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Mission

To produce quality graduates who would be able to cater to the present day industry having cutting edge technology and to enable them to cope up with the highly demanding knowledge-centric society. To nurture and sustain an academic ambience for the learning and training of textile technocrats for sustainable development of the nation and to accomplish its integration into the global economy.

Vision

"To Grow as a Global Centre of Excellence in Textile Education and Research for Up-liftment of Industry and Society"

Uttar Pradesh Textile Technology Institute, Kanpur
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आशुतोष टण्डन 'गोपाल जी'
मंत्री
प्राविधिक शिक्षा एवं
चिकित्सा शिक्षा विभाग

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संदेश

मुझे यह जानकार प्रसन्नता हुई है कि उत्तर प्रदेश वस्त्र प्रौद्योगिकी संस्थान के "जर्नल आफ फाइबर टू फिनिश" का 57वॉं अंक प्रकाशित हो रहा है।

मुझे आशा है कि वस्त्र तकनीकी क्षेत्र के अग्रणी संस्थान के प्रतिष्ठित "जर्नल आफ फाइबर टू फिनिश" में प्रकाशित विभिन्न तकनीकी आलेख छात्र–छात्राओं के तकनीकी ज्ञान सम्वर्द्धन एवं उनके बहुमुखी विकास में सहायक सिद्ध होंगे।

"जर्नल आफ फाइबर टू फिनिश" के सफल प्रकाशन हेतु मेरी हार्दिक शुभकामनायें।

आशुतोष टण्डन

प्रो. विनय कुमार पाठक
कुलपति
Vice-Chancellor

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Dr. A.P.J. Abdul Kalam Technical University
Uttar Pradesh, Lucknow

दिनांक : 20.07.2018

संदेश

मुझे यह जानकार अत्यन्त हर्ष हुआ है कि उत्तर प्रदेश वस्त्र प्रौद्योगिकी संस्थान, कानपुर अपने वार्षिक "जर्नल आफ फाइबर टू फिनिश" का 57वॉ अंक प्रकाशित करने जा रहा है। इस प्रकार के प्रकाशनों से निश्चय ही विद्यार्थियों को अपनी क्षमताओं को प्रदर्शित करने का अवसर प्राप्त होता है।

आपकी यह स्मारिका ज्ञानवर्द्धन तथा दिशा निर्देशिका के रूप में सफलता प्राप्त करें। आप सभी को स्मारिका के सफल प्रकाशन हेतु शुभकामनायें।

प्रो. विनय कुमार पाठक
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दिनांक : 21.07.2018

Message

It's a great pleasure for me to know that Uttar Pradesh Textile Technology Institute is going to publish the 57th edition of the Institute's Annual Journal "Journal of Fibre to Finish".

I feel extremely proud and fortunate to be in association with this highly reputed institute of the country that produced qualified technocrats and engineers serving the industry and society. The Journal "Journal of Fibre to Finish" is being published by the institute since last six decades successfully. The published technical papers of this journal containing valuable information related to the advances in Textile Technology will be helpful for the students facilitating their multidimensional growth.

I congratulate all the involved person of the institute on this occasion and hope for every success in future.

Prof. Ajeet Kumar Chaturvedi
BOG Chairman

From the Director's Desk........

The prestigious, Uttar Pradesh Textile Technology Institute (formerly GCTI) Kanpur publishes annual magazine "Fibre to Finish" since its inception almost sixty years back has made astonishing progress by opting the key to keep the focus on students, whether it is from UPTTI or from outside UPTTI.

Fibre to Finish possess an unbiased platform for academicians, industry experts and researchers to publish their research findings and prepare a data base and valuable study material for students across the nation.

In addition to developing excellent scientific and engineering environment, the students are motivated not only to dream big but also encouraged to think unconventionally to face the challenges of the future by publishing their work in Fibre to Finish. It has been our constant endeavor to instill in our students practicing research experiments and technical paper writing skill.

The institution has stood for quality and excellence and still thriving to be the best in future also and "Fibre to Finish" will become instrumental in this regard.

In a famous quote Zoey Sayward said "Don't wait for the perfect moment. Take the moment and make it perfect!". We are trying to shape the career of our students to make the best out of the opportunity.

Keeping our vision and mission of the institution forward we work on the theory of Imagine-Invent-Inspire-publish. As the saying goes "Team Work makes the dream work". At UPTTI Kanpur, we have committed team and the team is continuously responsible in achieving the vision and mission of the institution and is being personally guided by me.

I take this opportunity to congratulate the editorial team of "Fibre to Finish" 2018 alongwith committed students for their commitment towards value based learning.

Dr. Mukesh Kumar Singh
Director

From the Editor's Desk.....

Dear Readers,

It is not the sprawling lawns and magnificent building of an institute which goes into the records, it is the legacy of an Institute which is remembered by the rank and file. The Uttar Pradesh Textile Technology Institute which was formerly known as Govt. Central Textile Institute has a very old and strong legacy of providing multi-faceted knowledge of the textile manufacturing and helping the industry as well as other stake holders.

Institute every year publishes a journal, "Journal of Fibre To Finish " which serves the purpose of perpetuating our legacy of spreading the knowledge and helping the green horns as well as the experienced technicians. The content of the journal is all useful and worthy to read.

It's also a humble effort to echo a spirit of "Make In India." On behalf of the Editorial Board, I take an opportunity to extend the deepest regards to our Director, BOG Chairman, Secretary technical education Govt. of Uttar Pradesh and Vice Chancellor AKTU, Lucknow and all the paper contributors for their valuable help & contribution. I also wish the readers to relish the journal and give it a reason to excel.

Thanks.

Mahendra Uttam
Chief Editor

Contents

Aroma Therapeutic uses of Microencapsulated Textiles

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Abstract

Essential oils are the concentrated compounds that have long lasting effect onto the substrate. These oils are volatile liquid plant material, known as an important element around the world in aromatherapy, natural perfumery, insect repellent an in various fields of natural medicine, psychology and cosmetology. Citronella, lemon grass oil also the type of essential oil having medicinal, aromatic, antimicrobial, antidepressant properties. Microencapsulation is the process by which the individual particles and droplet of solid or liquid materials (used as core) are surrounded or coated with continuous film of polymeric material (the shell/coating) to produce capsules in the range of micrometer to millimeter, which are known as microcapsules. Microencapsulation of essential oil gives flavour to many novel applications, particularly for apparels, bed linens and upholstery. Present study was carried out to identify the effect of selected essential oils on the general psychological ailments of selected respondents with the help of textile substrates. Two essential oils as core material i.e. citronella & lemon grass oil and two gums as shall i.e. gum acacia & sodium alginate each were applied on lyocell fabric. These microcapsules were made through simple conservation technique. Durability of aroma in the microencapsulated fabrics was assessed. On the basis of durability of aroma on the textiles, the best combination of oil and gum was selected to measure psychological ailments such as stress, anxiety; mood swings etc. Results of the study showed that there was decrease in the respondent's level of psychological problems after using textile substrate encapsulated with lemon grass oil.

Key words: Lyocell fabric, essential oils, lemon grass oil, simple conservation technique

Introduction

Aromatherapy is a form of alternative medicine that uses volatile liquid plant materials, known as essential oils and other aromatic compounds from plants for the purpose of affecting a person's mood or health. Popular uses of these products include massaging products, medicine or any topical application that incorporates the use of essential oils. All types of textile are excellent media for transferring fragrant compounds and are significant to people according to their preference for them. The most difficult task in preparing the aromatherapeutic textile is how to prolong its odour for long period's lifetime. The key to aromatherapic textile is how to make microcapsules of fragrance compounds (essential oils) without omitting any ingredient in order to ensure its pharmaceutical effects. Microencapsulation is an effective technique to solve this. So keeping in mind the importance of aromatherapy a study was conducted on application of essential oil on lyocell fabric & its assessment for aromatherapy. Under the present study citronella and lemon grass oil each were applied on lyocell fabrics respectively. Lyocell fabric is eco friendly in nature and possesses good water absorbency as compared to the pure synthetic fabrics. Lyocell fabric is soft to touch, so it is used for apparel purpose, as it provides sensorial comfort to the wearer.

Materials and Methods

Lyocell fabric was chosen for the application of finish through microencapsulation techniques. Under the present study, two oil as core material i.e., citronella oil and lemon grass oil and two gums as wall material i.e. gum acacia (arabic) & sodium alginate were used. Simple coacervation technique of microencapsulation was used for formative of microcapsules. Formation of microcapsules in the solution was ensured by using Nikon Eclipse E1000 microscope (figure no 2).

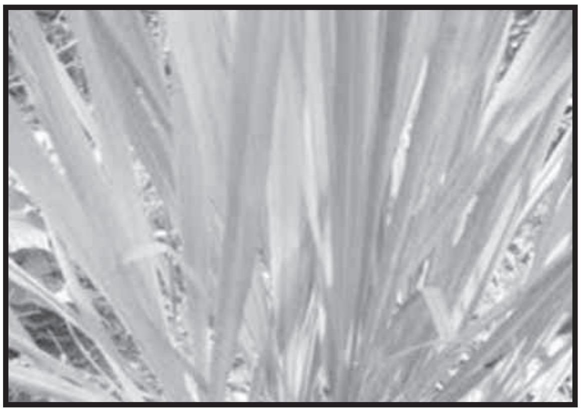

Figure 1: lemon grass plant

Figure 2: Formation of microcapsules in the solution

Table 1:

Formation of microcapsules with core & wall materials

Combination of wall and core materials	Simple Coacervation Technique
Gum acacia + citronella oil	✓
Gum acacia + lemon grass oil	✓
Sodium alginate + citronella oil	✓
Sodium alginate + lemon grass oil	✓

The finish was applied on lyocell fabric with the help of padding mangle. After application of microcapsules on the lyocell fabric, finished fabric was analyzed under Scanning Electron Microscopy using JSM- 6610LV apparatus to ensure the presence of microcapsules on the test specimens. It was observed that microcapsules were visible on the fabrics. Then durability properties of lyocell fabric were tested with the standard textile testing procedures & ranked accordingly.

Results:

It was noted from durability assessment of all the four microencapsulated lyocell test specimens that all the specimen were found suitable for their end uses i.e. apparel and furnishing items. In order to assess the psychological effect of aromatheraputic specimens, it was important to select fabric from all four specimens, due to time limit & economic factor. Therefore lyocell fabric test specimens, which had scored highest weighted mean in oil and gum combinations (Table 2) were selected to assess psychological effect of microencapsulated fabrics on the selected respondents.

Table 2: Durability assessments of specimens finished with microcapsules formed through simple coacervation technique:

Fabrics used	Combination of wall & core material	Rubbing fastness (cycles)						Washing fastness (washing cycle)			Light fastness	Perspiration fastness		Weighted mean score	Rank
		Dry			Wet							Acidic	Alkaline		
		10	20	30	10	20	30	2	5	10					
Lyocell	G + C	4	4	4	4	4	3	3	2	1	3	3	2	12.1	3
	G +L	4	4	4	4	4	4	3	2	1	4	2	3	12.7	2
	S + C	5	4	4	4	3	3	3	1	1	3	3	3	11.9	4
	S + L	**5**	**5**	**4**	**5**	**4**	**4**	**5**	**3**	**1**	**3**	**3**	**3**	**15.9**	**1**

(G+C- Gum acacia + citronella; G+L- Gum acacia + lemon grass; S+C- Sodium alginate + citronella & S+L- Sodium alginate + lemon grass)

An interview schedule was developed to assess the aromatic and therapeutic effect of microencapsulated fabrics on the ultimate consumers. Total sixty respondents were selected, 30 male respondents and 30 female respondents, they were the students and staff members of the G.B. P.U.A &. T. Pantnagar. Interview schedule was divided into two parts pre and post - test. Data was analyzed & comparison was made on the basis of pre and post test opinion of the respondents.

1. **Psychological problem of respondents (Pre analysis)**

Under the present research work the general psychology of each respondent was enquired because aromatherapy helps in curing the simple psychological ailments of an individual. To measure psychological problems such as stress, anxiety, mood swings etc., in the present research work questionnaire cum interview schedule tool was used.

Stress -

Various ailments like stress, anxiety, mood fluctuation, headache and sleep disorder are common to many human beings. The opinion of respondents regarding their stress level was enquired. It is evident from table 3 that 26.66 percent female and 46.66 percent male experienced moderate (4) level of stress. It was told by 13.33 percent female respondents that they were highly stressed (5) and 26.66 percent female respondents said that they suffer from mild (3) stress. It was clear from the table 3 that remaining 20 percent female used to experience less (2) stress. It was noted that 13.33 percent female respondents were not having any kind of stress.

In case of male equal percentage of respondents (26.66%) said that they experience mild (3) to less (2) problem of stress. Whereas maximum male (46.66 %) respondents said that they face moderate (4) level of stress.

Table 3: General problems faced by respondents N=60

S. No	Suffering from following problems	Rating Scale									
		Female (30) n(%)Male (30) n(%)					Male (30) n(%)				
		5	4	3	2	1	5	4	3	2	1
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
1.	Stress	4 (13.33)	8 (26.66)	8 (26.66)	6 (20)	4 (13.33)	-	14 (46.66)	8 (26.66)	8 (26.66)	-
2.	Anxiety	4 (13.33)	4 (13.33)	12 (40)	4 (13.33)	6 (20)	4 (13.33)	6 (20)	10 (33.33)	6 (20)	4 (13.33)
3.	Mood swings	4 (13.33)	6 (20)	12 (40)	8 (26.66)	- 8	-	4 (13.33)	16 (53.33)	8 (26.66)	2 (6.66)
4.	Headache	2	4 (13.33)	4 (13.33)	12 (40)	(26.66)	6 (20)	4 (13.33)	4 (13.33)	8 (26.66)	8 (26.66)
5.	Sleep disorder	(6.66)	6 (20)	12 (40)	8 (26.66)	4 (13.33)	-	4 (13.33)	10 (33.33)	8 (26.66)	8 (26.66)

-

5- Highly Problematic 4-Moderate Problem 3. Mild Problem 2-Very Less problem 1-No Problem

Anxiety -

It is evident from table 3 that in case of female respondents (13.3 %), it was expressed that they suffer from higher anxiety level (5). Same percentage (13.33%) of female respondents had problem of anxiety at moderate (4) and lesser (2) level. Maximum (40 percent) females were experiencing mild (3) anxiety problem. However 20 percent female respondents were found without any problem of anxiety. In case of male, 13.33 percent respondents were experiencing their anxiety at high level (5).

Mood swings -

It is generally said that female undergo more mood swings than males. It is clear from the table 3 that 13.33 percent female respondents said that they undergo high problem (5) of mood swings as compared to 20 percent, 40 percent and 26.66 percent female who were sensing moderate (4), mild (3) and less (2) problem of mood swings respectively.

In case of male 13.33 percent respondents were facing moderate (4), 53.33 percent mild (3) and 26.66 percent less (2) problems of mood swings. No problem of mood swings was found in 6.66 % male respondents .

Headache -

It is evident from table no. 3 that only one female respondent (6.66 %) said that she used to suffer from headache and considered it as highly problematic (5) as compared to 13.33, 13.33 and 40 percent females who used to face moderate (4), mild (3) and very less (2) problem of headache respectively. It was told by 26.66 percent female that do not they have headache problem. In case of male respondents 20 percent were suffering from headache as highly problematic (5) condition, compared to 13.33, 13.33 and 26.66 percent male respondents who used to face moderate (4), mild (3) and very less (2) problem of headache respectively. No problem of headache was reported by 26.66 percent male respondents.

Sleep disorder -

It is evident from table no. 3 that moderate (4) problem of sleeping disorder was expressed by 20 percent female respondents. It was told by 40 percent and 26.66 percent female respondents that they were experiencing mild (3) and less (2) problem of sleeping disorder respectively. Very few female respondents (13.33 percent) said that they have no problem of sleeping disorder. In case of males, maximum percentage (33.33%) of respondents said that they experienced mild (3) problem of sleeping disorder. Whereas 13.33 percent male respondents said that they moderately (4) suffered from sleeping disorder and less problem of sleeping disorder was felt by 26.66 percent respondents. Remaining male respondents (26.66%) were not facing any sleeping disorder.

Opinion of respondents regarding aromatherapy/ microencapsulated textiles (Post analysis)

After conducting pretest of selected respondents, they were given pillow covers encapsulated with lemon grass oil, where sodium alginate was used for wall material. Respondents were asked to use these microencapsulated pillow covers continuously for 15 days. After 15 days the post analysis was carried out. Respondents expressed their views about the microencapsulated fabrics used by them for 15 days. Effect of selected lemon grass oil finish was studied.

Level of relief from problems after using encapsulated fabrics (Lemon grass oil) Stress

It is evident from table no. 4 that only one female respondent (6.66 %) said that she was facing highly problematic (5) condition of stress as compared to 20, 26.66 and 13.33 percent female respondents who faced moderate (4), mild (3) and less problem (2) of stress after using pillow cover fabric, encapsulated with lemongrass oil. Maximum respondents (33.33) felt no problem of stress after using encapsulated fabric (lemongrass oil). In case of male equal percentage of respondents (26.66%) said that they experienced moderate (4), very less (2) and no problem (1) of stress respectively. It was told by 20 percent respondents that after using the lemon grass oilencapsulated fabric they faced mild problem of stress (3).

Table 4: Level of relief from problems after using encapsulated fabrics

Micro capsulated fabric	Suffering from following problems	Rating Scale									
		Female (n- 30) (%)					Male (n-30) (%)				
		5	4	3	2	1	5	4	3	2	1
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Fabric treated with lenom grass oil	Stress	2 (6.66)	6 (20)	8 (26.66)	4 (13.33)	10 (33.33)	-	8 (26.66)	6 (20)	8 (26.66)	8 (26.66)
	Anxiety	4 (13.33)	4 (13.33)	6 (20)	6 (20)	10 (33.33)	-	6 (20)	6 (20)	14 (46.66)	4 (13.33)
	Mood swings	4 (13.33)	2 (6.66)	6 (20)	12 (40)	6 (20)	-	4 (13.33)	8 (26.66)	8 (26.66)	10 (33.33)
	Headache	-	2 (6.66)	6 (20)	10 (33.33)	12 (40)	2 (6.66)	4 (13.33)	6 (20)	10 (33.33)	8 (26.66)
	Sleep disorder	-	2 (6.66)	10 (33.33)	4 (13.33)	14 (46.66)	-	2 (6.66)	4 (13.33)	10 (33.33)	14 (46.66)

5- Highly Problematic 4-Moderate Problem 3. Mild Problem 2-Very Less problem 1-No Problem

Anxiety -

When the fabric treated with lemon grass was assessed by respondents, it was found that equal percentage of female respondents (13.33%) felt high (5) and moderate (4) level of anxiety. Equal percentage of respondents (20 %) said they experienced mild (3) and less (2) problem of anxiety. Maximum percentage of respondents (33.33) faced no problem of anxiety after using encapsulated fabric of lemon grass oil (table 4).

