes for the development of Indian Textile Industry and Energy Audit under the Chief Coordinator ship of Dr. Saatish Lavate on 15th January, 2022.

Mr. N. D. Mhatre Director General (Technical) of Indian Textile Accessories and Machinery Manufacture Association (ITAMMA) elaborated on Schemes, Facilities and Subsidies available for the industries and developments in machines.

Mr. Pramod Daspute shared the practical case studies on Energy Saving as well as Energy Audit. Prof. (Dr.) P. V. Kadole, Director (DKTE) welcomed the gathering hinting on needs of Energy Saving in Textile Industry.

At the end, Dr. Saatish Lavate, Hon. Secretary TAI-IMU expressed the vote of thanks.

Dr. Saatish Lavate

Mr. N. D. Mhatre

Mr. Pramod Daspute

Prof. (Dr.) P. V. Kadole

Ahmadabad Unit

Unit organized the distribution of Oil & Rice to the needy members

The Textile Association (India) – Ahmadabad Unit established in the year 1948, having more than 4200 strong membership. Unit is always performing various activities for their Unit member & families along with academies. Unit is also helping the region in its difficult situations including pandemic. Unit organized Prize Distribution Function to bright students; Medical checkup & Full body blood tests; Financial Assistance to the needy members and also helped financially to the members who suffered during COVID-19 and lost loved one and facing financial burden after it. TAI Ahmadabad unit organized such several activities and acts as Unit Social Responsibility.

Recently on 05th January, 2022, TAI Ahmadabad Unit organized Oils cans and Rice bags distribution to the needy members at much discounted price.

Mr. Hasmukhbhai S. Patel, President of TAI Ahmadabad Unit took initiative and managed this activity with S/s A. D. Patel, J. H. Patel, R. J. Shah, B. S. Patel, H. V. Trivedi, and Welfare Chairman T. L. Patel, and Hon. Secretary H. C. Shah.

There was very good response and all members highly appreciated the Unit for organizing such programs.

Indian Union Budget 2022

(Views by Mr. R. K. Vij, President - TAI)

The Union Budget is focused on the growth over fiscal consolidation. Apart from 'Atmanirbhar Bharat', Budget focuses on supply-side measures with capex a target. The Rs. 7.50 lakh Crores capex planned for the year 2023 is higher than Rs. 5.40 lakh crores in 2022 planned. This expenditure is likely craved in private investment and support economic growth. As per estimates for every Rs. 1.0 Crores of capex by Government, economics production grows by Rs. 2.45 Crores.

This Budget is focused on creating Modern Infrastructure and Simplify the Process, Improving Roads Connectivity, Railways, Airports, Ports, Mass Transports, Water ways etc. will help in efficient transport of Goods & People.

The budget is rightly focused on ways to ease and improve business conditions for MSMEs. Expansion and Extensions of ECLGS to March 2023 and revamping the GGTMSE Scheme will ensure Credit flows to the sector.

Due to Atmanirbhar, we will reduce the imports and Export will increase. PLI schemes in 14 team sectors will increase our Domestic production and more jobs. Govt. should widen the HS codes Nos. under chapter head to have more investments under PLI scheme.

Allocation of Rs.17693 Crores to Cotton Corporation of India (CCI) to procure Cotton for the year 2021-22 and 2022-23 under minimum support prices will help CCI to wipe out its losses during the last two years. Cotton industry was expecting reduction of Custom Duty on Cotton to ease the Cotton prices, but Govt. only simplified the custom duties.

Exemption provided on items such as embellishment, trimmer, fastener, buttons, zipper, lining material will be beneficial to knitwear is welcomed. The decision of the Government for replacing special economic zones act with new legislation will enable the states to become Partner In the development of enterprise and service hubs. It will cover the existing Industrial Enclaves and enhance the competitiveness of our textile exports.