In case of male respondents equal percentage of respondents (20%) said they have moderate (4) and mild (3) level of anxiety where as maximum respondents (46.66%) faced less (2) and 13.33 percent respondents sensed no problem (1) of anxiety after using encapsulated fabric of lemon grass oil.

Mood swings -

Highly problematic (5) condition of mood swings were experienced by 13.33 percent female respondents. Whereas one female respondent (6.66%) said she was facing moderate problem (4) of mood swings. Remaining 20, 40 and 20 percent female respondents experienced mild (3), less (2) and no problem (1) of mood swings respectively after using fabric treated with aroma of lemon grass oil. In case of male respondents 13.33 percent respondents said they had moderate (4) problem of mood swings as compared to 26.66 percent males who had mild (3) and less problem (2) of mood swings. Maximum 33.33 percent male respondents did not face problem (1) of mood swings. It is clear from the above result that positive psychological effect of fabric treated with lemon grass oil was found on both the gender of respondents.

Headache -

It is evident from table no. 4 that only one female respondents (6.66%) reported moderate problem (4) of headache. Mild (3) problem of headache was reported by 20 percent respondents. Whereas, 33.33 percent female respondents experienced less problem (2) of headache. Maximum percentage of respondents (40%) faced no problem (1) of headache after using aromatic fabric of lemon grass oil. In case of males only one respondent (6.66) experienced highly problematic (5) condition of headache. It was told by 13.33 and 20 percent respondents that they faced moderate (4) and mild (2) problem of headache. Maximum respondents (33.33%) had less problem (2) of headache as compared to 26.66 percent respondents who did not experience headache problem after using aromatic textiles of lemongrass oil.

Sleep disorder -

It is evident from table no. 4 that one female respondent (6.66%) said that she faced moderate problem (4) of sleep disorder. Mild problem (3) of sleep disorder was reported by 33.33 percent female respondents. 13.33 percent respondents faced very less problem (2) of sleep disorder as compared to maximum respondents (46.66%) who felt no sleep disorder.

In case of male also 6.66 percent of respondents felt moderate problem (4) of sleep disorder. Whereas 13.33 percent had mild (3) and 33.33 percent had very less (2) sleep disorder instances. Maximum percentage of respondents (46.66) said they experienced no sleep disorder problem after using aromatic fabric of lemongrass oil. After analyzing results of pre and post evaluation of psychological parameter surveyed, it is clear that slight relief was noted in respondents suffered from stress, anxiety, mood swings and sleep disorder after using encapsulated aromatic textiles.

Value addition in clothing has changed the global textile scenario (R. Anitha et. al. 2011) Textile and clothing manufacturers worldwide have adopted value addition as their strategy to differentiate themselves and their products from the rest (Sodhi. S. N. 2013). A novel and holistic approach of the 21st century has been, the use of microencapsulation in textiles finishing. Creative designers of the 21st century want to diversify their vision from visual aesthetics to performance value like sense of smell, color change technology, phase change materials and bactericides. The global market for microencapsulation has grown exponentially in the last few years (PR Newswire. 2017) due to increase in awareness about health and hygiene people increasingly want their clothing to be hygienically fresh (Karolia and Mendapara, 2005).

Conclusion

Essential oil of lemongrass is commonly used in aromatherapy, which offers a variety of health benefits.Lemon grass is commonly used in cleaning and therapeutically, for support of the immune system, gets relief from psychological problems, muscular and joint systems. From the comparison between pre and post data analysis, it can be said that there was a decrease in stress, anxiety, mood fluctuation, and headache and sleep disorder of the respondents after using encapsulated fabric of lemon grass oil. This is due to the medicinal properties of lemon grass oil.

It can be concluded that microencapsulation of essential oils, is an effective technique, and could be applied successfully to the textile substrates. Garments create the microclimate for the wearer, therefore release of essential oils through friction and movement of body will play significant role for aromatherapy. This technique will widen the scope of essential oils in garment/textiles sector. Thus its requirement will be enhanced, may reflect a positive impact on the productive demand of essential oils.

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Development of Fashion Apparels from Bamboo and Cotton Blends

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Abstract

The fashion fabric is made of bamboo and cotton different blend are recent development in textile materials has revealed that it has an enormous potential as a comfort and mechanical properties and eco friendliness. The main aim of this research work is to study the comfort and mechanical properties of Bamboo/Cotton blended fabrics using plasma treatment. The blending of bamboo/cotton is carried out during carding itself and fibers are converted into yarn using ring spinning method to 40'sNe count. Then yarns are tested for Tenacity, elongation, imperfection and friction. The yarns were converted to woven fabric using lab model Rapier weaving machine and the fabric is tested to find the improvement in comfort and mechanical properties like air permeability, water permeability, thermal resistance, gsm and thickness .Based on the results obtained blended fabric will be chosen for making the apparels.

Key words: Bamboo, Cotton, yarns, fabrics, oxygen gas, plasma and testing.

Introduction

Plasma surface treatment used to modifying the functional properties of fibers possesses advantages in comparison with traditional techniques. Plasma includes less water usage and energy consumption, with very small fibre damage, then making plasma process very attractive. It will be used to enhance the quality of textile products in fabric preparation and in dyeing and finishing methods.. The textile industry must go towards sustainable technologies, developing environmentally safer methods of processing and finishing fabrics. Optimization of bulk and surface properties of materials can represent a promising approach for meeting technical and economical requirements. Because of costs related to study and production of new fibers, polymer researchers now focus on modifying existing fibers to impart the desired aesthetic or functional properties. Conventional fibre modification methods include various thermal, mechanical, and chemical treatments. Another important method to modify the fibre, to increase the uptake of dyes and finishes or to impart unique functionality, is performed through the plasma treatment. Characteristics that can be improved include after plasma treatment wet ability, flame resistance, adhesive bonding, printability, electromagnetic radiation reflection, surface hardness, and hydrophilic hydrophobic tendency, dirt-repellent and antistatic properties. Plasma treatments can answer the demand of textile industry. Besides the base function of dressing people, textiles contribute to human health and safety, protecting from exposure to dangerous environments.

Bamboo fiber have very thin when compared to hair and it has a round and smooth surface which makes it abrasion proof better. Then the bamboo fiber present naturally antibacterial, antifungal and anti-static properties. Bamboo has a unique anti-bacteria and bacteriostasis bio-agent which bonds tightly with bamboo fiber the cellulose growth will be normal. Bamboo fiber contain it naturally anti-bacterial, UV protective, green & biodegradable, breathable & cool, strong, flexible, soft and has a luxurious shiny appearance. This feature gets retained in bamboo fabrics too. When many tests have been conducted for bamboo fiber which show the results over 70% death rate after bacteria was incubated on bamboo fiber fabric.

Cotton is the most widely used fiber. Almost one half of total world fiber demand is for cotton. The cotton has good strength fiber with good abrasion resistance. Because cotton is an absorbent fiber, it is comfortable to wear in hot, humid weather. The fiber is most often spun into yarn or thread and used to make a soft, breathable textile.

Materials and Testing Method

The bamboo and cotton yarns were spun on a miniature ring frame with 24 twists per inch.

Table 2.1 shows the properties of bamboo and cotton spun yarns.

Sl. no	Cotton		Bamboo	
1	Fibre length	30 mm	Fibre length	35 mm
2	Fibre uniformity ratio	47 %	Moisture regain	11.3%
3	Fibre fineness	4.3 ug/in	Elongation	22.7%
4	Fibre maturity	81.2%		

Table 2.2 Fibre blends ratios of Bamboo and Cotton yarns

Sl. no	Fibres	Blending Ratios
1	Bamboo	100%
2	Cotton	100%
3	Bamboo/ Cotton	50-50

Table 2.3 Fibre Properties Testing Method Standard

Sl. no	Fibre properties	Instrument for testing	Standard
1	Length	Hand stapling method	ASTM D5103 - 07(2012)
2	Strength	Stelometer	ASTM D1445 / D1445M - 12
3	Elongation	Stelometer	ASTM D1445 / D1445M - 12
4	Fineness	Micronaire instrument	ASTM, D1445

The Bamboo and Cotton yarn, which are used for this work, properties have been studied using standard testing method using appropriate testing instrument as shown in Table 2.4.

Table 2.4 Yarn Properties Testing Method

Sl. no	Yarn Properties	Instrument for testing	Standard
1	Yarn strength	Electronic Count Balance	ISO/TC 38/SC 23, British Standard
2	Yarn Electronic	Uster Tensorap	ASTM D-5034:1995
3	Yarn Tenacity	Electronic tensile tester	In house method SITRA/YP/01:2015
4	Yarn imperfection	Uster tester	ASTM D 1425/D 1425M: 2014
5	Yarn friction	Yarn Friction (L & H) (Metal to yarn)	(ASTM-D-3108/D 3108 M-13)

Methodology

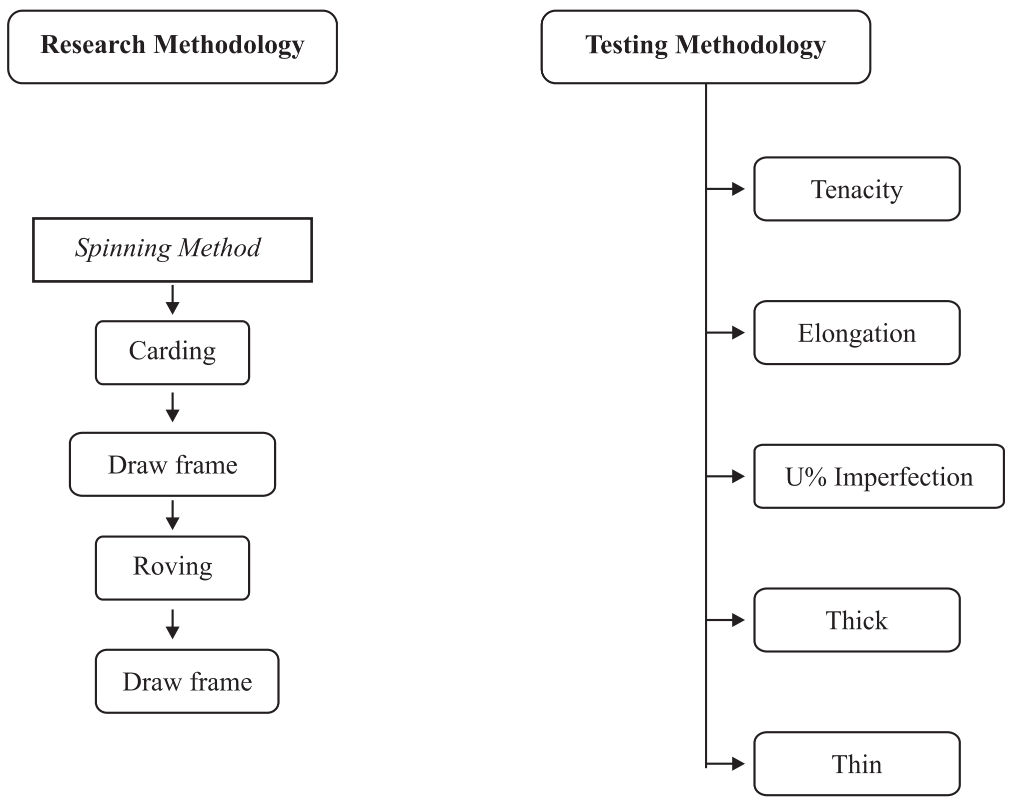


Table 2.5 Fabric Comfort Properties Testing Method

Sl. no	Testing Method	Instrument for testing	Standard
1	Air permeability	Air-Tronic Permeability Testere	ASTM D737
2	Water permeability	SDL Atlas M261	BS7209
3	Thermal resistance	Czechkoslovakia (skin model)	ISO 11092

Table 2.6 Development of woven fabrics (plain weave) using the above developed blended yarns.

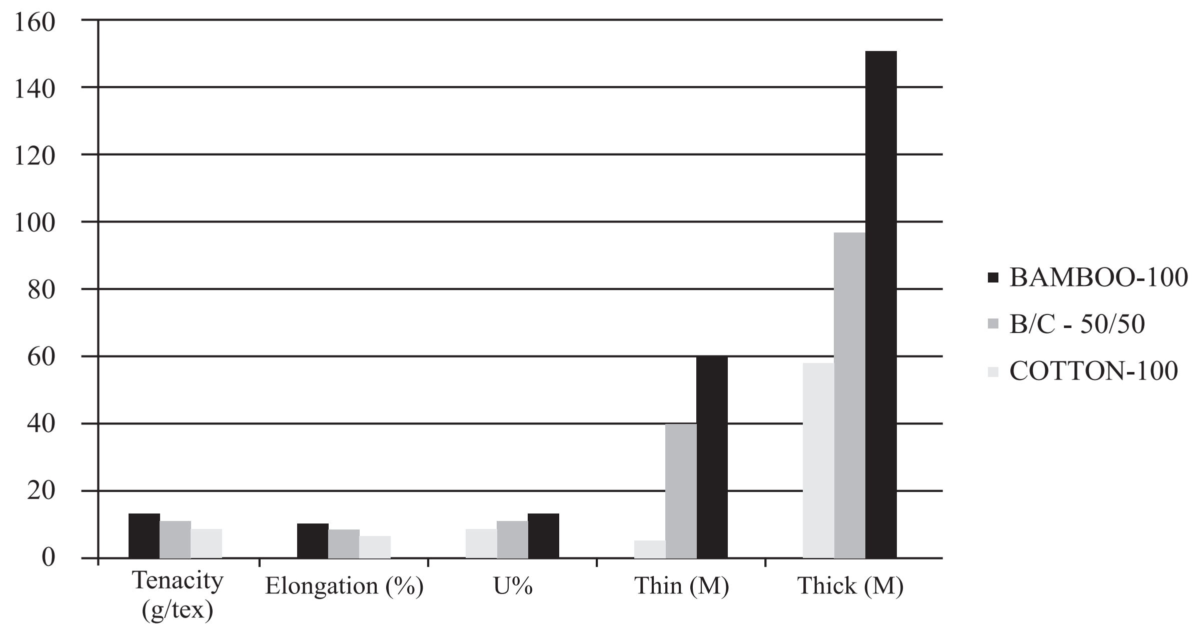
Sl. no	Parameters	Determined
1	Count	40s
2	EPI	78
3	PPI	72
4	Cover factor	18.4
5	Thickness	0.38 mm

Results and Discussion

The three varieties of blend of yarns samples were developed and tested their physical properties such as tenacity, elongation, imperfection, thick and thin are rating and their quality analysis are given below.

Table 3.1 Yarn Testing Report

Sl. no	Blending Ratio	Tenacity (g/tex)	Elongation (%)	U%	Thin (M)	Thick (M)
1	Bambo-100	17	12	10	6	58
2	B/C - 50/50	14	7	11	40	97
3	Cotton-100	10	5	15	60	149



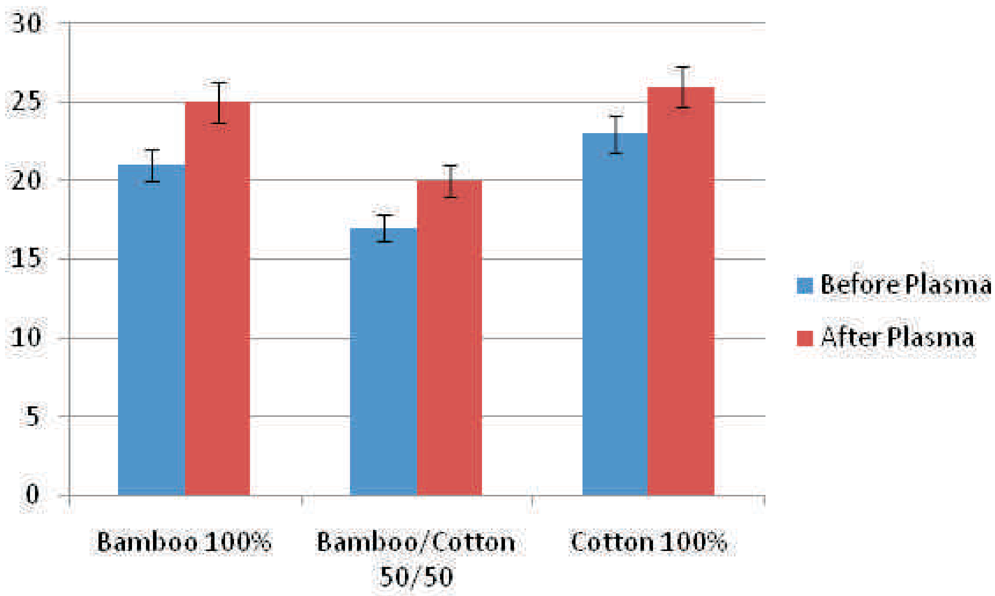
Graph 3.1 Tenacity,Elongation and U%

Graph 3.1 Tenacity,Elongation and U%

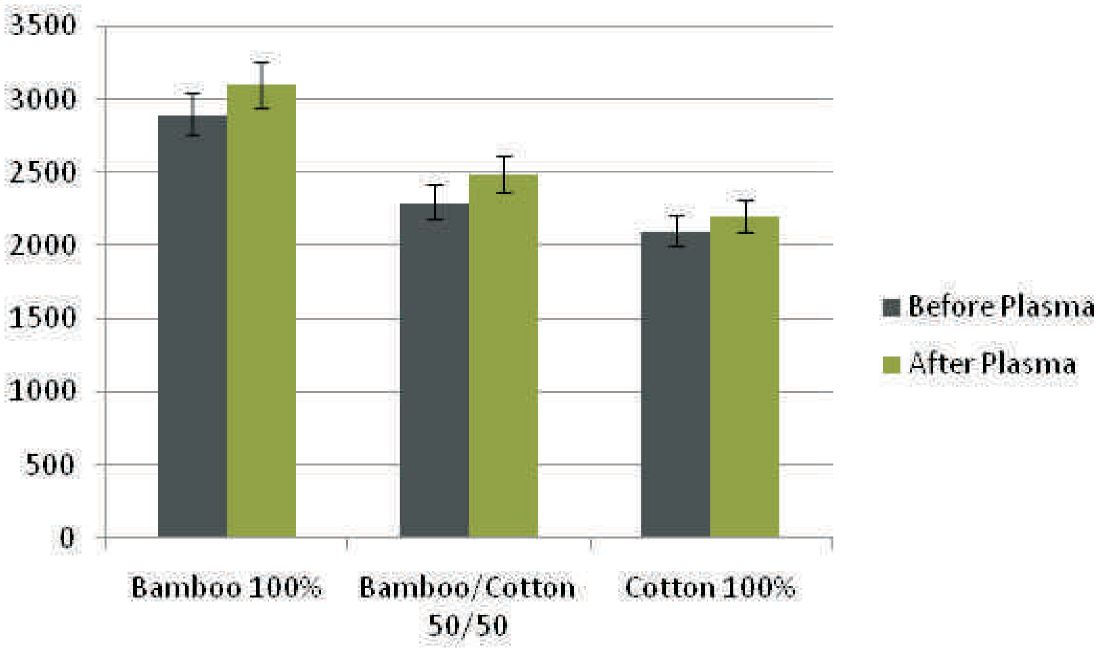
Graph 3.1 shows the result of Tenacity 100% bamboo 17 (g/tex) is higher value than other blends yarn. So the result gives bamboo yarn has higher attributes value. Elongation 100% bamboo 12 (g) is higher value than blends yarn. So the result gives bamboo yarn has higher attributes value. U% Imperfection 15 % mean 100% cotton yarn is higher value than other blends yarn. Because other blend yarn has containment is less.

Table 3.2 Fabric Comfort and Mechanical properties testing Report

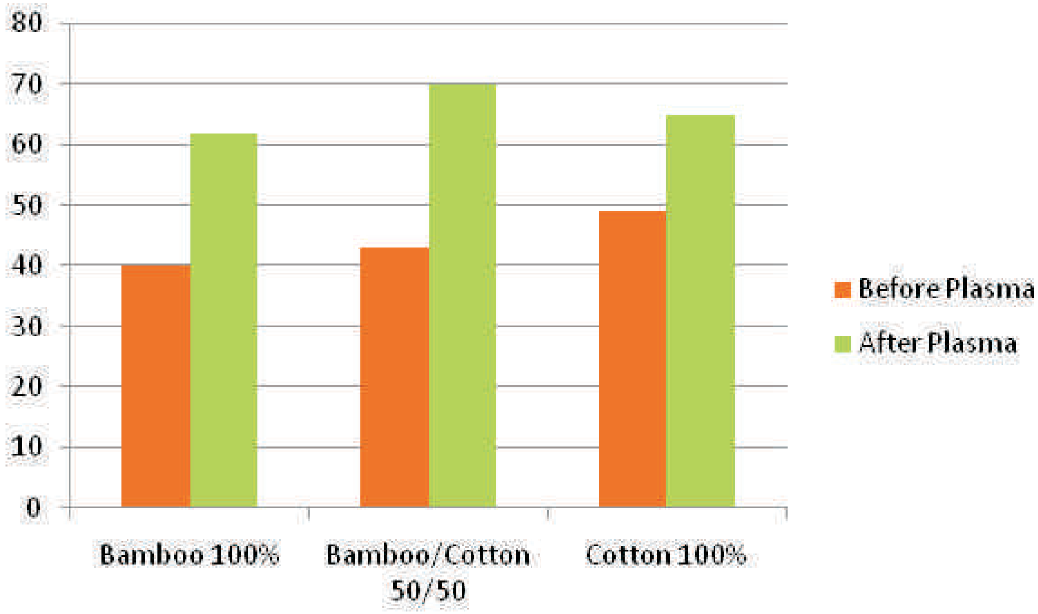
		Air Permeability l/min/20cm2		Water Vapour Permeability (g/m2/day)		Thermal Resistance (m2.mk/w)		Gsm		Thickness (mm)	
Sl. no	**Blend ing Ratio**	**Before Plasma**	**After Plasma**	**Before Plasma**	**After Plasma**	**Before Plasma**	**After Plasma**	**Before Plasma**	**After Plasma**	**Before Plasma**	**After Plasma**
1	Bamboo 100%	21	25	2900	3102	40	62	89	91	0.29	0.26
2	Bamboo/ Cotton 50/50	17	20	2300	2490	43	70	97	101	0.33	0.31
3	Cotton 100%	23	26	2102	2206	49	65	102	105	0.37	0.33



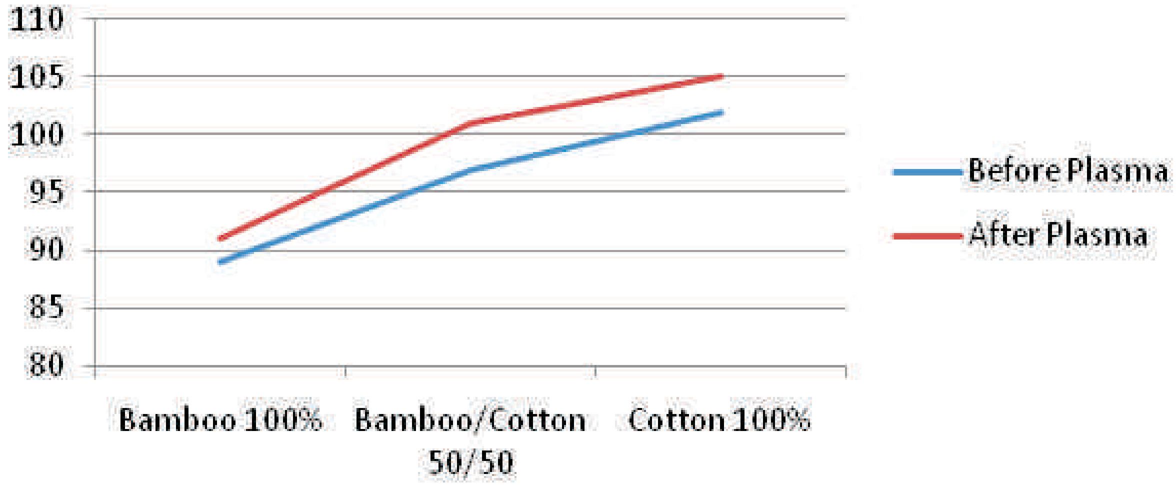
Graph 3.2 Shows the result of Air Permeability of bamboo cotton different blends of fabric the 100% cotton fabric gives higher air permeability before (23l/min/20cm2) and after plasma (26 l/min/20cm2) treatment using oxygen gas, where compared to other blend fabric.



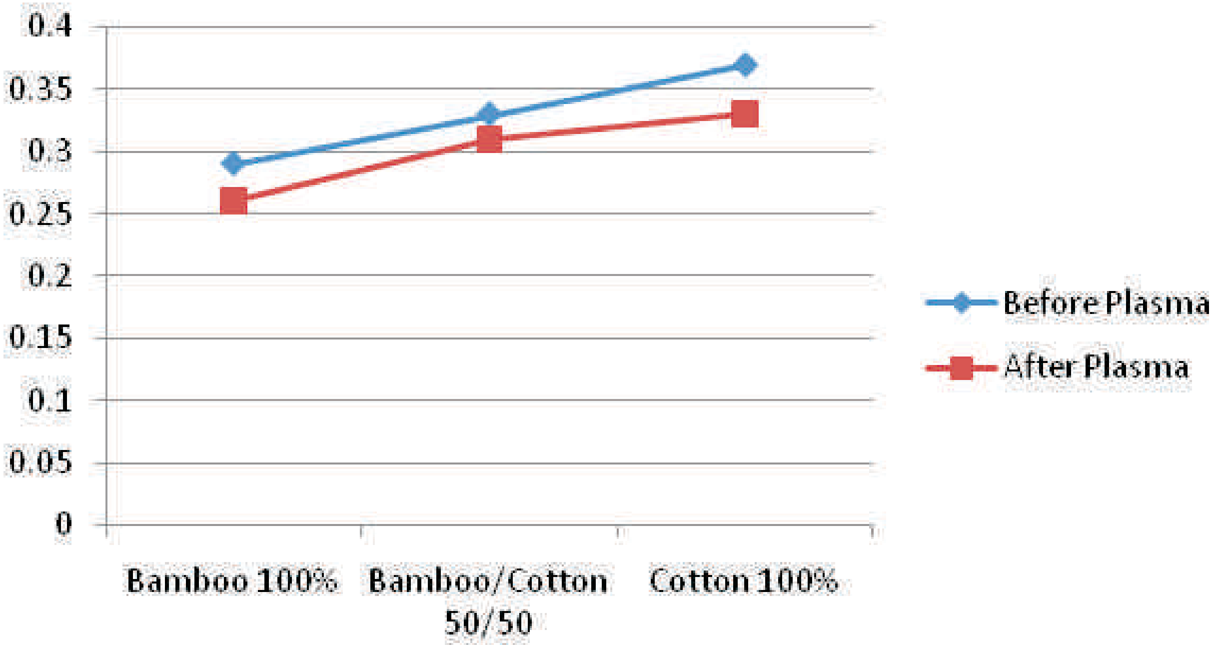
Graph 3.3 Shows the result of Water vapour permeability of 100% bamboo is higher vapour penetrate before plasama(2900 g/m2/day) and (3102 g/m2/day) after plasma. Where compared to other blend fabrics.



Graph 3.4 Thermal Resistance shows the result of 100% Bamboo before plasma is 40 (m2.mk/w) is lower compared to after plasma is 100% cotton is 65 (m2.mk/w) is higher attribute value.



Graph 3.5 The Gsm value of bamboo/cotton blend fabric is after plasma treatment gsm value increase in all blend fabric.



Graph 3.6 The Thickness value of bamboo/cotton blend fabric is after plasma treatment thickness is decreases in all blend fabric.

Conclusion

1. Plasma treatment is good to substitute for pollution free to processing the comfort and mechanical properties.
2. The elongation of blended yarns increases when bamboo content increase.

3. Evenness, friction & U % showed improvements where bamboo content is high.
4. The mechanical properties like Gsm and Thickness after plasma decrease the value.
5. The Bamboo and Cotton fabric of average testing result of comfort properties such as air permeability 100% cotton fabric allows more air to pass in materials.
6. The water vapour permeability 100% bamboo is higher vapour to penetrate in fabric.
7. Plasma treatment with oxygen gas gives higher surface modification on material

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Fabric Engineering for Dermatological Safety

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Abstract

Human skin is very sensitive to various environmental attributes like wind, dirt; dust etc in which ultraviolet rays are prime which rapidly alters not only the moisture level on skin surface but also the skin shine or glow. Fabric engineering covers fibre type, yarn types, weaves, cover factor, and fabric manufacturing techniques which influences various service and functional properties of garments. Ten fabric samples with two set of warp yarns (2/40s Ne and 20s Ne) were manufactured on Picanol air jet loom at weft insertion speed of 1000 meter per minute and processed under identical conditions. In all fabric samples end per cm and picks per cm were kept 54 and 42 respectively to keep fabric areal density 300 g/m2. Moisture vapour permeability, air permeability, thermal conductivity and ultraviolet protection factor of all fabric samples were tested with appropriate instruments as per approved standards.

Introduction

Fabric engineering is very effective tool to strengthen the potential of various types of garments for human being. Various types of yarns having diffident fibre configurations inside the yarn body which influences various comfort parameters of the fabrics (Matsudaira, 2009). Various types of yarns like open end yarns, carded and combed ring yarns, cotton/lycra yarns have different yarn structures in terms of fibre migration etc (Basu 2009). The interlacement of warp and filling yarns in various fashion also have great influence on fabric functional properties like ultraviolet protection factor (UPF) which is index of safety against ultraviolet (UV) rays. Higher UPF does guarantee about the dermatological safety by garment to the wearer (Dubrovski, 2010). Other dermatological comfort aspects are moisture vapour permeability; air permeability, warm-cool feeling (qmax) and thermal conductivity can also be engineered by fabric engineering as per our desirous. This study is dedicated to explore the possibility of various factors to optimize various dermatological soothing attributed by fabric engineering.

Materials and methods

Various 10 fabric samples were made using two different sets of warp yarns. First five fabric samples were made using 20s Ne open end yarn and next five fabric samples were made by using 2/40s Ne ring yarn. All fabric samples were made on Picanol Airjet loom with weft insertion speed of 1000 meters per minute. Two types of weft yarns one 16s Ne multifilament polyester yarn and other 16s combed cotton yarn, other 16s recycled 52:48 polyester/cotton blended ring yarn, next 16s cotton/lycra blend yarn and fifth 16s open end cotton yarn was used as filling yarn to develop 3/1 (three up one down) twill weave. The ends per cm and picks per cm were kept 28 and 22 respectively. Sucker Muller Hacoba sizing machine was used to size various warp yarns which were required to size.

Table 1 Details of Fabric Samples formed with 2/40s Open end warp yarns (W1), 20s Ne Combed cotton yarn (W2) with various weft yarns with fabric set: EPC 54, PPC 40

Sl. no	Weft yarns	Sample code	Sl. no	Weft yarns	Sample code
1	W_1 and 16s OE Cotton yarn	W_1OC6	6	W2 and 16s OE Cotton yarn	W_2 OC
2	W_1 and 16s Combed Cotton yarn	W_1CC	7	W_2 and 16s Combed Cotton yarn	W_2CC
3	W_1 and 16s Recycled PET/Cotton yarn	W1PC	8	W_2 and 16s Recycled PET/Cotton yarn	W_2PC
4	W_1 and 16s Cotton/Lycra yarn	W1LC	9	W_2 and 16s Cotton/Lycra yarn	W_2LC
5	W_1 and 16s Carded Cotton yarn	WICD	10	W_2 and 16s Carded Cotton yarn	W_2CD

All fabric samples were desized by using "Benninger Desizing bath for 16h by neutralizing process. Tensile behavior of fabric samples was tested on Titan-2 Games Heal Tensile Tester as per ASTM D 4964 OR 50/34 keeping sample size 4 8 inch, maximum force of 5000 Newton. Tearing resistance of fabric samples was tested Elma Tester Tester of James and Heal as per ASTM D1424. The moisture vapour permeability of fabric samples was tested by PERMETEST. Warm cool feeling (qmax) and thermal conductivity were tested by ALAMBETA while air permeability was estimated by TEXTTEST 3300 air permeability tester. The details of fabric samples are given in Table 1. UPF of fabric samples was tested by GESTER UPF Tester.

Results and Discussion

Fabric samples were tested for various comfort parameters and presented in Table 2.

Table2. Fabric Parameters for Dermatological Comfort

Sample Code	UPF	qmax	Water vapour permeability %	Air Permeability $cm^3/cm^2/s$	Fabric Thickness mm	Thermal Conductivity W m-1K-1 10-3
W_1OC	17.6	0.23	22.7	10.9	0.298	52.3
W_1CC	17.3	0.27	24.9	10.8	0.287	54.2
W_1PC	16.3	0.21	27.3	12.2	0.281	50.5
W_1LC	18.9	0.19	19.4	08.9	0.304	55.7
W_1CD	17.6	0.22	21.7	09.5	0.296	51.3
W_2 OC	17.8	0.24	23.9	10.2	0.294	52.9
W_2CC	17.3	0.29	24.9	10.5	0.285	55.1
W_2RPC	16.3	0.22	28.2	12.4	0.277	50.8
W_2LC	19.2	0.19	19.9	08.4	0.302	55.9
W_2CD	17.8	0.23	22.8	09.2	0.292	51.7

Dermatological Safety

Woven fabrics are capable to provide simple and conventional safety against UV radiation if the fabric engineering is performed in the phase of a new product development. There are several factors influencing UV protection properties of woven fabrics like yarn construction (fibre type, twist, yarn packing factor), fabric construction with its primary (type of weave, yarn fineness, warp/weft density, relative fabric density or fabric tightness) and secondary (cover factor, open porosity, mass, thickness, volume porosity) parameters of fabric geometry, additives (dye, pigment, delusterant, optical brighteners, UV absorbers), laundering and wearing conditions (stretch, wetness).

The UPF of fabric sample W1OC is 17.6 that decrease to 16.3 because the presence of recycled polyester decreased the UPF due to more openness in W1PC. Maximum UPF has recorded in case of WILC which has Lycra elastane fibre to offer better compactness in fabric structure. Similar trend is recorded in case of W2 fabric samples which had 20s Ne warp thread.

Warm-cool Feeling

The warm-cool feeling was recorded in terms of qmax which is instant heat transfer from human body to fabric. The qmax value 0.27 is highest for fabric sample W1CC and W2CC which fad combed compact weft yarns. These yarns have smooth surface which gives higher surface contact with human skin and consequently higher amount of instant heat transferred to human skin and cool feel takes place. The Lycra containing fabric W1LC and W2LC had lowest qmax because lycra containing fabrics had very compact structure which reduces specific surface area contact with human skin.

Thermal Conductivity

Heat transfer by conduction depends on the materials' heat conductivity, i.e. their capacity for transferring heat from a warmer surface to a cooler one (Onofrei, 2009). The main characteristics of heat conductivity are as follows: Conductivity factor ? [W/(mºC)] expresses the heat flow (Q), W, passing in 1 h through area (A) of 1 m2 of the fabric thickness (L) at a temperature difference (T1 - T2) of 1ºC, as given in the following equation:

$$\lambda = \frac{QxL}{At\,(T_1 - T_2)}$$

The thermal conductivity of fabric samples are shown in Table 2. The thermal conductivity of W1LC and W2LC is highest which indicated that lycra containing fabrics are suitable for summer wear while the fabric samples containing cotton fibre with other yarn type may be suitable for winter wear with poor thermal conductivity.