Government in Textile Sector announced other schemes like RoDTEP, PLI, RoSCTL, Mega Textile Parks well before the budget.

It is now for India to look for other sectors like Infrastructure development liquidity, labour and power issues, availability of raw materials ease of doing business, FTA, Technology transfer etc. to enhance the cost competitiveness of Indian products in the global markets.

At the last current Union Budget doesn't make any direct announcement for the Textile and Clothing sector, however, if we see the entire Budget, it talks more about the inclusive development of the 'New India'.

Overall sentiments are on positive toward Budget 2022 being growth-oriented.

(Views by Mr. Rajiv Ranjan, President – TAI Mumbai Unit)

The budget allocation announced on Feb 1, 2022, for the Textile Sector for the year 2022-23 is a mixed bag. While the increase in the budget allocation is marginal, the emphasis in the budget on boosting infrastructure and ease of doing business should go a long way in supporting the sector to grow substantially, especially in exports.

The allocation for the Sector stands at about Rs.12,382.14 crore which is about 8.1% higher than the revised budget allocation of 2021- 22 ,which stood at about Rs.11,449.32 crores. The allocation during 2021-22 was initially Rs.3,631.64 crores. However, it was later revised to Rs.11,449.32 crores mainly due to an increased allocation for 'Procurement of Cotton by Cotton Corporation of India (CCI) Ltd. under Price Support Scheme', from Rs.136 crore to Rs. 8,439.88 crores.

For the year 2022-23, the Government has allocated about Rs.9,243.09 for procurement of cotton which is about 9.5% higher than the revised allocation of last year. Thus the net allocation for the Textile Sector, other than cotton procurement, is higher by a marginal 4.31% at Rs. 3139.05 cr for the year 2022-23 as compared to revised allocation of Rs.3009.44 for 2021-22.

According to the Union Budget presented on Feb 1, 2022, of the total allocation of ₹12,382 crore for the textile sector for next financial year, ₹133.83 crore is for Textile Cluster Development Scheme, ₹100 crore for National Technical Textiles Mission, and ₹15 crore each for PM Mega Integrated Textile Region and Apparel parks scheme and the Production Linked Incentive Scheme. With the announcement of an allocation of about Rs.133.83 crores for 'Textile Cluster Development Scheme', the total budget allocation for Research and Capacity Building for Textiles has increased by 73.4% to reach about Rs.478.83 crore in 2022-23 as compared to the revised budget allocation of Rs.276.10 crore in 2021-22. The recently announced Production Linked Incentive (PLI) Scheme and PM Mega Integrated Textile Region and Apparel (PM MITRA) Scheme also saw an allocation of Rs 15 crore each for 2022-23. The Government has also allocated Rs.105 crore for the year 2022-23 towards 'Raw Material Supply Scheme' which has already been approved for the implementation during the period 2021-22 to 2025-26.

While this is not a part of the allocation for the Textile Sector, the government has also announced the PM GatiShakti National Master Plan which encompasses the seven engines for economic transformation, seamless multimodal connectivity and logistics efficiency. The seven engines that drive PM GatiShakti are Roads, Railways, Airports, Ports, Mass Transport, Waterways and Logistics Infrastructure. Steps have been taken by the Government for the extension of Emergency Credit Line Guarantee Scheme (ECLGS) up to March 2023. The guarantee cover under ECLGS will be expanded by Rs. 50,000 Crore to a total cover of Rs. 5 Lakh Crore. Similarly, Rs. 2 lakh crore additional credit for Micro and Small Enterprises will be facilitated under the Credit Guarantee Trust for Micro and Small Enterprises (CGTMSE). The Government is also rolling out Raising and Accelerating MSME performance (RAMP) programme with outlay of Rs 6000 Crore. All these steps will strengthen the MSME Segment which holds major share in the Textile & Clothing Sector.

Decisions like 'Amritkaal' the next phase of Ease of Doing Business (EODB) 2.0 and Ease of Living will be launched by the Government shortly. Actions of the government like the additional allocation of Rs.19,500 crores for Production Linked Incentive for manufacturing high efficiency solar modules to meet the goal of 280 GW of installed solar power by 2030 will be fruitful for the textile industry in the coming years. The decision of the Government for replacing Special Economic Zones Act with new legislation will enable the States to become partner in the 'Development of Enterprise and Service Hubs'. It will cover the existing industrial enclaves and enhance the competitiveness of our textile exports. The government has also announced various moves to incentivise exports. Gradually phasing out of the concessional rates in capital goods and project imports and applying a moderate tariff of 7.5 percent will be conducive to the growth of domestic sector and 'Make in India'.

Certain duty exemptions for advanced machineries that are not manufactured within the country shall continue and help the textile sector as Indian textile sector depends on state-of-the-art textile machineries. Exemptions on items such as embellishment, trimming, fasteners, buttons, zipper, lining material, specified leather, furniture fittings and packaging boxes will help the textile sector.

The current Union Budget doesn't make any direct announcement for the textile and clothing sector. However, if we see the entire budget speech in totality, it talks more about the inclusive development of the new India. The Government has already gone beyond a level and has done so much for the textile sector. It is now for India Inc. to look for developing at other important aspects of the businesses like infrastructure development, liquidity, labour and power issues, availability of raw materials, ease of doing business, FTAs, technology transfer, etc to enhance the cost competitiveness of Indian products in the global market.

(Source: Various Newspaper & CITI Reports)

Dr. P. R. Kakkanavar
DTT, GMTA,
M. Tech (Textiles).
PhD (Textile Technology)

Mr. P. R. Kakkanavar qualified with PhD

Mr. Pramod Kakkanavar, did his Diploma in Textiles (DTT) in 1985 from the Institute of Textile Technology (ITT), Bangalore and before joining CSTRI Bangalore, he worked for 4 years in The Century Textiles Mumbai and The Davanagere Cotton Mills, Davanagere. Then he Joined Central Silk Technological Research Institute (CSTRI), Bangalore, as Technical Assistant. He was involved in the R&D, Training and Extension Program in the World Bank assisted him National Sericulture Project (NSP) during the period 1989-1996. He concentrated in the areas of Silk Yarn Manufacture and Energy Conservation. While serving the Institute Interalia the Indian Silk Industry, his burning desire to up skill his knowledge in the field of work. He was motivated by the institute to pursue Distance Education program of the Textile Association (India) through Professional Award Committee (PAC) to obtain Graduate Membership of Textile Association (GMTA).

He passed GMTA in first rank and got Medal during the convocation held at Ichalkaranji (1996).

The skill and knowledge up-gradation through Experiential Learning Technique (ELT) under Distance Education Program of TAI, made him more proficient in serving the organization and industry with enhanced technical vigor.

During the year 2005, Central Silk Board encouraged him to pursue his Masters' Degree in Textiles Technology (M. Tech) and deputed him to do the course full time to Vishweswaraiah Technological University (VTU) at SKSJTI, Bangalore. He finished M. Tech in first Class with distinction during the year 2007.

Mr. Pramod did not quench his thrust with M. Tech, he requested the authorities of the Central Silk Board to pursue Ph. D in Textile Technology of Vishweswaraiah Technological University (VTU). The organization once again encouraged him to take admission as an in-house PhD Scholar at CSTRI, Bangalore as it is recognized as Research Centre of the VTU. In between, he worked as Officer In-charge of the Power loom Service Centre at Gadag Betgeri, Gadag District on deputation to Karnataka State Government under Power Loom Development Corporation. Using this opportunity, he chose the Product Up-gradation and Product Diversification of Handloom and Traditional Products being manufactured in the cluster- Gadag- Betgeri as topic of Research for his PhD program. He did extensive work as part of Ph D research work and made significant contribution in up-gradation / diversification of Power / Hand Loom products and income generation potential of the local artisans and Entrepreneurs. He is being awarded the Doctor of Philosophy in Textile Technology under the faculty of Engineering and Technology of VTU for his thesis titled "Studies on product up-gradation and diversification in Gadag- Betgeri Textile Cluster". His journey of Skill and Knowledge up-gradation of over 37 years has made him from Pramod Kakkanavar Diploma in Textiles in 1989 to Dr. Pramod Kakkanavar, Doctor of Philosophy in 2022.