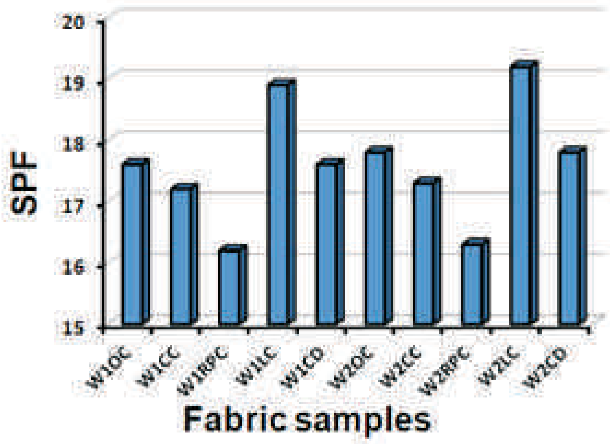

Fig.1 Effect of yarn type on SPF

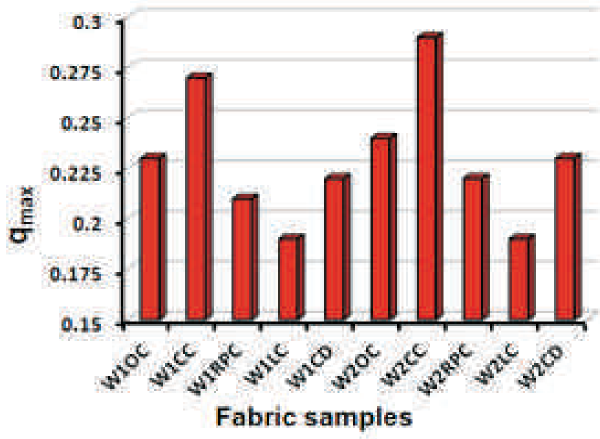

Fig.2 Effect of yarn type on qmax

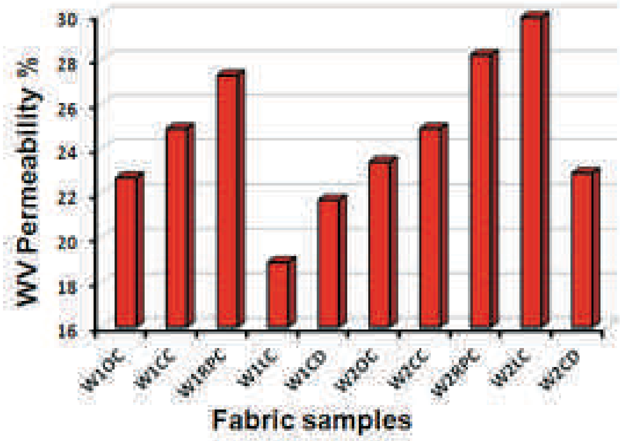

Fig.3 Effect of yarn type on WV Permeability %

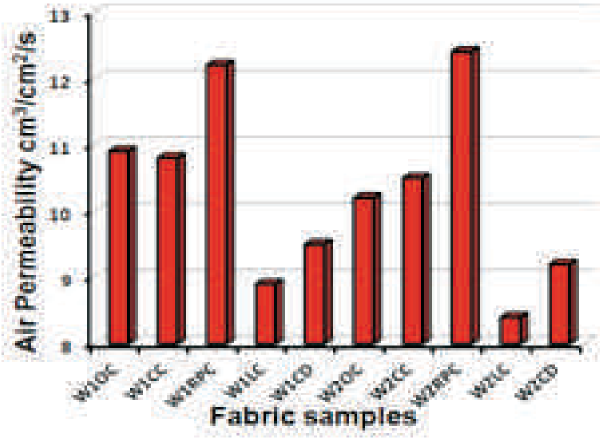

Fig.2 Effect of yarn type on Air Permeability

Water vapour permeability

Water vapour permeability is quite important attribute because inadequate moisture permeability of fabric forced to alter the feel, glow and comfort level at human skin (Das et al., 2009). Water vapour permeability data is presented in Table 2. Fabric sample W1PC and W2PC had highest water vapour permeability among their groups and that may be based on the fact that presence of polyester enhances yarn surface smoothness as shown in Fig 3. Polyester is a hydrophobic fibre in nature which diffuse moisture vapour quickly compare to cotton yarns. As polyester fibre content replaced by elastomeric fibre Lycra trend of moisture vapour permeability reverses and finally suppressed to 19.4 due to shrinkage of yarn and fabric structure.

Air Permeability

The air permeability of fabric samples is the resistance of air drag offered by the fabric against the fabric flow (Havlova, 2013). Air permeability depends on fabric openness also. Air permeability decides the amount of fresh air in microclimate also. The air permeability of fabric contains polyester fibre is highest in both fabric groups (containing warp W1 and W2). Fabrics having Lycra cotton yarn showed lowest air permeability due to very high compactness in fabric structure and that results due to elastic nature of lycra fibre (W1LC and W2LC fibre) as shown in Fig. 4. The fabric samples having carded weft, W1CD and W2CD, showed air permeability on lower side due higher hairiness on yarn surface which offer significant air drag against air flow.

Conclusions

The study is able to infer following conclusions:

1. Fabrics with lycra fibre content gives higher ultraviolet protection factor (UPF). The UPF increases as 2/40s Ne warp is replaced by 20s Ne warp, although change is not considerable.
2. Fabrics with recycled polyester fibre gives lower UPF followed by compact spun filling yarn fabrics
3. Fabric with compact ring spun yarn with smoother surface yarn gives higher cool-feel with highest value of q_{max}

4. Fabric has lycra fibre containing fabrics gives relatively less cool feel
5. Fabrics with recycled PET offer higher moisture vapour permeability while lycra containing fabric shows lower moisture vapour permeability
6. Fabrics have cleaner yarn surface with reduced hairs on surface gives higher air permeability due to lesser air drag against air flow.

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Role of Skill up Gradation in Carpet Industry in Socio- Economic Perspective

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Abstract

The uniqueness of the age old handmade carpet industry is maintained with its full grace. It is mostly an export oriented and labor intensive industry. In its core objective, the handmade carpet industry is basically a domain specific skill based industry, where people are involved in specific task, viz designing, dyeing, carpet manufacturing, finishing etc. In doing so, the industry requires involvement of a huge number of skilled workers with basic traditional knowledge of design, color and craft making. Due to globalization, like other industries handmade carpet industry is also facing stiff challenges of 3-C (customer, competition and change). So, with the fast changing market trend and variable taste, it has become very important to understand the demand of the consumers and offer them the desired product with additional features in a limited time frame. Many of the times, it has been felt that due to scarcity of the skilled work force, the bulk orders could not be executed in time. The need of skill development in hand made carpet sector has been realized from last few decades. In the recent time many private, government and non-government organizations have come up with skill development schemes to minimize this gap.The current study focuses on the role of skill development to ensure sustainability of the handmade carpet industry in the global scenario in terms of in-time delivery of product with desired quality and pricing. The need of skill development thus plays a pivotal role in all the socio -economic aspects of handmade carpet industry.

Keywords: Handmade carpet, Craft, Skill development, Artisan, Training

Introduction

Carpet being the heritage industry of modern India, occupies the significant role to create employment generation in the villages and underprivileged areas of the country. Since the infrastructural requirement is not to that of most sophisticated type, there is less risk of maneuvering of the processes. But still it contributes a sustainable income to the people who are attached to it since decades. Hence patronizing skill development program for the carpet sector is the beam of rays of morning sun. One of the most important point is prevalent, are we ready for fruitful result? Or burdened with formalities of exhibition? The choice is obvious to become self -reliant, and then we shall be able to make carpet sector a part of vibrant economy of modern India.

Rationale

Carpet industry is a labor intensive industry, where large number of work force is needed to be involved to achieve desired output. The underlying principles behind the need of skill up gradation are:

- To fortify the carpet industry with requisite workforce of required skill and aptitude.
- Up gradation of skill of artisans to help them to work with improved tools and accessories.
- Application of new improved and market oriented designs and color combinations. This is being done through skill up gradation programs with regard to different varieties/types of raw materials, carpet designs developed through CAD.

- Improved technology of yarn dyeing, product appraisal through modern testing equipments.
- To orient knowledge of weavers through improved techniques of carpet manufacturing through newly developed looms and corresponding techniques to handle the manufacturing process.
- To build awareness among workforce about ongoing scenario in the international market in respect of demand and supply of carpets.
- To build awareness among carpet exporters and buyers about standardization of product and process for the industry, Geographical Indication (GI) act and its benefits etc.
- Building general awareness about desired quality and its importance, consistency, value addition, process improvements etc.
- Ensuring a comprehensive advertising and publicity policy to keep the workers informed about the developments in the industry from time to time.
- Building general awareness among weavers/ exporters/ contractors about various government sponsored schemes and projects of various departments/ministries. This shall also include awareness about availability of financial support in terms of infrastructure or loan.

Methodology

(a) Development of objectives of skill development

The skill development at organization level takes place mostly in an informal way, i.e. persons acquire skill at the work-place. Such persons do not have a formal certificate and thus earn lower wages and are exploited by employers. They have come through informal system due to socio-economic circumstances of the family and the compulsions of earning a livelihood rather than attending a formal course. While their productivity is low, their contribution to the national GDP cannot be ignored. If a system of certification can be created, which not only recognizes their skills but also provides education and training in a mode that suits their purpose. It will not only benefit the workforce to earn a decent living, but also contribute to the national economy by better productivity of this workforce.

(b) Analysis of requirements of skills

The requirement of skills should be analyzed first, so as to enable the system make an easy to handle mechanism of skill up-gradation program without much interference to the day to day operation/work.

(c) Analysis of Demographic data requirements

Potential groups and their Caste, religion, education, sex, age etc. are to be analyzed and categorization of trainee groups to be made accordingly.

(d) Devising frame work for skill development program

- Demand driven conduction of short term training courses based on modular employable skills decided in consultation with Industry.
- Flexible delivery mechanism (part time, weekends, full time)
- Different levels of programs (foundation level as well as skill up-gradation) to meet demands of various target groups.

  Optimum utilization of existing infrastructure to make training cost effective.

- Testing of skills of trainees by independent assessing bodies who would not be involved in conduction of the training program, to ensure that it is done impartially/ transparently.
- Testing & certification of prior learning (skills of persons acquired informally).

(e) Analysis of basic traits of target groups

- Safety consciousness and safe working practices
- Care of equipment and tools
- Punctuality, discipline and honesty
- Concern for quality
- Respect for rules and regulations
- Concern for health and hygiene
- Cordial relationship and cooperation with co-workers and team Work
- Positive attitude and behavior
- Sense of responsibility and accountability
- Communication Skills
- Concern for environment and waste disposal.

(f) Basic qualitative aspects for skill up-gradation program

- Identification of 'minimum skills set' which is sufficient to get an employment in the labor market.
- The skill up gradation program should incorporate multi-skilling, multi entry and exit, vertical mobility learning opportunities in a flexible manner.
- It also allows recognition of prior learning (certification of skills acquired informally)
- The various skill up-gradation programs should ensure certification of trainees which can be regarded as equivalent to National trade certificate or higher, so that the trained work force can get equal access to any place for the particular job.

(g) Segmental forms of training

Training of trainees - Based on the prior level of learning artisans are trained subsequently to achieve workable skill.

Training of trainers - For conduction of effective and efficient training of trainees the trainers should be trained first.

Training of assessors or evaluators - It is an indispensible process in regards to the skill development process.

(h) A modular course matrix for Carpet industry (for crafts person only)

Based on the educational background and status of pre learning (SPR), three levels are decided as below:

- **Level 1**

Entry Qualification: Class V (Minimum). Higher qualification may be envisaged for specific jobs.

Age: 14 years (Minimum)

Terminal Competency: After completion of course the candidate would be able to work as a semi skilled worker.

Duration: 240 h or 3 months.

Level 2

- Entry Qualification: Class V (Minimum) & passed Level 1 or equivalent to it. Higher qualification may be envisaged for specific jobs.

  Age: 18 years (Minimum)

  Terminal Competency: After completion of course the candidate would be able to work as a fully skilled worker.

  Duration: 240 h or 3 months.

Level 3

- Entry Qualification: Class V (Minimum) & passed Level 1 & Level II or equivalent to it. Higher qualification may be envisaged for specific jobs.

  Age: 18 years (Minimum)

  Terminal Competency: After completion of course the candidate would be able to work as a fully skilled worker.

  Duration: 240 h or 3 months.

Nodal Agencies for Skill up gradation for carpet sector

- Director General of Employment & Training (DGET), Ministry of Skill development & Entrepreneurship, Govt. of India& their subsidiaries/ attached bodies.
- National Skill Development Council (NSDC) set up by Ministry of Finance, Govt. of India and their subsidiaries/ attached bodies.
- Handicrafts & Carpet Sector Skill council (HCSSC) promoted by EPCH & CEPC, Govt. of India and their subsidiaries/ attached bodies.
- Development Commissioner (Handicrafts), Ministry of Textiles, Govt. of India and their subsidiaries/ attached bodies.
- Indian Institute of Carpet Technology (IICT), Bhadohi (under the aegis of Development Commissioner (H), Ministry of Textiles , Govt. of India,
- Carpet Export Promotion Council (CEPC), Under Ministry of Textiles, Govt. of India.
- Concerned state government authority/ Department
- Various non -governmental organization

Socio economic benefits for skill up gradation

Personal Benefits

- The program is beneficial for the artisan to got awareness regarding various technical as well as non-technical aspects.
- The Program is beneficial for the artisan to learn new techniques of carpet yarn manufacturing, dyeing, designing, carpet weaving, carpet finishing etc.

- The program is beneficial for the artisan who can learn customer tastes, Importance of quality and new market interventions. By this approach, artisans may promote their initiative to take advantage of all this so as to emerge as an independent business man.

Industrial Benefits

This program upgrades and updates the skill and working methods of artisans and ensures quality production befitting the taste and likings of customers in different market segments.

- Formation of self-help groups of artisans who can be linked to other schemes available with the central and state Government from time to time and also for policy formulation.
- Organization can supply and execute the order in minimum time.

Social Benefits

- Through this program, the artisans are empowered in terms of improvement in skill in compliance to market demands and growing competition in the market.
- The increased involvement of artisans with different aspects of carpet trade and manufacturing helped them to be self-reliant and developed in them the interest to boost the scale of production.
- The higher output with better quality fetches higher earnings for the artisans to fulfill their physiological, social and esteem needs.
- The value addition to the skill and knowledge of artisans confer upon them recognition in the society where the level of skill was a determinant of their social importance.
- The consumers are largely benefited with variety of products at cheaper price than the past with good quality.

Conclusion

Skills and knowledge are the driving forces of economic growth and social development for any country. Countries with higher and better levels of skills adjust more effectively to the challenges and opportunities of world of work. China, Japan, Korea are few countries in Asian continent who largely depend on this aspect. As India moves progressively towards becoming a 'knowledge economy' it becomes increasingly important that the country should focus on advancement of skills and these skills have to be relevant to the emerging economic environment.One of the most advantageous parts of skill development program in India is that India is one of the few countries in the world where the working age population will be far in excess of those dependent on them. As per the World Bank, this will continue for at least three decades till 2040. This has increasingly been recognized as a potential source of significant strength for the national economy, provided we are able to equip and continuously upgrade the skills of the population in the working age group.

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A Critical Review on: Development of An Absorbent Fitness Wear using Hemp Fibre

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Abstract

Though manmade fibres are being extensively used in most of the apparel, the petroleum based fibres like acrylic, nylon, spandex and polyester are not so environment friendly. Time has changed from using manmade fibres to search for natural fibres. And recently, fashion world is slowly adopting for sustainability by choosing natural fibres and more eco-friendly process that causes very low or no harmful effects for the environment. This paper deals with the properties of hemp fibre that can be reasonably used for development of an absorbent fitness wear.

Introduction

Hemp fibre is obtained from the bast of the plant Cannabis sativa L. It grows easily - to a height of 4 m - without agrochemicals and captures large quantities of carbon. Long, strong and durable, hempfibres are about 70% cellulose and contain low levels of lignin (around 8-10%). The fibre diameter ranges from 16 to 50 microns. Hemp fibre conducts heat, dyes well, resists mildew, blocks ultraviolet light and has natural anti-bacterial properties. Shorter, woody core fibres ("tow") contain higher levels of lignin. The world's leading producer of hemp is China, with smaller production in Europe, Chile and the Democratic People's Republic of Korea. In the European Union hemp is grown on around 15 000 ha of land. Major producers are France, Germany and the UK. Between 2000 and 2006, world production of hemp fibre grew from 50 000 tonnes to almost 90 000tonnes, almost half of it produced in China. Production in the EU was 23 000 tonnes. China is the largest exporter of hemp textiles, mainly to Europe and North America, where the market for hemp clothing is growing rapidly. China also exports hemp-based fibreboard. Hemp has been used for centuries to make rope, canvas and paper. Long hemp fibres can be spun and woven to make crisp, linen-like fabric used in clothing, home furnishing textiles and floor coverings.

Elma M.J, Salentijn, Qingying Zhang, Stefano Amaducci, Ming Yang, and Luisa M. trindade, (New developments in fibre hemp, 2015) observed that fibre hemp is a sustainable and high yielding industrial crop that can able to meet the high global demand for fibres. Hemp can be grown for fibre, seeds, and/ or for dual purpose in a wide range of geographic zones ad climate. Currently, the main hemp producing regions in the world are China, Europe and Canada. The number of new cultivars developed for each of these regions has gradually increased, with each region producing their own typical hemp cultivars for different purposes. They also discussed the inestimable value of next generation technologies to breed new hemp cultivars that are suitable for bio based economy.