In addition, Dr. Kakkanavar keeps interest in education and helps his wife Mrs. Sunita Kakkanavar in running the School and Music Classes. He is an Artist- instrument (Tabla) player and keeps interest in training.

A.T.E. offers Morgan Tecnica PLY1 - The Fastest Single Layer Cutting System for Textiles

'Customisation' and 'quick delivery' are the current imperatives across all business sectors, and more so for apparel, home, and technical textile products. To meet these requirements, textile mills require machines featuring greater flexibility for customisation and rapid production of small and irregular lots.

PLY1, the single ply cutting system from Morgan Tecnica, Italy, is designed to meet these demands of the industry. This breakthrough technology, high performance single ply cutting system is equipped with linear motors that offer high accuracy coupled with low running costs. The PLY1 features multiple cutting heads that can cut both soft as well as hard textile materials. PLY1 can handle all types of textiles including carpet fabric, and even special materials of different compositions and dimensions including thicknesses up to 60 mm – with great precision and high speed.

PLY1 line customisable according to the customers' needs

Cutting system

Printed marks matching

PLY1 works with different cutting windows and conveyor extensions to manage any type of material and meet every production requirement. It can be equipped with Morgan Tecnica's VisionScan system, a fully automatic solution to monitor, scan and manage the detection and proper matching of stripes, plaids and repeated prints.

With the VisionScan system the material is preliminarily scanned before cutting, and the information is then processed by different software applications. The system then automatically shifts, rotates or even distorts (if needed) the pieces in the marker, in order to obtain proper matching, optimise the cutting time and reduce waste.

PLY1 lines are fully customisable through different optional modules, such as the automatic fabric roll feeding, loading, unrolling cradles for fabric feeding, labelling and collection systems for cut piece picking and sorting. This helps to meet the specific needs of each customer and industry application optimally.

For more details, please contact:
A.T.E. Enterprises Private Ltd.
M: +91-98696 57281 T: +91-22-6676 6100
W: www.ategroup.com

Er R. P. Gautam elected as Chairman of IEI, Indore Chapter

Mr. R. P. Gautam has been elected as Chairman of Institution of Engineers (India) (IEI), for Indore (M.P.), Local Centre for the period 2021-2023 during the election and the result announced in their AGM held on 31st October, 2021. Elections for the year 2021-23 for Indore Centre were held and Mr. R. P. Gautam was elected as Chairman. Charges handed over to new elected team.

The Institution of Engineers (India) (IEI) is the largest Multi Disciplinary Professional Body of Engineers, established in 1920 with its HQ at Kolkata with 125 Centres all over india, 6 overseas chapters having Corporate Membership of over 2 lacs.

Mr. R. P. Gautam is B.E. (Electrical), M.E. (Industrial Engineering & Management), and Graduated in 1975 from Government Engineering College, Ujjain. He started as trainee engineer and Rose up to Head of Unit. He has a wide experience of last 45 years in Power Plants, Projects, Energy Efficiency and Management including assignments of Vietnam and Bangladesh. In continuation he worked as an Advisor in LNJ, Bhilwara Group Companies. Energy Efficiency and Sustainability are his core interest areas. He is a Member on Board of Examiner's, Boiler Board, Government of M.P., Lead Auditor - Energy Management System and ISO 50001:2011.