Ralf Pecenka, CarstenLühr, and Hans-JörgGusovius (Design of Competitive Processing Plants for Hemp Fibre Production, 2012) observed that Despite an annually growing demand for natural fibres accompanied by worldwide increasing fibre prices as well as long tradition and experience in fibre processing, the production facilities for hemp and flax fibres are very limited in Europe. At present, the lack of modern harvesting and economic processing technologies seem to be the greatest obstacles for hemp fibre producers under the changing conditions of international raw material markets. Therefore, detailed investigations of all process stages of hemp fibre processing have been carried out at the Leibniz

Institute for Agricultural Engineering (ATB). A novel hemp processing line has been developed, installed, and tested at industrial scale in the last 3 years. Investigations regarding optimum plant layout have shown that a straw throughput of approximately 4?t h?1 is required for economic fibre production for all new processing lines at currently high straw prices of more than 150?€?t?1. Throughputs in the range from 4 to 6?t h?1 showed a favourable relation between profit and investment cost. At throughputs higher than 6?t h?1, the profit per ton processed straw can be further increased. But investment and straw logistic cost increase at these high-throughput levels often much faster.

Zhang Jin-Qiu and Zhang Jian-Chun (Effect of finishing treatment with softening agent on spinnability of hemp fibre, 2010) observed thatthe efficiency of finishing treatment using softening agent DT150A for improving the spinnability of processed hemp fibre has been investigated. The mechanical properties of hemp fibre have been measured before and after soft finishing. The uniformity of length, flexibility, surface friction and moisture absorption increase significantly, and the spinnability of the hemp fibre improves after soft finishing.

Rahman MMM, SayedEsfahani MH (Study of Surface characteristics of Hemp fibres Using Scanning Electron Microscopy, April 1979.) observed that like Jute, flax, hemp is regarded as the bast fibre or soft fibre in commerce and is generally extracted from the cultivated plants of the genus Cannabis. Cannabis is monotypic, but since the plant exhibits several different growth forms, it has been described under different names such as Manila hemp, sisal hemp, Mauritius hemp, and sunn hemp. The true hemp plant Cannabis Sativa.L is cultivated mainly its fibre for a variety of specialised textile uses.

Need for absorbent fitness wear using Hemp Fibre

Presently most of the fitness wear are made of synthetic fibres like polyester, nylon and spandex which are not eco friendly and bio degradable although they are highly absorbent and possess a greater fit. Hence in this research work an attempt is made to produce a fitness wear using natural fibres such as hemp and from blend of hemp and cotton which are available in abundance and also has excellent absorbent properties besides being eco friendly.

Sports and Fitness Clothing: A Research Brief

The global market for Sports and Fitness Clothing is projected to reach US$231.7 billion by 2024, driven by rising health consciousness and the resulting increase in participation in sports and _fitness activities. In addition to the healthy lifestyle crusade, the market is also poised to benefit from technology innovations aimed at enhancing user comfort and apparel performance and from the evolution of sportswear into a high-street fashion trend with the ability to make a strong style statement. Few of the noteworthy fabric and material innovations in the market include smart nanotechnology based fabrics that trap and suspend moisture and keep the wearer dry; compression fabrics that supports muscles during a workout; and ultra-thin insulation that retains body warmth. Europe represents the largest market worldwide. Asia-Pacific ranks as the fastest growing market with a CAGR of 6.9% over the analysis period, led by factors such as rise in income levels, Westernization of lifestyles, emergence of low cost Asian countries as production hubs forsports apparel due to cheaper labor and raw material costs; growing popularity of the gym culture among the young millennial and the resulting demand for shape performance gym apparel and clothing.

- Increase in the Number of Fitness Clubs and Gyms Spurs Demand for Men
  and Women Gym Fashion Apparel

- Fabrics With Body Temperature and Moisture Management Capabilities to
- Prevent Overheating During Athletic and Fitness Activity to Benefit Sales Growth
- Blurring Line Between Casual Wear and Sports Apparel Expands the Frequency of Purchase
- Increased Participation in Mountaineering and Cycling Fuels Demand for Performance Apparel

Hemp - An Alternative for Cotton

On an annual basis, 1 acre of hemp will produce as much fiber as 2 to 3 acres of cotton. Hemp fiber is stronger and softer than cotton, lasts twice as long as cotton, and will not mildew. Cotton grows only in moderate climates and requires more water than hemp; but hemp is frost tolerant, requires only moderate amounts of water, and grows in all 50 states. Cotton requires large quantities of pesticides and herbicides- 50% of the world's pesticides/herbicides are used in the production of cotton. Hemp requires no pesticides, no herbicides, and only moderate amounts of fertilizer.

Regarding comfort, continuous wear of cotton causes 'breaks in' to become even more comfortable. There is no denying how soft cotton can be, but it is also true that cotton fibres break down over time and the more it is washed the faster it breaks down. The hemp fibre used in clothing is a strong natural fibre that, like cotton, gets progressively softer with each passing day you wear it and each time you wash it. Although it may not start off quite as soft, it is still soft and certainly would not be considered uncomfortable. The plus is that the fibre is much stronger and durable. Repeated washed will not break the fibre down anywhere near as quickly as cotton. Creating more hemp clothing would mean we would need to produce much less clothing.

Breathability is certainly a strong suit for cotton. It also does not hold odours for very much. This is quite possibly one of the biggest downsides to synthetic fibres, they don't dispel odour well and don't often deal with moisture well either. While cotton has a natural wicking system, it also holds moisture a little longer than what might be considered most desirable. Performs very well when it comes to breathability and wicks moisture away from the body effectively. Hemp also carries anti-bacterial properties that trump any other natural fibre. This means hemp will not mold or grow mildew very easily. Since it also does not hold odours,

Without the use of dyes, cotton comes naturally in white, cream and off-white. Cotton can be dyed naturally or synthetically to achieve a desired color. The growing knowledge that cotton is very taxing on the environment and not healthy for our skin is creating quite the demand for organic cotton. Given the various processes available to remove fibres from the stem of a hemp plant, hemp can be naturally creamy white, black, green, grey or brown. Without even requiring the use of dye, hemp comes in a variety of colors. Of course, you are still able to dye hemp both naturally and synthetically. Hemp is quickly becoming more and more popular in the fashion market as designers see the potential in the material while being a very environmentally sound option. Since it is durable and lasts a long time, it can be attractive to certain designers.

Advantages of Hemp Fibre

- **Strong:** Clothing made of hemp fiber is lightweight, absorbent and, with three times the tensile strength of cotton, strong and long-lasting.

- **Weather Resistant:** UV and mold-resistant, hemp is excellent for outdoor wear.
- **Versatile:** Hemp can be blended with other fibers for different qualities in the garment. Hemp/silk and hemp/cotton garments are now available.
- **Cost-Effective:** Hemp is less expensive to farm because of its minimal growth requirements.
- **Easy on the Environment:** Hemp farming uses very little water, does not require the use of chemical pesticides or fertilizers, and is a readily renewable resource.

Production, Extraction and Processing of Hemp Fibre

Harvesting and separating Hemp Fibres:

For cultivating the fibre, both the male and the female hemp plants are cut down as soon as the male being to pollinate. For separating fibre from the seed, the males are allowed to pollinate and the females are left to mature until the seeds are ripe and then the plant is cut down for separating fibres from the seeds. In 1996, a study in Hungary resulted in a conclusion that male fibres were finer than female fibres.

Retting of Hemp Fibre

Once the plants have been cut, the stems are usually laid out along the ground for several weeks so that retting can occur. This is a process of decay whereby the pectin that binds the fibres together decomposes on exposure to light and air, and the long bast fibres are exposed. Bast fibres are those that occupy the phloem or inner bark of dicotyledonous plants such as hemp and flax. Two types of retting techniques are followed. They are:

Water retting: Involves soaking the stems in water tank, ponds or streams for about 10 days.Most effective is warmed water laden with bacteria.

Dew retting: Entails laying the crop on the ground for three to six weeks, turning the plants occasionally to allow for even retting.

Decorticating the Hemp Fibre

Decortication is the removal of the central woody core from the stem. This step can be performed immediately after retting, while the stems are still wet; in this case, the damp fibres are peeled off the core and then dried. Alternatively, the stems can be dried and then processed with specialised machinery, which breaks up the woody core by a process known as breaking and separates it from the fibres. This process is known as Scutching.The fibres are then hackled (combed) to remove any remaining woody particles by hackling prpocess and to further align the fibres into a continuous sliver. Modern decorticators often negate the need for long retting periods and separate decortication processes, instead combining the processes into one and producing ready-to-bale fibre within a few minutes of cutting the plant.

Treating the Hemp Fibres

Once the fibres have been separated, they are formed into bales and removed from the field to be processed into yarn. Often, the fibre is spun without further processing but some cases includes soaking the fibres in a near-boiling solution of soap and carbonate of soda, before being washed with water and soaked in dilute acetic acid. The fibres are washed in pure water once more, then dried and combed to produce an end result of exceptional softness and fineness.

Removing Lignin from the Hemp Fibre

Lignin is a hard, woody biopolymer that makes up 8-10% of the dry weight of hemp fibre, and is responsible for the rough, scratchy feel of traditional hemp fibre. If the lignin is removed, the resulting fibre is much smoother and softer. The inability to remove lignin from hemp without reducing its strength led to other crops being favoured over it-yet another reason that its use began to decline so dramatically in the post-industrial period.

In the mid-1980s, researchers developed a new technique to remove the lignin through enzymatic & microbial means: the protein-digesting enzyme protease is first applied to the hemp fibre, which reduces the nitrogen in the stems; then, a species of fungus known as Bjerkandera is allowed to grow upon the fibres, where it consumes the lignin. The fibres produced with this technique were far more versatile, and hemp began to be used in garment-making once more.

Spinning of Hemp Fibre into yarn

Hemp yarn is spun similarly to other natural fibres; typically, the fibres are twisted together to form long, continuous threads, which are often sealed with wax or a similar agent to render the end result waterproof or more durable.

It is usually at this stage of the process that other fibres are added to the blend: rather than blended cloth being woven from threads made purely from one type of fibre, the thread itself is a blend of fibres that influence its final characteristics.

Weaving of the Hemp Fibre into fabric

Spinning takes the hemp fibers and spins them together to produce a long continuous strand of yarn. This yarn is then used to weave or knit the fabric used in hemp textile products. The main difference in the spinning process between hemp fibers processed using chemical methods and fibers from organic methods is generally the length of the hemp fiber and the spinning machines that are required to spin the long fiber organic hemp and the short fiber, chemically processed hemp.

When the hemp fabric is washed and shrunk, the weave will naturally close up. This is in direct proportion to the degree of shrinkage obtained. In practical terms, this means that identically woven fabrics may appear different if one of them has been washed, dyed, bleached, or shrunk.

Unlike long fiber hemp, short fiber "cottonized" hemp created by chemical processing can be spun and finished on slightly modified cotton or wool processing equipment, so that the existing and cost effective infrastructures for the processing of cotton and wool could be used.

Softening and cleaning of the Hemp Fibre

After the weaving process, the resulting loomstate fabrics are washed with ecological detergents or sometimes just with plain water which is afterwards treated. Drying is made by using constant temperatures. The temperature level differs from fabric to fabric, depending on its thickness, in order to avoid burning or weakening the strength of yarns' structure.

The hemp yarn used for knitted fabrics is dyed by a specialized dyeing facility with internationally certified reactives.Same as in the woven fabrics' case, the softening process implies adding certified fiber-reactive substances which provide a unique softness to the fabrics. The boiling is made at constant-level temperatures, the entire process being closely supervised in order to obtain a beautiful shade all along the fiber's length.

Dyeing and finishing

Each stage of the finishing process follows extremely strict parameters which depend on the yarn's or fabric's thickness. The fabric is Sanforized. This process implies feeding the fabric into a special sanforizing machine and therein moistening the cloth with steam. A rotating cylinder presses a rubber band against another heated rotating cylinder, thereby the rubber band briefly gets compressed and afterwards shrinks to its final size. The fabric to be treated is transported between the rubber band and heated cylinder and is forced to follow this brief expansion and recontraction. The purpose of this process is to open up the fiber's molecules and, under pressure, fixate them. Thus, the yarns are finely arranged within the weave, resulting a higher strength level of the fabric.

The final phase of the finishing process, before the fabric reaches final consumers or our designing department, consists in quality control. This implies analyzing the fabric meter by meter in order to identify potential processing errors and make adjustments, if necessary. If the fabric presents weaving faults, it is used in-house avoiding the damaged sections, thus keeping to the minimum the quantity of scrap fabric. In case of finishing faults, the fabric is returned and corrected according to our standards.

Eco-friendly finishing processes for Hemp Fibre

- **Tentering:** Process for holding a fabric to desired width during drying. A tenter frame machine holds the fabric firmly at the edges by pins or clips as it advances through a heated chamber. This is generally the final step in finishing, giving the fabric its finished appearance.
- **Sanforized:** A trademarked control standard of shrinkage performance. A method of compressive shrinkage involving feeding the fabric between a stretched blanket and a heated shoe. When the blanket is allowed to retract, the cloth is physically forced to comply. Leaves fabrics with a residual shrinkage of not more than one percent.
- **Compacting:** A permanent treatment by which heat and pressure shrink a fabric so that resulting texture is crepey/crinkled and bulky.
- **Calendering:** Fabric is passed between heated cylinders under pressure to produce a flat, glossy, smooth, high luster surface.
- **Steam Chamber:** Stabilizes the colors of dyes after printing and dyeing processes. Process where steam is passed through fabric. This partially shrinks and conditions the fabrics when applied, especially on wovens.
- **Heat Shrinkage:** Improves shrinkage resistance and shape retention of fabric and often other desirable properties, such as wrinkle resistance by means of either dry or moist heat.
- Singeing: Burning off protruding fibers from fabric by passing over flame or heated plates. Imparts the smooth surface necessary for printing and clear finishes.
- **Brushing:** Utilizes multiple brushes or other abrading elements to raise fiber ends thus producing a nap on surface of fabric.
- **Sanding or Sueding:** Process by which fabric passes over rapidly revolving rollers covered with abrasive paper.
- **Napping:** Raising the surface fibers of fabric by means of passage over rapidly revolving cylinders covered with metal points/fine wire brushes or teasel (plant) burrs.

- **Enzyme Washing:** The use of an enzyme (organic catalyst used to speed up a chemical reaction) to produce stone washed effects on fabrics. This process id less damaging to fabrics than actual stone washing and produces a highly desirable soft hand.
- **Biopolishing:** Where cellulose (any group of enzymes that degrade cellulose) enzymes hydrolyze the fiber surfaces. This treatment improves hand, reduces fuzz and pilling and gives clearer finish. Biopolishing agents should adhere to the following requirements to be considered environmental:
    - Softeners used are biodegradable.
    - No Formaldehyde based resins.
    - No undisclosed chemical finishes.
    - No acid wash/No stone wash.

Characteristics of Hemp Fabric:

- Hemp fiber is one of the strongest and most durable of all natural textile fibers. Products made from hemp will outlast their competition by many years. Not only is hemp strong, but it also holds its shape, stretching less than any other natural fiber.
- The more hemp is used, the softer it gets. Hemp doesn't wear out, it wears in. Hemp is also naturally resistant to mold and ultraviolet light.
- Due to the porous nature of the fiber, hemp is more water absorbent, and will dye and retain its color better than any fabric including cotton. This porous nature allows hemp to "breathe," so that it is cool in warm weather. Furthermore, air which is trapped in the fibers is warmed by the body, making hemp garments naturally warm in cooler weather.
- Apparel made from hemp incorporates all the beneficial qualities and will likely last longer and withstand harsh conditions. Hemp blended with other fibers easily incorporates the desirable qualities of both textiles.
- Hemp fabric is naturally more suitable to people with chemical sensitivities such as Multiple Chemical Sensitivities than cotton.
- They are longer, stronger, more absorbent, more mildew-resistant, and more insulative than cotton. This means that hemp will keep you warmer in winter and cooler in summer than cotton.
- Hemp is more effective at blocking the sun's harmful ultraviolet rays.
- The nature of hemp fibers makes them more absorbent to dyes, which coupled with hemp's ability to better screen out ultraviolet rays, means that hemp material is less prone to fading than cotton fabrics are.
- It can have a significantly positive impact upon the environment and the lives of people.
- The soft elasticity of cotton or the smooth texture of silk combined with the natural strength of hemp creates a whole new genre of fashion design.

Conclusion

In this paper a critical review on "Development of an absorbent fitness wear using hemp fibre" has been carried out highlighting on the properties, extraction, production and processing of hemp fibres with their advantages. Also hemp as an alternative to cotton is also presented.

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Antibacterial Finishing of Cellulosic Textiles from Natural Sources

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Abstract

Present time is the time of environmental consciousness, today new requirements not only emphasizes on the internal functionality and long service life of the product but also a manufacturing process that is eco friendly. In the field of antimicrobial textile finishing, many synthetic antimicrobial agents have been developed but they are associated with various side effects, harmful and not eco friendly. Therefore new direction of research in the field of antimicrobial finishing is to use more and more eco friendly antimicrobial agents based on natural products such as chitosan, neem extract, natural dyes and other herbal products. Although there are many cited literatures, where efforts have been made to exploit these eco friendly bioactive natural products for textile application, but there are very limited studies which have been carried out systematic in-depth investigation. So this study is an effort in this direction.

Key words: Antimicrobial agents, natural dyes, bioactive agents, chitosan etc.

Introduction:

Now a day's increasing global competition in textiles has created many challenges for textile researchers and industrialists. The growth of microbes on textiles during use and storage affects negatively to the wearer as well as textile material itself1. Textiles have long been recognized as media to support the growth of microorganism such as bacteria and fungi. These microbes are found almost everywhere in the environment and can multiply quickly

when basic requirements such as moisture, nutrients and temperature are met2. Natural textile materials are more prone to microbial attack than the synthetic one. Cellulosic as well as protein fibers also provide all essential basic requirements such as moisture, oxygen, nutrients and temperature for bacterial growth and multiplication. This microbial growth produces many unwanted effects like generation of unpleasant odor, stains, discoloration in the fabric and reduction in the fabric mechanical strength. For these reasons, it is essential that the growth of microbes on textiles should be minimized or controlled during their use and storage. Hence a need of antimicrobial finishes development.