Mr. Gautam is a Hon. Visiting Faculty with Devi Ahilya University, School of Energy, and Founder President of National Institute Industry Forum for Energy. He organised several National and International Conferences on Energy and Environment.

Mr. R. P. Gautam is Vice Chairman of The Textile Association (India), M.P. Unit and is an Advisor to Maral Overseas Limited.

M.: 9826628884, E-mail: rjendragautam101@gmail.com

View of audience

L to R: D. S. Parihar, Hon. Secretary, Deepak Shah, Ex Hon. Secretary, Dr. (Mrs.) Shilpa Tripathi, Ex Charman & R. P. Gautam, Chairman

KARL MAYER New Innovation Hub for Sectional Warping in India

KARL MAYER opens demo center for the ISOWARP in Ahmadabad.

KARL MAYER Group in India had two reasons to celebrate: on the auspicious day of the Hindu festival celebrating "Dussehra". Its affiliated company, KARL MAYER Textile Machinery India Pvt. Ltd., paid homage to the Hindu Deity Satyanarayan and opened a new demo centz`er at its site in Ahmadabad, in order to be even closer to the market and to its

ISOWARP Democenter E

customers. The highlight of the new location for the presentation of machines is the ISOWARP. This powerful sectional warping machine is built in Ahmadabad to facilitate short delivery times and optimum spare parts supply to our customers. KARL MAYER Textile Machinery India delivered its first ISOWARP model with a working width of 3600 mm on 15th October, 2021.

ISOWARP Democenter E

The ISOWARP processes spun yarns and filament yarns and is particularly suitable for standard applications in the fields of apparel fabrics and home textiles. It is able to produce warp beams of exceptionally high quality and thus enables significant increases in quality and productivity in the weaving mill.

Interested parties can now see this for themselves in the new demo center. "We are looking forward to welcome our visitors. Our customers can come to us and see exactly how the ISOWARP works.

We will show them the most important features of the machine in practical use and will be available for questions and discussions," explains Kevin Socha, Director at KARL MAYER Textile Machinery India Pvt. Ltd. The KARL MAYER India team and the ISOWARP will also be available in Ahmedabad for processing tests. This helps customers to test their pattern development and can help decide which products should go into bulk production, it can also be used for the preparation of warps for smaller production lengths.

The company also offers training for its customers' technical personnel. "Only with the right knowledge of the warp preparation process can the potential for competitive advantages be exploited," says Raja Poptani, General Manager Finance & Administration at KARL MAYER Textile Machinery India Pvt. Ltd. The training offer includes courses at the textile manufacturers' premises, but also qualification events with theoretical and practical parts in the, just opened, demo center on the ISOWARP.

And, of course, customers who opt for the high-performance sectional warping machine can benefit from the R&D know-how of the KARL MAYER Group and the support of its worldwide service organization. "We offer full support, from development to the finished pattern," says the KARL MAYER India Team.

For more details, please contact:

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Management Succession Planning at Uster Technologies AG

Succession plan ensures 'seamless transition' for company and customers

ARISE, the textile division, Integrated Industrial Platform (IIP), based in the UAE, has joined ITMF as a new Corporate Member in January, 2022.

ARISE Integrated Industrial Platforms (IIP) identifies industrial gaps in African countries to unlock value and create new industries. The objective is to industrialize key sectors by creating local transformation, maximizing production, efficiency, and cost, which in turn generates local value addition.

Arise IIP seek to boost exports, enable local transformation of raw materials and promote trade by tailor-made special economic zones in Gabon, Benin and Togo. In Benin and Togo Arise IIP will focus at creating value chains for the textile industry – from raw material sourcing to resource transformation through manufacturing, to exporting final products.

The International Textile Manufacturers Federation (ITMF) founded in 1904 is the international forum of the global textile value chain. Its members are from textile and apparel producing countries representing 90% of global production.

“By becoming a Corporate Member of ITMF, Arise IIP will benefit from a unique international network, the expertise of ITMF, and an international platform for the global textile value chain where international trends and are discussed.