To meet the above mentioned demand a range of synthetic antimicrobial agents such as triclosan, metal and their salt, organometallics, phenols and quaternary compounds have been developed and quite a few are also available commercially. Though these antimicrobial agents are very effective against a range of microbes and give a durable effect on textiles but these are also associated with various side effects, water pollution and action on non target microorganisms. Hence there is a great demand for antimicrobial textiles based on ecofriendly agents.[3]

Natural dyes as antimicrobial agents:

Coating of antimicrobial plant with natural dyes and bioactive plant extract onto cotton fabrics is an emerging technology in the production of medical cloths. As many of the identified compounds from plants are colored, they are used as natural antimicrobial dyes and pigments for dyeing natural and synthetic fibers [4-6]. Ecologically friendly pigments have also been produced by the fermentation of microorganisms such as fungi and bacteria [7, 8].

Many natural dyes obtained from various plants are known to have an antimicrobial property. The plants contain large amount of tannins viz. pomegranate (Punica granatum) and several other plants rich in napthoquinones such as henna, walnut etc. are reported to exhibit antibacterial and antifungal activities [9].

Deepti Gupta et. al. (2004) reported the antimicrobial properties of eleven natural dyes against three types of Gram-negative bacteria. Seven of the dyes showed activity against one or more of the bacteria. The minimum inhibitory concentration for three selected dyes was determined. The results demonstrate that certain dyes are able to reduce microbial growth almost completely in the case of Escherichia coli and Proteus vulgaris. Selected dyes would therefore be valuable for the dyeing of sheets and gowns for hospital use, and on articles which are less suitable for laundering such as mattresses and upholstery. The dyes examined exhibited good wash fastness and the antibacterial effect is therefore likely to be durable[10].

Dutta et. al.[11] reported that many natural dyes which obtained from plant materials are found some medicinal values. The dyeing materials were prepared from pomegranate (Punicagranatum), wild maangosteen (Diospryos peregrine), myrabalan (Terminalia chebula), arjun (Terminalia arjuna), betel nut (Areca catech), onion (Allium cepa), tea (camellia sinensis), eucalyptus (Eucalyptus cenerea) and dye flower (Coreopsis basalis). Cotton fabrics were dyed with the extracted coloring materials and evaluated antimicrobial property against Bacillus subtilis (gram positive) and Escherichia coli (gram negative). The cotton fabrics dyed with extracts of arjun, betel nut, pomegranate, tea and onion were found to have antimicrobial activity against both the test bacteria at varying efficiency. The dyed fabrics also showed reasonably good wash fastness; hence have good potential for adding antibacterial properties along with vibrant colors to textiles of medical and other delicate uses[11].

Raja and Thilagavathi [2011][12] reported that wool fabrics treated with four natural dyes viz. Silver oak, flame of forest, tanner's senna and wattle bark; having in vitro antimicrobial efficacy to both gram positive and gram negative bacteria with and without the use of enzyme and mordants. The test results showed that the antimicrobial efficacy of dyed wool samples was significantly influenced by enzyme and mordants treatments. The control dyed fabrics showed antimicrobial efficacy only against gram positive S. aureus bacteria whereas the enzyme treated fabrics had antimicrobial efficacy against both S. aureus and gram negative E.coli bacteria. This may be due to 17% higher dye uptake in the enzyme treated materials. The mordant treated wool fabrics generally showed less antimicrobial efficacy against S. aureus compared to control dyed fabrics[12]. Anita et. al. [2016] used stem barks of *Meliacomposita* as a natural dye and antifungal activity of dyed fabric was assessed against standard strains of five fungi namely *Aspergillus flavus, A. niger, A. parasiticus, Fusariummoniliforme and Penicilliumcanescensusing* agar-well diffusion method. They observed remarkable antifungal activity of natural dye from barks of *M. Composita*[13].

The dye extracted from bark of Araucaria columnarisis, known as Christmas tree, using two solvents-methanol and ethyl acetate and its antimicrobial activity was tested against major clinical pathogens. The methanol extract showed the maximum antibacterial activity with the inhibition zones ranging from 15 to 20 mm against both gram positive and gram negative bacteria. The extracts were treated with cotton fabrics which showed dark brown color (methanolic) and light brown color (ethyl acetate) on cotton fabric. A dyed fabric shows interrupted growth underneath the fabrics14. Ramasamy23 used natural dyeing solutions obtained from rind of P.granatum for dyeing cotton fabrics. He also confirmed that fabric dyed with the natural colorant from P.granatum extracts displayed excellent antibacterial activity against test organisms S. aureus and E. colli. Mohammad et. al. 16 [2013] reported that natural dye extract obtained from walnut; applied on polymide fabric; showed antibacterial activity against pathogenic strains of gram positive (Staphylococcus aureus) and gram negative (Escherichia coli) bacteria. Curcumin a common dye used for fabric and food coloration, a dye isolated from Quercusinfectoria and the colorant Berberine which contains the quaternary ammonium group all exhibit durable antimicrobial efficacy when attached to textiles. Other dyes like kerrialacca, rubiacardiofolia and acacia catachu have also indicated antibacterial activity upto some extent17.

Natural bioactive agents

Natural bioactive agents with antimicrobial properties have become increasingly important for bio-functionalization of textile fibers because they enable the production of safe, non-toxic, skin- and environment-friendly bioactive textile products. These antimicrobial compounds, which are mostly extracted from plants, include phenolics and polyphenols (simple phenols, phenolic acids, quinines, flavonoids, flavones, flavonols, tannins and coumarins), terpenoids, essential oils, alkaloids, lectins, polypeptides and polyacetylenes [18-20].

Jothi21 applied aloe gel to cotton fabric to develop antimicrobial fabric. Cotton fabric was treated with aloe vera extract (aloe barbadensis mill) at various concentrations by pad-dry-cure method. Methanol was used as a solvent for aloe gel extraction from aloe vera plant. The aloe gel (5 gpl) treated fabrics exhibited antimicrobial activity against the staphylococcus aureus. The wash durability of the treated samples was found good even after 50 wash21. **M. Joshi** et al reported that various natural products based bioactive agent such as chitosan, natural dyes, neem extract and other herbal products may also be used as antimicrobial agent22. The Aloe Vera extract applied on the cotton in various concentrations in presence of eco-friendly cross linking agent glyoxal in pad-dry cure technique[22].

Application of *glycyrrhiza* glabra (yashtimadhu) roots, herbal solution to cotton fabric imparts functional properties of antimicrobial and thermal resistance (Veni and Mani, 2012). They reported that 50% conc. treated fabric proved to possess best antimicrobial and coolant properties. The treated fabric is found to be very hygienic with less fungi and bacteria as well as making the cloth much softer than before. They also concluded that this herbal treatment give better coolant effect and reduce the heat on the human eyes[23].

Rajendran et al. (2012) studied on application of natural silk protein- sericin as antimicrobial finish on cotton. They extracted sericin with ice cold ethanol and coated onto cotton fabric by a pad-dry-cure method. Quantitative assessment by percentage reduction test showed a reduction percentage of 89.4% and 81% for S. aureus and E. coli, respectively. They suggested that sericin might be a valuable ingredient for the development of antimicrobial textiles[24.] Purwaret al.[25] reported washing durability of natural and synthetic antimicrobial finishes against Escherichia coli, Staphylococcus aureus, Aspergillus niger and Aspergillus fumigates. Antimicrobial agents were applied on the cotton fabric by pad-dry-cure and exhaustion method. They observed that the samples treated with antimicrobial agents considerably retained antimicrobial properties up to 15 washes[25].

Joshi *et. al.*[26] studied on development of bio-functional polyester-cotton blended fabric using seeds of Neem tree (Azadirachta indica) as antimicrobial agent. Thilagavathi *et. al.* (2007)[27] imparted antimicrobial finish on cotton fabric using extracts of neem and Mexican daisy by direct application and by microencapsulation using pad-dry-cure method. Microcapsules are produced using herbal extracts as core and acacia as wall material. They observed that the microencapsulated herbal extracts possess a very good resistance for microbes even after 15 washes. Mahesh *et. al.* (2011) reported that pomegranate rind extract coated on cotton fabric is an effective as antimicrobial finishing of textile, followed by neem and turmeric. Among various methods tested exhaust coating was found to be more effective than dip coating. The pomegranate, neem and turmeric extracts coated on fabrics exhibit more antimicrobial efficiency on gram negative bacteria than gram positive bacteria28.

Chitosan based antimicrobial agents:

Chitin is a polysaccharide found in the outer skeleton of arthropods including insects, crabs, shrimps, and lobsters. It is the second most plentiful, naturally occurring polymer, after cellulose. Chitosan, derived from Chitin, is prepared by partial deacetylation of chitin. For commercial uses Chitin and Chitosan are primarily sourced from shrimp and crabs industry. Although, they are waste products for these industries, yet they are widely used in other industries ranging from health and beauty aids to water purification, biomedical applications, agriculture, biotechnology, nutrition, and treatments in the finishing process of textile fibers.

Chitosan is biodegradable and is distributed into the environment in a dispersed manner. Thus when it is used in textile dyeing process, it represents an environmentally sound practice.

Chitosan have been found to inhibit the growth of microbes. It has a MIC of 0.05-0.1% (w/v) against many common bacterial species, although the activity can be affected by its molecular weight and degree of deacetylation. The antimicrobial ability, coupled with non -toxicity biodegradability and biocompatibility is facilitating chitosans emerging applications in food science, agriculture, medicine, pharmaceuticals and textiles. Chitosan has also been reported as a binder and thickener for pigment printing of polyester and polyester/cotton blends. Antibacterial properties of prints showed a 95% reduction of S. aureus colonies within one hour. Both wet and dry crock fastness of the print was found to be good[29].

Giri Deva et al. (2009) applied Henna on wool fabrics along with chitosan to impart antimicrobial characteristics[30]. They reported that antimicrobial properties of chitosan and natural dye both when applied independently and collectively on fabrics. The results proved that the chitosan treated wool fabrics showed increase dye uptake of fabrics. The treated fabrics were found to be antimicrobial and the chitosan treatment enhances the antimicrobial characteristics of the dyes. The neem (Azadirachta indica) - chitosan nanocomposites were prepared using multiple emulsion/ solvent evaporation method (Rajendrin et. al., 2012)[31]. The neem chitosan nanocomposites were finished on to 100% cotton fabrics using pad dry cure method. The treated fabrics showed an increased antimicrobial activity. The nano-composites having spherical in the size range of 50- 100nm.

Ali *et. al.* (2011) extracted natural dyes from Cassia fistula and onion peels to dye wool that is pretreated with chitosan by using tannic acid as a mordant. They observed that K/S increases after treatment with chitosan. It is also noticed that K/S increases with an increasing concentration of chitosan. K/S also increases with an increase of mordant concentration until 4% and then decreases. The antimicrobial activity of chitosan-treated wool fabric is tested in accordance to diffusion agents. Test organisms, such as Escherichia coli, *Bacillus subitilus Pseudomons aeruginosa* and Staphylococcus aureus are used and the results indicate that the samples treated with a lower concentration of chitosan exhibit a smaller inhibition zone[32].

Dongwei et.al. (2009)[33] synthesized chitosan-based silver nanoparticles by reducing silver nitrate salts with nontoxic and biodegradable chitosan. The silver nanoparticles thus obtained showed highly potent antibacterial activity toward both Gram-positive and Gram-negative bacteria, comparable with the highly active precursor silver salts. Silver-impregnated chitosan films were formed from the starting materials composed of silver nitrate and chitosan via thermal treatment. Compared with pure chitosan films, chitosan films with silver showed both fast and long-lasting antibacterial effectiveness against Escherichia coli. The silver antibacterial materials prepared in our present system are promising candidates for a wide range of biomedical and general applications. Erben et al. (2012) prepared chitosan-coated polypropylene nonwoven textile using dielectric barrier discharge plasma activation. It has been concluded that the chitosan coating exhibits antibacterial properties.

Rahman Bhuiyan[34] et al told that the treatment of cotton fabric with chitosan can significantly enhance the antibacterial activity of cotton fabric. It also improves the abrasion resistance and crease recovery property but a slight reduction in strength, elongation and softness characteristics of fabric.

Natural dyeing is gradually making its way in the world market and the production of natural dyed textile material itself is a boon to save the environment from hazards synthetic dyes. Natural dyes may be used to improve antibacterial and UV protective property[35].

Another study suggests antimicrobial activities of jute fabric increases significantly due to the combined effect of natural dye henna and biopolymer chitosan. Chitosan has a high potential as a nontoxic, eco friendly and multifunctional finish providing dyeing and antimicrobial properties[36].

H.M. Rafie37 et al have shown that when cotton fabric is finished with ethnolic extractsof sea grass marine organismby the dip technique, microencapsulation technique and by the pad-dry cure technique, results shows that both antimicrobial and antifungal property is increased significantly.

Conclusion: Now a day, the growing concern for the usage of hygienic textile products has resulted in the application of antimicrobial finishes on fabrics and production of antimicrobial fibers. Various synthetic agents like metal salts, quaternary ammonium compounds, triclosan, PHMB, phenolics and halogen compounds, are generally the base of commercially available products. Though these are very effective for inhibiting the growth of microorganism but these are also associated with various side effects, skin allergy and water or air pollution. There is a vast resource of natural products like natural dyes, neem, tulsi, aloevera, chitosan etc. which can be used for imparting antimicrobial property to the textile substrate. There are many cited litertures where efforts are done to use these as a antimicrobial agents, but there are very limited studies which have been carried out in depth and in a systematic way. These natural antimicrobial agents are still in very high demand because of their eco friendly nature and non toxic properties. Future research will be directed for the development of suitable antimicrobial agents which are environment friendly, durable and retain the desirable properties of the fabric.

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Green Technology for Pashmina Shawl Manufacturing

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Abstract

The word *Shawl* has got its name from a Persian word Shal, meaning a class of woven fabric. In Persia, Shawl was being worn on a girdle, rather than across the shoulders as is the case in India (Sharma et al. 2008). Although, *Shawls* prepared from any material, anywhere in the world have got their own identity but those prepared in Kashmir are different from all (Yaqoob et al. 2012). These Shawls are known all over the world, the way they are being prepared right from sorting of raw material to finishing of final product (Wani et al. 2004). This *shawl* making is a skill over which *Kashmiri* artisans have expertise themselves over the generation (Ahmad and Gupta 1990).The art of shawl making has been taught to the people of Kashmir by King Zain-ul-Abidin, hence remembered as the founder of shawl industry. Shawls are prepared from different fibres viz; wool, silk, angora wool, Pashmina, etc. Among these, Shawls prepared from pashmina is most attractive, soft and elegant. It has achieved a royal status all over the world and are liked by all, irrespective of sex, age, and nation (Wani *et al.* 2013a). Shawl is prepared from a king of fibers known as *Pashmina.* Pashmina is known for its fineness, warmth, softness, desirable aesthetic value, and timelessness in fashion. It is the most luxurious fiber and command higher price among all natural fiber (Ryder 1984). It has occupied a unique position among all the fiber of animal origin, because of its warmth, lightness, handle and its ability to absorb dyes and moisture (Ryder, 1987). It is a down fiber or under coat derived from domestic goat known as Capra hircus which is native to Asia (Von burgeon, 1963). As far as the processing of pashmina shawls are concerned, these are prepared traditionally, adapting traditional tools and techniques making it an environment friendly enterprise. The traditional method of shawl making/processing in Kashmir is divided into four broad processing steps. These include pre-spinning, spinning, weaving and finishing (Yaqoob et al 2012).

Kyewords: Pashmina Shawls, processing of Pashmina

Pre-Spinning Processing

Pre-spinning processing includes those processing steps which are done before preparation of yarn. It includes dehairing, combing and glueing.

Dehairing means separation of pashmina from guard hairs. The sorting of pashmina is done manually, mostly by women folk and is full of drudgery. Now-a-days, at some places the process of manual dehairing has been replaced by machine dehairing. Although with the advent of machine dehairing, there is a reduction in physical drudgery but at the same time, there is deterioration in the quality of pashmina. (Bumla et al. 2012).

Combing means parallelization of fibres and removal of impurities associated with the pashmina. Traditionally, combing is done by impaling dehaired raw pashmina repeatedly on an upright comb (10 cm wide, set on a wooden stand). The small lumps of fibers are straightened on the teeth of the comb by drawing each tuft through it by hand. The process is repeated 3 or 4 times until the tuft seen is in a clean enough state to be spun (Yaqoob et al. 2012).

Glueing means application of glueing material to pashmina. Its purpose is to provide extra strength, moisture and softness to the fiber. Traditionally, it involves application of environment friendly material viz; pounded rice. The pashmina is placed in a container over which pounded powdered rice is sprinkled and left on pashmina for a night or two. Pashmina is again combed to get rid of all traces of the crushed rice powder. The pashmina so cleaned is now given a shape of a patty, locally called thumb. (Yaqoob et al. 2012).

Spinning

Spinning means converting continuous untwisted strand of fibers into yarn of requisite count and twist suitable for further processing. This is done by women folk on a traditional spinning wheel locally known as Yander (Yaqoob et al. 2012). It comprises of spinning wheel connected with the spindle through cotton thread type conveyor belt. The spinner operates the charkha in a specific sitting posture (Wani et al. 2013a). In this method, a small tuft (tumb) of pashminais held between the second and third finger of the left hand supported by the thumb. As the spinner turns the wheel with her right hand, she raises and lowers the left hand holding and releasing the fiber in a perfect harmony to the rhythm of turning wheel. The yarn produced as such is spun on a grass straw or any light holder locally called phumblet. The spun yarn on these holders is doubled on hand reeler. The double yarn is subjected to twisting/pilling on the same charkha with the direction of twist reversed. These yarns are then made into hanks on the wooden reeler locally called Yarandul for marketing (Yaqoob et al. 2012).

Weaving

Weaving means processing of fabric by interlacement of threads. This operation starts with opening of the hanks on the large wooden stands locally called thanjoor and is mounted on a wooden spindle termed as prech. The yarn is washed in luke warm water followed by sun drying. This is an environment friendly process where yarn is scoured by using environment friendly herbal material called reetha soap. After drying, yarn is reeled back on racks.