Likewise, ITMF and ITMF's members will benefit from Arise's activities in West Africa", stated Dr. Christian Schindler, Director General of ITMF.

Mr. Rajaguru Raja, the CEO of Arise IIP (Textile Division), commented that "by joining ITMF we have access to all major players in the global textile and apparel value chain. The world is getting more and more integrated. Therefore, cooperation along the global textile value chain and understanding its complexity and dynamics are paramount".

For more information about Arise IPP, please consult: www.ariseiip.com

For more information about ITMF, please consult: www.itmf.org

Report of Khadi Bazar 2021 & Fashion Show

Institute of Fashion Technology (IFT) IPS Academy conducted 'Khadi Fashion Show' under the joint aegis of Khadi and Village Industries Commission, Ministry of Small Micro, Small & Medium Enterprises, Govt. of India and The Textile Association of India – M.P. Unit in Khadi Bazaar-2021 exhibition at Urban Haat, Indore on Dec 12th 2021 on the occasion of Azadi Ka Amrit Mahotsav.

The guests included Dr Rajneesh Shrivastava, Additional Collector, Deputy Commissioner (Revenue), Indore

Division, Indore; Shri B.P.S. Parihar, Deputy Commissioner of Police, Indore & Dr. Vivek Gawde, writer, Mahatma Gandhi Awardee.

The inaugural was done by Dr. Vivek Gawde & Ms. Preity Sarva, Principal, IFT IPS Academy.

The students of IFT showcased the Khadi Garments sponsored by the available National-Reputed stalls in the fair. Students showcased the Garments in Four rounds; in the first round the students showcased the Tussar Silk, hand painted Saree in a very different way. The second round was the pride of India, Khadi Kurta in which male models wearing Kurta, Kashmiri Shawl and Jacket walked on the ramp in a very creative way. The third round was the Dropping round in which the female models drapped Tussar Silk with Dabu & Nandna print Dupatta teamed with jeans and top. The forth and the last round was for female models in which they presented Khadi Kurta & Khadi Pants and Kaftans. Thus the show created awareness about Khadi among the youth. The show was praised by guests, other

dignitaries and by the audience also.

Mr. Ashok Veda, Chairman, TAI - Central along with the other Office Bearers of TAI – M. P. Unit handled the administrative part of the event apart from the KVIC. TAI MP Unit sponsored the food for all. The TAI dignitaries volunteered the dinner.

More than 300 delegates attended the event which was a grand success. This huge gathering encouraged TAI – M. P. Unit.

CEMATEX Launches Start-Up Valley to Support Entrepreneurship

CEMATEX, the European Committee of Textile Machinery Manufacturers, has launched a new initiative to support start-ups with new and innovative offerings, and to inspire innovation for the textile, garment and fashion industry.

The owner of ITMA and ITMA branded exhibitions; CEMATEX will provide selected young enterprises with solutions for the textile and garment industry with a grant to exhibit at the Start-Up Valley during ITMA 2023. The CEMATEX Start-Up Grant will cover the rental costs of a special design stand and fittings, as well as entitlements such as business matching.

CEMATEX president Mr. Ernesto Maurer said: "We are excited to launch this initiative to attract innovative start-ups to ITMA 2023. The Start-Up Valley will be a good complement to the ITMA Research & Innovation Lab".

"As the largest textile technology exhibition attracting leading textile and garment manufacturers from around the world, ITMA offers young entrepreneurs a useful platform to put their innovations in front of a global audience, to find investors and collaborators and to leverage industry connections and professional networks."

In addition to exhibiting at ITMA 2023, Start-Up Valley exhibitors can also take part in various onsite activities, including speaking at the Innovator Xchange and participating in the ITMA Sustainable Innovation Award and Innovation Video Showcase.

Eligibility and selection

To be eligible for the grant, start-ups must have a product or service that is within ITMA 2023's exhibit profile. The company should also be incorporated for not more than 8 years, and has either generated revenue for at least a year or raised capital from investors or grants from other incubator programmes.

A key selection criterion is the environmental, economic and/or disruptive impact of the innovation, solution or product. Other criteria include the scalability of the innovation and its relevance to ITMA's theme: Transforming the World of Textiles, and the four trending topics, namely advanced materials, automation and digital future, sustainability and circularity, and innovative technologies. Applicants are also advised to share information such as reference partners to institutions, associations, or commercial partners and the innovative and intellectual content for their products, services, patents or applications, and if they have won any awards.

A panel of industry experts has been invited to form the selection committee to evaluate the start-ups. It comprises

- Mr. Chris McHugh, Dry Fibre Development Manager, Advanced Manufacturing Research Centre (AMRC) with Boeing (United Kingdom)
- Ms Elin Larsson, Programme Manager, RISE Research Institutes (Sweden)
- Mr. Ruggero Frezza, President, M31 Italia Srl (Italy)

Interested start-ups may apply for the CEMATEX grant by 30 June 2022. Successful applicants will be advised by 28 October 2022. For more information, visit www.itma.com/exhibitors/start-up-valley.

ITMA 2023 will be held at Fiera Milano Rho, Milan, from 8 to 14 June 2023. The exhibit profile has been expanded to include a dedicated chapter on textile reinforcement structures for composites. The deadline for stand space application is 15 March 2022. More information can be found on www.itma.com. For participation enquiries, please email: application@itma.com. The last ITMA exhibition was held in Barcelona in 2019, featured exhibits from the entire textile and garment making value-chain, including raw materials and fabrics. It drew a record-breaking participation of 1,717 exhibitors from 45 countries and visitor ship of over 105,000 from 136 countries.

For more details, please Contacts:

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KARL MAYER Speed PLUS Variety in Elastane Processing

KARL MAYER's new HKS 2-SE PLUS opens up new application possibilities with its additional range of lapping options

HKS 2 SE PLUS

Simple, lightweight, plain fabrics with elasticity have become indispensable in the underwear and sportswear sector. KARL MAYER's two-bar, high-performance tricot machines have long set the standard in terms of quality and productivity.

HKS 2 SE PLUS

The portfolio of the established machines has so far included the HKS 2-SE – a high-speed model designed exclusively for the production of elastic articles using locknit and double tricot lapping – and the HKS 2-S, which offers greater flexibility in terms of yarns and lapping options, with lower production speeds.

The manufacturing repertoire also includes qualities with two-needle-overlap, and non-elastic fabrics such as embroidery grounds and tulle are also possible.

In order to combine both product variety and speed, KARL MAYER has now added another machine to its range of elastane-processing machines – the HKS 2-SE PLUS. This builds on the proven basic concept of the HKS 2-SE and, thanks to a modified knitting motion, can be used for both elastic locknit and double tricot, as well as two-needle overlap.

The two needles overlap is carried out by the GB 2 ground guide bar, which processes elastane. This results in fabrics

with a higher modulus, making swimwear, sportswear and shaping corsets just as much a part of the HKS 2-SE PLUS range as fine lingerie qualities. In terms of speed, the new machine is almost in the same performance range as the HKS 2-SE, and it achieves higher production speeds than the HKS 2-S.

Just like the HKS 2-SE, the PLUS variant is offered in gauges E 32, E 36 and E 40. The available stitch density is also the same. The working width is 130", and can be extended by 4". With its special focus, the new HKS 2-SE PLUS is a high-performance all-rounder that puts KARL MAYER's elastic customers one step ahead in their respective markets.

For more information, please visit:
https://www.karlmayer.com/en/hks-2-se-plus/

Maral Overseas Limited received a Industry Excellence Award

Maral Overseas Limited has been awarded Industry Excellence award in 36th Indian Engineering Congress organized at Vigyan Bhawan, New Delhi, recently.