This is followed by warp making. It is the warp-maker's job to twist the yarn into the required thickness and strength for wrap. The yarn is placed in a bowl, where it is steeped in a rice water starch called maya. This is taken out after two days and spread out in the sun to dry. The dried yarn is wound now on wooden spool called prech, whereas the process is called tulun. Four to six rods are being erected into the ground. Two persons work together and transfer yarn from prech onto the iron rods by using sticks. This process is called yarun. About 1200 threads are stretched in this manner to form warp locally called yaen which is enough for 4 to 6 shawls. The warp (yarn) is now given to wrap-dresser (Bharan-gour) to stretch the wrap. He spends a week or so to fix each wrap thread in the saaz (heddles of the loom). The loom is constructed of wood with a bench on which two people can sit comfortably. The finished length of woven material is known as thaan. This is washed in cold water with powdered soap nut, reetha or of special soap made from herbal ingredients (Yaqoob et al 2012).

Finishing

The final stage of shawl preparation is finishing which includes purz, washing, dyeing, embroidering and ironing.

a) Purz: The fabric is tweezed, clipped or brushed out to rid it of any superficial flaw on the surface.

b) Kasher: In this, the cloth is rubbed with a dried wiry core of gourd, bitter gourd, or a maize cob known as kasher.

c) Washing: The fabric is now washed by washer man or dhobi who washes the fabric in running water, by repeatedly striking it against a hard smooth surface or stone.

d) Dyeing: If the fabric needs to be dyed, it is sent to the dyer who dyes it as per the demand and requirement.

e) Stretching: The fabric is rolled and left stretched for several days. It is then ironed packed in plastic bags and finally handed over to the broker (dral) who sells it.

f) Embroidering: The shawls may undergo value addition by way of embroidering, done by the skilled artisans by hand in different designs.

Conclusion

Pashmina shawls are being processed by adapting traditional practices using traditional tools and techniques. These tools and techniques on one hand are primitive, labour intensive, full of drudgery, less efficient, yielding low output per unit of time spent and on the other hand are environment friendly yielding a matchless finished product with international reputation. The advent of mechanization has not even left the art of pashmina processing untouched. The use of chemicals and machines is being practiced at some places. These include machine dehairing, use of nylon as carrier fibres, machine spinning, machine weaving, use of HCl for dissolution of nylon, synthetic dyes etc. These alternative arrangements although make the enterprises less laborious and more profitable but at the same time, the quality of pashmina shawls deteriorates enormously as well as is not environment friendly. In order to save the art from mechanization; and environment from chemicals, attempts have been made to improvise the traditional tools and techniques, making the art more lucrative and environment friendly. These include improvisation of charkha (Wani et al. 2013b), improvisation of handloom (Wani 2014), improvisation of warping system (Sofi et al. 2017), use of natural dyes (Wani 2014) etc. Pertinent to mention that the improvisation of traditional tools and techniques for pashmina processing is a need of an hour, but not at the cost of original product.

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A Production of Bacterial Cellulose from Sugarcane molasses and different cheap dual carbon sources for the Application of Medical Textiles

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Abstract

Bacterial cellulose is a unique form of cellulose which is strong and ultrapure produced naturally by several Acetobactor species. High strength, purity and biocompatibility of bacterial cellulose make it biomaterial for various interesting applications. The synthesis of bacterial cellulose is still a great challenge for biotechnologists. High yields, grow in low nitrogen content are the major field of interests of current biotechnologists. In this study, with Gluconacetobacter xylinum, an attempt was made to reduce the cost of production medium for cellulose by using natural cheaper carbon sources. Various fruit juices including sweet lemon, pomegranate, orange, sugarcane molasses (3% v/v), coconut water were used alone; out of which coconut water gave a highest cellulose yield of 6.5 g/L. While in other experiment sugarcane molasses (3%) in combination with other fruit juice (10:1) as dual carbon sources was used, out of which, the combination of sugarcane molasses (3%) and sweet lemon (10:1) gave the highest cellulose yield of 8.2 g/L. High mechanical strength in the wet state, moisture vapour and liquids permeability and low irritation of skin indicated that the gelatinous membrane of bacterial cellulose is very useful to be used as an artificial skin during treatment of burn injury and wound covering. In case of blockage of coronary vessels around the heart, bacterial cellulose based artificial blood vessels can be used during bypass surgery of heart. Bacterial cellulose in native and modified can be used as artificial scaffold manufacturing materials. Phosphorylated and sulfonated BCs can be used for bovine chondrocytes. Gelatinous membrane of bacterial cellulose is also found its way in wound care management.

Keywords: Bacterial Cellulose, Gluconacetobactorxylinum, molasses, biopolymers; bioprocess parameter.

Introduction

Cellulose, a linear polysaccharide of beta (1-4) linked glucose units, is the most abundant nontoxic biodegradable polymer on earth, having tremendous economic importance globally. Major producers of cellulose are vascular plants, However some algae *(Vallonia), fungi (Sparolegnia), slime moulds (Dictyostelium discoideum) and bacterial species (Acetobacter xylinum, A. aceti, A.acetigenum, A.hansenii, Sarcina, Agrobacterium, Rhizobium, Pseudomonas, Chromobacterium, Achromobacter, Aerobacter, Alcaligenes, Zooglea)* have been recognized for cellulose production . Among the various microbial sources of cellulose, bacterial cellulose (BC) produced by Gluconacetobacter xylinum (formerly called as Acetobacter xylinum) is commercially important (1-5). Gluconacetobacter is one of the most frequently characterized acetic acid bacteria for BC production (6). Recently, the mass production of BC by Gluconacetobacter species has been extensively studied. Gluconacetobacter has superior BC production ability than other microorganisms (7). Bacterial cellulose (BC) is a pure form of cellulose, devoid of other contaminating polysaccharides, and its isolation and purification is relatively easy as compared with plant cellulose. Microbial cellulose has a large specific surface area, higher water retention value, moldability, and high tensile strength (8-10).

The fibril size of BC is much narrower than the plant cellulose and possesses dense reticulated fibril network structure. The unique porous structure of BC enhances its water retention value that makes it a versatile material for use in medical fields along with high mechanical strength and crystallinity. BC has been successfully used as wound dressing and healing material, finds potential applications in drug delivery systems, novel vascular grafts, and scaffolds for tissue engineering, medical pads, high performance speaker diaphragms, and electronic paper display (11).

Since its discovery, BC has remained the subject of keen attention to develop some methods for low cost BC production. Serious efforts were made by researchers to resolve the issues like expensive cost of media and slow production processes for industrial scale up of BC. The most interesting approach for improved production of BC is the utilization of cheap and waste sources and their combinations like waste of beer fermentation broth, fruit juices, molasses, and industrial wastes etc. Different studies were carried out to produce cellulose effectively using different carbon sources in the combination of two among which fructose and sucrose combination was reported for highest yield [12].

In this study, with Gluconacetobacter xylinum, an attempt was made to reduce the cost of production medium for cellulose by using natural cheaper carbon sources. Various fruit juices including sweet lemon, pomegranate, orange, sugarcane molasses (3% v/v), coconut water were used alone; out of which coconut water gave a highest cellulose yield of 6.5 g/L. While in other experiment sugarcane molasses (3%) in combination with other fruit juice (10:1) as dual carbon sources was used, out of which, the combination of sugarcane molasses (3%) and sweet lemon (10:1) gave the highest cellulose yield of 8.2 g/L.

Materials and Methods

Bacterial Strain and Culture Conditions:Gluconacetobacter xylinus used in this study was procured from Microbial Type Culture Collection (MTCC), Institute of Microbial Technology, Chandigarh, India. The cell suspension was stored as glycerol stock at - 800C. Culture was revived, in revival medium by incubating at 30 0C and 120 rpm. The culture was maintained at 4° C on Hestrin-Schramm agar medium (HS agar) and LB slants.

All the chemicals used were of analytical grade. Cell growth and bacterial cellulose production was studied in standard Hestrin-Schramm (HS) medium and differentfruit juices of pomegranate, tomato, sweet lemon, orange and Sugarcane molasses as a carbon source .

The HS medium consisted of (g/L) D-glucose-20; yeast extract-5; peptone-5; disodium phosphate-2.7; and citric acid-1.15; pH 6.0.

In this study, pomegranate, tomato, sweet lemon and orange fruits were purchased at a local marketfor the preparation of juices. These fruits were washed, crushed, squeezed and separated to the juices and residues. The juices were diluted and adjusted to pH 6 with disodium hydrogen phosphate buffer; filter sterilized and stored at -20°C for future use. Sugar concentration in each sample was determined by anthrone method (14) and the dilution was based on the sugar content originally present in the fruit juices. The crude sugarcane molasses was diluted to 3% (v/v) with distilled water and centrifuged at 6000 rev/min for 20 min to separate the solid materials. The supernatant was designated as molasses solution. The molasses solution was adjusted to pH 5.5, and autoclaved, total carbohydrate content was determined by anthrone method.

Different dual carbon source media were prepared by mixing 3% sugarcane molasses with different fruit juices in 10:1 ratio.

Fermentation and cellulose production

Fermentation studies were performed in different 100 ml culture media contained in 250 ml conical flask, and inoculated with 5 % (v/v) cell suspension of Gluconacetobacter xylinus at 300C; the flasks were initially incubated at 110 rpm for 2 days and then statically until the end of the fermentation (15 days). The pellicle formation was checked at each alternate day of cultivation. Effect of bioprocess parameters, viz Temperature, pH and agitation, on cell growth rate and BC production was also analyzed.

Treatment of cellulose pellicle

The pellicle formed was removed carefully, treated with 0.1M NaOH for 2 hrs and thoroughly washed with distilled water. The drying was carried out at 50°C in an oven for 8 h. The dry weight of the cellulose obtained was calculated.

Results and Discussion

It has been reported that Gluconacetobacter xylinus effectively utilized glucose, fructose, sucrose, mannitol and glycerol for BC production, and giving maximum yield with sucrose glycerol and fructose (15). Many fruit juices are rich in carbohydrates, vitamins, and trace elements; hence can be used as good media for the production of pure bacterial cellulose. Use of fruit juices should provide economical sources of nutrients for the production of bacterial cellulose. Sugarcane molasses are produced as by product of sugar factories, contains about 40% sucrose out of total carbohydrate; hence are cheap and good source of carbon.

It has been reported that 3% sugarcane molasses media was metabolized to produce 4.8-5.0 gm/l cellulose in 15 days by Gluconacetobacter xylinus under shaking condition at pH 6.0. The yield was low in static condition (3.6 gm/l) as shown in Fig. 1.

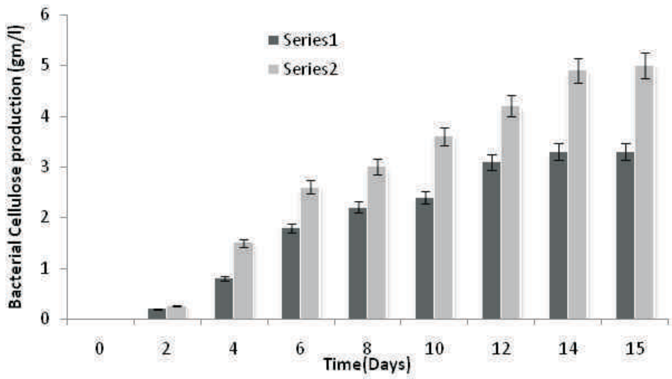

Fig.1 Bacterial cellulose production by Gluconacetobacter xylinus, in sugarcane molasses medium (3%), for 15 days under shaking and static cultivations strategy.

In the present study different natural and cheap carbon sources alone and along with sugarcane molasses were used as fermentation media and all natural carbon sources were able to give substantial yield of cellulose.

Figure 2 shows the comparison of bacterial cellulose yield from various natural carbon sources. The amount of sugar present in the natural carbon sources was first estimated by anthrone method. When tomato juice, pomegranate juice, sugarcane molasses, sweet lemon juice, orange juice and coconut water were provided as carbon and nutrient sources, the organism was able to produce 2.8, 3.4, 5.6, 6.0, 6.0, 6.5 gm/l of BC respectively. Thus, maximum BC yield was given by coconut water.

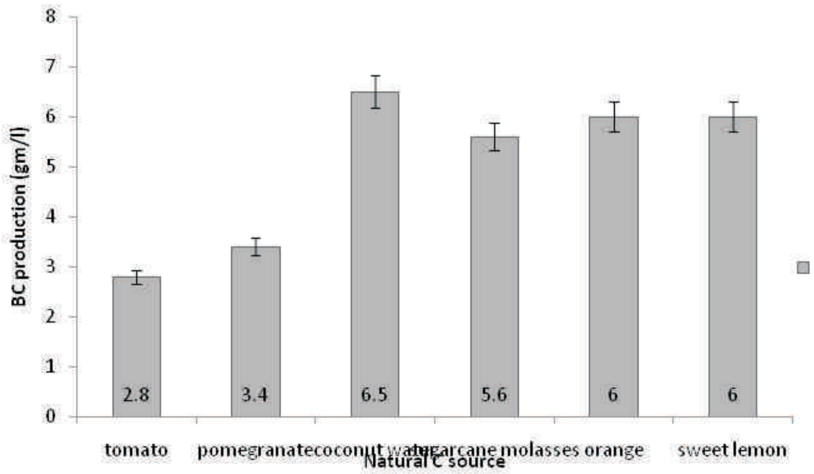

Fig. 2 Effect of Natural C sources on BC production by Gluconacetobacter xylinus.
Tomato 2.8, pomegranate 3.4, coconut water 6.0,sugarcane molasses 5.6 orange 6.0 sweet lemon6.5

In the dual carbon source containing medium, different combinations of sugarcane molasses with natural carbohydrates (10:1) were provided as carbon sources. Figure 3 shows the yield of cellulose after incubation and cellulose estimation. Combinations of pomegranate, tomato, sweet lemon, orange and coconut water with 3% sugarcane molasses Gave cellulose yield of 6.5, 6.0, 9.4, 8.2, and 7.6 gm/l.

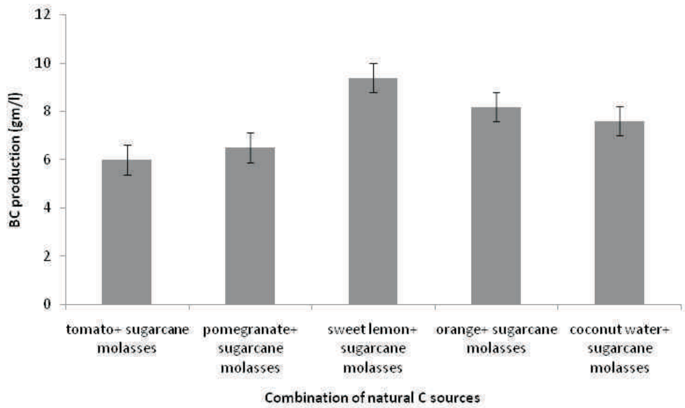

Fig.3 Effect of combination of C sources on BC production by Gluconacetobacter xylinus.

Conclusion

It is noteworthy that, pure coconut water as carbon source gave higher and pure tomato juice gave lower yields of cellulose while combination of sugarcane molasses and sweet lemon juice gave highest cellulose yield.

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Study on the static & dynamic strength and weavability of polyester/viscose blended spun yarns

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Abstract

This study reports on the analysis of tenacity and breaking elongation of ring-, rotor- and air-jet- polyester/viscose spun yarns measured using static- and dynamic tensile testers. The weavability, a measure of performance of these yarns in post spinning operations is quantified. The yarn diameters and helix angles of fibres in these yarns are measured in order to analyze the effect of types of spun yarn and blend proportion on the yarn strengths. The dynamic tenacity is found having good and valid correlation with the weavability. The minimum static tenacity obtained from 100 tests too has been found to have good correlation with the dynamic tenacity. The present study indicates that it is appropriate to evaluate the performance of spun yarns in winding, warping and weaving based on the dynamic yarn tenacity measured while running a 200 m length of yarn at a using constant tension transport tester or the minimum static yarn tenacity obtained using any conventional constant rate extension (CRE) tensile testers corresponding to a total test length of 50 m.

Keywords: Polyester, Viscose, Tenacity, Dynamic, Post-spinning, Weavability

Introduction

The breaking strength of a spun yarn is one of the most important parameters for assessing the yarn quality and one basic way to increase profit and quality in textile process is to hold yarn breakage to a minimum level [1]. In the standard test procedure, a gauge length of 500 mm with time to break of 20 ± 2 s is employed. A clamped yarn breaks in its weakest place according to the principle of the 'weakest link' and this strength value is assigned to the whole length [2]. As the test sample is gripped at the two ends and maintain that static state during the testing process, the evaluated tensile properties are often treated as static tensile properties and the strength and elongation % measured by the single thread tensile test method is referred to as static yarn- strength and elongation % respectively [3].Researchers have experimentally determined that the static yarn strength measured at 500 mm gauge length is more appropriate to simulate the mechanical properties of fabrics and cannot accurately predict the running behavior of yarn on post spinning machines: warping, weaving and knitting [4].

The yarn is in motion during the post spinning processes viz. winding, warping, sizing, singeing, weaving and knitting under tension with long free lengths, as such, the weakest place along the entire yarn length decides the occurrence of yarn breaks or the processing performance of the yarn. Statistically, the strength of this weakest place must be lower than the average tenacity measured from the CRE based static tensile tester. Dynamic/continuous tensile testing of spun yarn involves transporting a long length of yarn (200 m) at a constant throughput speed with a maximum possible tension without yarn break. Dynamic yarn strength is the maximum tension level at which the yarn is transported without any break for a length of 200 m, at a speed of 40 m/min. The measured extension at this tension is considered as the dynamic extension [5]. In the continuous tensile testing every inch or millimeter of the yarn is tested to generate true elongation of the yarn at a specific yarn tension and speed condition, and the tensile characteristics are continuously assessed. Hence, the dynamic tensile properties measured by continuous testing, simulate the actual manufacturing conditions more closely than the static tensile testing [6-9].