This award has been instituted by The Institution of Engineers (India) to promote excellence in Engineering, Production system and Process. The Institution of Engineers is a premier organization of engineers in India having its chapters in India and Abroad and has recently completed its 100 years since its foundation. The award was given by the central Industry Minister Shri Mahendra Nath Pandey and it was received by Mr. R. P. Gautam, Advisor, Maral Overseas Limited.

The Yarn Bazaar bags 1 Cr. at Shark Tank India

Mumbai: City-based Company the Yarn Bazaar, a 1-stop yarn solution, has bagged 1 Cr. funding in the first season of Shark Tank India.

The investor included:
1) Peyush Bansal (Lenskart)
2) Ashneer Grover (BharatPe)
3) Anupam Mittal (People Group)
4) Aman Gupta (Boat)

On receiving funding from Shark Tank India the Founder & CEO of The Yarn Bazaar Mr. Pratik Gadia said, "This is a great testament to the efforts of our team and I would like to thank everyone and the entire textile industry for being such a great support to us. This is not our success but the success of Indian Textile industry"

About The Yarn Bazaar:
The Yarn Bazaar (www.theyarnbazaar.com) is a 1-stop yarn solution with a vision to organize the unorganized textile industry. It started operations in 2019; the company has done a business worth 230+ Cr on 100% advance payment.

In addition to yarn buying & selling, The Yarn Bazaar has also been proudly associated with many national and international events as a Media and Marketing partner. The Yarn Bazaar has been at the forefront of adding value to the industry by conducting interviews & podcasts with several industry leaders.

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Guidelines and Instructions to the Authors

The Journal of the Textile Association (JTA) is an Open Access, international indexed prestigious bi-monthly Peer Reviewed Textile Technology Journal published by the Textile Association (India) since over 82 years, devoted for publication of communications embodying the results of original work of Research / Review which covers in different branches of Textile Science, Technology, Engineering and Management that provides rapid publication.

JTA is indexed by Scopus (Elsevier), National Academy of Agriculture Science (NAAS), Indian Citation Index (ICI) and National Institute of Science Communication & Information Resources (NISCIAR) and by some others. Now Articles has got allotted DOI No.

JTA is Abstracted by Chemical Abstract (USA), Science Abstract (India) and World Textile Abstract (UK) etc.

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Original Research Articles	≤250 words	≤4000 words	7-8 pages	≤40
Review Articles	≤300 words	≤6000 words	10-12 pages	≤60
Short Communications	≤150-20 words	≤2000 words	3-6 pages	≤15-20
Texperience	NA	≤1000 words	2-4 pages	NA
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It should be written in English only on MS Word 2007 or above in single column. No Header & footer to insert. Illustrations (Figures & Tables) and clear readable images (JPG) must be inserted in the article at the appropriated position to appear. Articles should be concisely in 1.15 spaces in A4 paper size with required margins. Article shall be prepared in Times New Roman using font size 11 normal and for Article Title (14 bold faces, each of first word in Capital and others in Lower case). Author/s Name using font size 11 bold faces, Institute, Department with location using font size 11 Italic faces are to be used. For citation/references follow the journal style. It should be numbered in the text consecutively, like [1] [2] or [1, 2] etc. formatted as superscript.

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3. Materials and Methods
4. Results
5. Conclusions
6. Acknowledgement (if any)
7. References

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Acknowledgements
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- **Journal references**

[1] N. Gokerneshan, A. J. Abisha Raju, Lakshmi Sudheer & K. M. Pachiyappan, "Acoustic Properties of Woven - Part II: Studies on Corduroy and Fabric with Polyester Fabrics made from Staple and Textured Weft Yarns", Journal of the Textile Association, 82/2 (2021) 61-67, https://doi.org/10.17605/OSF.IO/YKAFM

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- **Websites**

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