Few literature [6-9] reports on the suitability of dynamic tenacity over the static tenacity for prediction of the post spinning performance solely based on the concept of dynamic testing, but not on the basis of experimental evaluation. However, many studies have been reported the on the static tensile behaviour of blended yarns [10-17]. In this work we report on the static and dynamic tensile properties of polyester/viscose spun yarns along with the weavability test results. From the analysis of the test results in relation to the weavability, appropriate ways of assessing the post spinning performance of spun yarns are discussed.

Experimental

Sample Preparation

Viscose fibers of 1.5 denier and 44 mm length and polyester fiber 1.4 denier and 44 mm length were spun to produce polyester/viscose blended yarns of different fibre proportions (0/100, 33/67, 50/50, 67/33, 100/0) on ring, rotor and air-jet spinning systems. The nominal counts of yarns was 22s Ne. The spinning parameters employed for each yarn were those that are considered appropriate by commercial spinners, based on their experience with each of the spinning systems. The twist multipliers (TM in cotton system) for ring, rotor and air-jet spun yarns were 2.8, 4.2, and 4.2 respectively. The tracer fibers were mixed before opening in the blow-room in such a proportion, to have an average of 6 tracers of different colours in a given yarn cross-section. The six different colours selected for tracer fiber preparation were red, green, orange, violet, black and blue with shades well visible when the yarn was observed under a projection microscope by immersing it in benzyl alcohol solution. The mix ratio of polyester- and viscose-tracer fibers was as per the blend ratio of blended yarns, as an example, a 4:2 ratio was maintained for the 67/33 polyester/viscose yarns.

Helix Angle and Yarn Diameter

The helix angle of fiber represents the axial orientation of fibers with respect to the yarn axis. The yarn containing the tracer fibers was dipped in the benzyl alcohol solution and observed with a magnification of 40X in a Lieca digital microscope. The images of yarn were captured at 400 places randomly along the yarn. One such image is shown in Figure 1. The recorded images were processed through the Lieca Quin image analyzer to measure the values of helix angle and the yarn diameter.

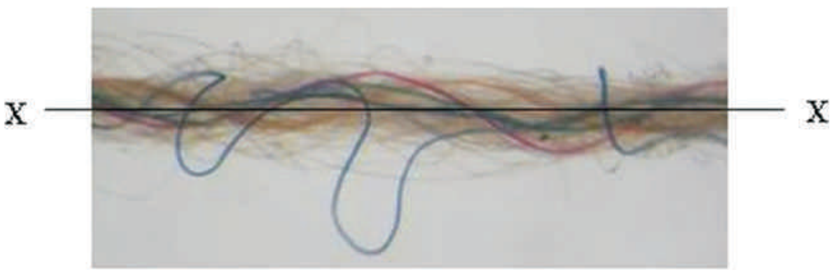

Figure 2. An image of spun yarn having a tracer fibre

Tensile Testing

The tensile properties of fibers were measured with FAVIMAT Fiber Tester in accordance with ASTM D-1577:1996. Thetensile properties of yarns were measured on an INSTRON 4301 Tensile Tester at a standard gauge length of 500 mm and 180 mm/min extension rate. For each yarn, 100 tests were carried out.

The dynamic testing of yarns was carried out using a CTT (Constant Tension Transport) instrument from Lawson-Hemphill Inc, at a constant transport speed of 40 m/min with the test module of CTT-DET. The yarn path is shown in Figure 2. The tension was initially set at zero and was gradually increased in steps of 50 cN till the yarn breaks. The yarn tension was gradually decreased from this maximum tension level in steps of 5 cN to trace out the maximum tension level at which the yarn can successfully run for 200 m without any break and this tension is treated as the dynamic tensile load. The yarn elongation % observed at this tension is considered as the dynamic elongation %. The elongation % recorded in the dynamic tensile tester is the ratio of the speeds of front and back rollers multiplied by 100.

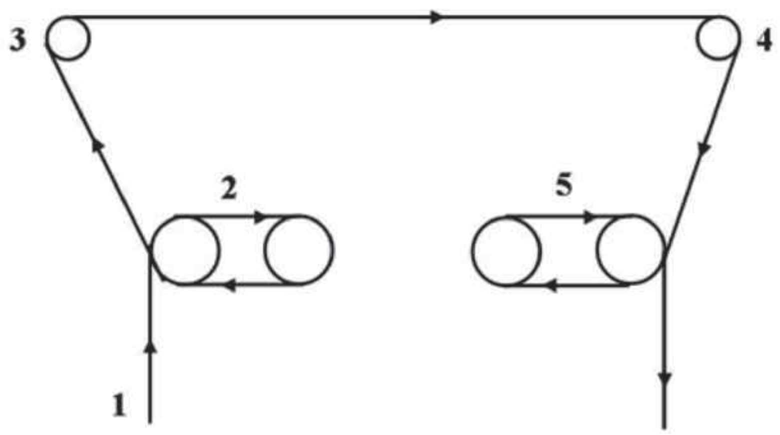

Figure 2. Yarn path in the CTT Instrument for the dynamic tensile testing: 1- spun yarn, 2- back rollers, 3-tension arm, 4- tension sensor, 5- front rollers

Weavability of Yarns

The weavability of yarns was measured with Sulzer Ruti Reutlinger webtester. Sulzer Ruti Reutlingen webtester simulates all major stresses occurring during weaving such as cyclic extension, axial abrasion, flexing and bending excluding beat up and yarn entanglements. Like a loom, the above-mentioned weaving stresses are applied simultaneously on a sheet of parallel 15 threads held at preselected constant tension. The representative diagram of working principle of Sulzer Ruti Reutlingen webtester is shown in Figure 3. Instrument records cycles required to break the first 10 threads. The number of weavability cycles is the average number of cycles recorded for the first 10 yarn breaks. For every break, load is decreased by 1/15th of the initial preset tension in order to maintain constant tension on each yarn throughout the completion of test. During test, if some yarns elongate and become slack, they do not experience fatigue and abrasion. Since such slack end; not have any serviceability on loom, are called as pseudo-breaks. Therefore, they are manually removed at the cycles at which they become slack and a break is recorded on the instrument [18].

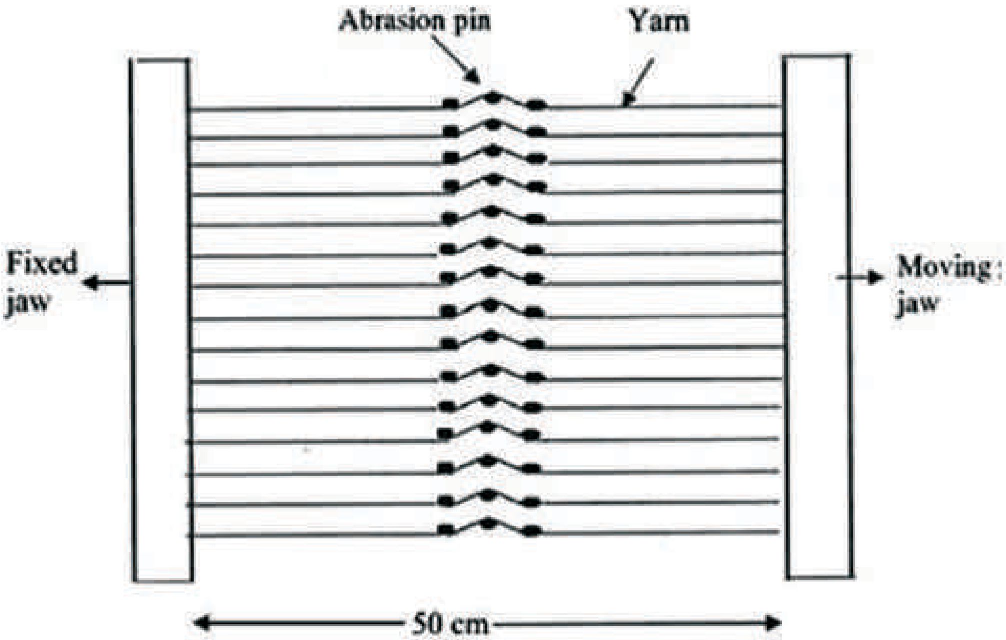

Figure 3. Sulzer Ruti Reutlingen webtester

Results and Discussion

Dynamic Tensile Properties

The dynamic tensile properties of yarns are shown in Table 1. The ring spun yarn has the highest dynamic tenacity followed by the rotor- and air-jet- spun yarns. This could be ascribable to the structural development associated with the spinning systems [19, 20]. The interlocking of fibers provided by the intense migration of fibres across the yarn cross-section and the higher packing density of fibers in the ring spun yarn compared to others contribute to its high strength.

Table 1. Dynamic- tensile properties (strength and breaking elongation) of spun yarns

		Dynamic tenacity (cN/tex)			Dynamic breaking elongation %	
Yarns	Ring	Rotor	Air-jet	Ring	Rotor	Air-jet
100% viscose	6.5	5.1	3.7	3.7	6.4	1.9
33/67 polyester/viscose	7.4	6.2	3.0	5.5	7.6	1.7
50/50 polyester/viscose	9.0	6.7	3.8	5.5	7.9	2.0
67/33 polyester/viscose	11.7	8.0	3.7	7.1	7.9	1.9
100% polyester	15.2	8.4	4.5	7.2	7.9	2.1

The observed lower dynamic tenacity for the rotor spun yarns is attributed to the relatively shallower fiber migration, a fairly large number of folded fibers, high twist multiple, differential twist structure, inferior degree of fiber alignment and loose packing of fibers, that contribute to a poor distribution of load over the fibers and consequently, lower strength. The parallel and straightened fiber bundle in the core, which comprises the vast majority of total fibers in the cross-section of air-jet spun blended yarns, which caused less generation of transverse pressure under tension and as a result of that there is less resistance to fiber slippage. This caused the lowest dynamic tenacity of blended air-jet spun yarns.

It is observed that the dynamic tenacity of ring- and rotor- spun blend yarns improve with the increasing proportion of strong polyester fibres. The tenacity of polyester and viscose fibers were 53.46 cN/tex and 18.45 cN/tex respectively. No specific trend of dynamic tenacity was noticed with increase in the polyester content of the air-jet spun blended yarns.

The dynamic yarn elongations are the highest for rotor spun yarns followed by ring and air-jet spun yarns. The yarn dynamic elongation is dependent on the fiber breaking elongation, helix angle of fibers and compactness of the yarns. The breaking elongations of the polyester and viscose fiber are 19.8 % and 20.1 % respectively; and are similar. Hence, their contribution to the dynamic yarn elongation could be ignored. The compactness of yarns was indirectly assessed by measuring their diameters. The fiber helix angle and yarn diameter are shown in Table 2. The compactness of rotor spun yarns are the lowest followed by the ring and air-jet spun yarns. The measured helix angle of the fibers is the highest for rotor spun yarns, followed by ring and air-jet spun yarns. The fibers positioned at higher inclination to the yarn axis can rearrange in the free spaces of the yarn; in doing so it contributes to the yarn extension. So the combined effect of yarn diameter and helix angle has led to such a trend. The correlation coefficients of yarn dynamic elongation % with the helix angle of fibers are: 0.99, 0.92, 0.93, 0.77 and 0.84; and with the yarn diameter are: 0.94, 0.99, 0.99, 0.82 and 0.84 for the 100% viscose, 33/67 polyester/viscose, 50/50 polyester/viscose, 67/33 polyester/viscose and 100% polyester yarns respectively.

Table 2. Fiber helix angles and yarn diameters of spun yarns

	Helix angle ^{o}			**Yarn diameter (µm)**		
Yarns	Ring	Rotor	Air-jet	Ring	Rotor	Air-jet
100% viscose	15.3	27.7	9.8	229.9	244.3	196.4
33/67 polyester/viscose	14.5	26.6	9.7	236.7	254.2	206.8
50/50 polyester/viscose	15.5	27.3	11.4	247.0	271.1	212.7
67/33 polyester/viscose	15.8	28.6	11.9	255.0	297.5	236.1
100% polyester	14.2	24.5	8.5	266.1	304.4	244.9

The dynamic yarn elongations of the blended yarns were observed to follow no specific trend with the change in the proportion of polyester fibers. This could be ascribed to the resultant effect on the yarn diameter and helix angle with the change in blend proportions. The yarn diameter values are observed to increase with the increase in the polyester content for all the types of spun yarns; whereas the helix angle observed to follow no specific trend; hence their combined effect has led to no specific trend on the dynamic elongation with the change in the polyester content.

The yarn diameter values were observed to decrease with the increase in the viscose content of the blend. The denier of polyester & viscose fibers used for yarn sample preparation is 1.4 & 1.5 respectively. The density of polyester & viscose fiber is 1.38 g/cm3& 1.52 g/cm3, so the area of cross section of polyester fiber is higher than the viscose fiber (polyester = 1.127 10-4 cm2, viscose = 1.096 10-4 cm2). The decrease in the yarn diameter with the increase in the viscose content in polyester/viscose blended yarn is due to the lower cross-sectional area of viscose fibers and higher cohesiveness of viscose fibers compared to polyester fibers, which leads to more compactness of yarns. The cohesiveness of polyester and viscose fibers was indirectly assessed by measuring the tenacity of polyester and viscose rovings at a standard gauge length of 500 mm and straining rate of 180 mm/min. The tenacity of polyester and viscose rovings are 0.29 cN/tex and 0.55 cN/tex respectively.

Effect of Applied Tension and Testing Speed on Dynamic Elongation

All the three technology blended spun yarns indicated similar trends under different tensions and speeds conditions, hence the behaviour of only viscose ring spun yarns are reported herewith. The dynamic yarn breaking elongation of viscose ring spun yarn at different yarn tension levels and speed conditions are shown in Table 3. It is observed that the dynamic elongation increases with the increase in the applied tension and at a constant tension level on the yarn, the dynamic elongation decreases up to testing speed of 70 m/min and then remain more or less similar with the increase in the testing speed, indicating a shift towards brittleness in the yarn. This is due to the well known phenomenon of visco-elastic nature of fibers and the less time available for the fibers to rearrange themselves to relieve their stresses associated with high speed.

Table 3. Effect of tension and testing speed on dynamic elongation of viscose ring spun yarn Dynamic breaking elongation %

Yarn	Testing speed (m/min)							
Tension (cN)	20	70	120	170	220	270	320	360
30	1.6	0.8	0.7	0.8	0.8	0.7	0.7	0.6
50	1.9	1.8	1.6	1.7	1.5	1.6	1.5	1.5
70	2.1	1.7	1.7	1.7	1.7	1.7	1.7	1.7
90	2.6	2.4	2.3	2.2	2.1	2.2	2.2	2.2
100	3.4	3.4	3.0	3.0	2.9	2.7	2.7	2.8
110	3.5	3.4	3.1	3.2	3.0	3.1	3.0	2.9
120	4.4	4.1	4.0	3.9	3.8	3.6	3.6	3.5
130	4.9	4.4	4.3	4.1	4.1	4.0	3.7	3.7
140	5.2	4.8	4.5	4.4	4.3	4.1	4.2	4.1
150	5.2	5.0	4.6	4.7	4.6	4.6	4.6	4.4

Weavability of Polyester/Viscose Blended Spun Yarns

The weavability values of yarns are shown in Table 4. The weavability values are the highest for ring spun yarn followed by rotor and air-jet spun yarns. The weavability is higher for the 100% polyester yarns compared to the 100% viscose yarns. In line with this finding, blended yarns with high proportion of polyester have higher weavability, except the air-jet spun blended yarns. The failure of spun yarn occurs during the weaving process, because of the resultant effect of flex abrasion and fatigue due to cycling loading. The polyester fiber has much higher flex resistance than the viscose fiber [21] and the viscose fiber display poor fatigue resistance compared to polyester fiber due to low work of rupture and elastic recovery [22]. The higher flex and fatigue resistances of polyester fiber caused the higher weavability for the 100% polyester yarn compared to the 100% viscose yarn.

The static tensile properties of yarns are reported in Table 5. The correlation coefficients of static tenacity and dynamic tenacity with weavability were calculated to asses the appropriate parameter for predicting the performance of yarn in post spinning operations. The correlation coefficients of weavability with the static tenacity are: 0.46, 0.55, 0.57, 0.59 and 0.43; and with the dynamic tenacity are: 0.93, 0.99, 0.97, 0.96 and 0.86 for the 100% viscose, 33/67 polyester/viscose, 50/50 polyester/viscose, 67/33 polyester/viscose and 100% polyester yarns respectively. These correlation coefficients indicated that it is more appropriate to use dynamic tenacity over static tenacity for predicting the performance of spun yarns in the post spinning operations.

Table 4. Weavability of spun yarns

	Weavability (Cycles)		
Material (Yarn)	Ring	Rotor	Air-jet
100% viscose	232	217	165
33/67 polyester/viscose	250	233	148
50/50 polyester/viscose	287	258	164
67/33 polyester/viscose	306	280	159
100% polyester	338	310	170

Table 5. Static tensile strengths and breaking elongations of spun yarns

Yarns	Static tenacity (cN/tex)			Static breaking elongation%		
	Ring	Rotor	Air-jet	Ring	Rotor	Air-jet
100% viscose	12.8	8.1	9.3	11.4	10.9	8.3
33/67 polyester/viscose	16.7	10.8	11.4	11.2	10.7	8.2
50/50 polyester/viscose	18.2	11.6	12.6	10.9	10.2	8.1
67/33 polyester/viscose	21.0	13.6	14.1	9.5	9.2	7.6
100% polyester	26.1	14.8	17.5	7.4	9.0	7.5

Relationship between Static and Dynamic Tensile Properties

The static tenacity values are the highest for ring spun yarn followed by the air-jet and rotor spun yarn and this observation is in contradictory with the trend of dynamic tenacity values (Table 1 and Table 5). The rotor spun blended yarns displayed higher value of dynamic tenacity compared to air-jet spun yarns. The lowest static tenacity values obtained from 100 test results are shown in Table 6. It is observed that the lowest static tenacity values of air-jet spun yarns are lower than the lowest static tenacity values of rotor spun yarns. It is observed that the trends of lowest static tenacity and dynamic tenacity are quite similar (Table 1). The correlation coefficients between the dynamic tenacity and the average static tenacity are: 0.76, 0.64, 0.75, 0.80 and 0.82; and with the lowest static tenacity are: 0.99, 0.91, 0.97, 0.94 and 0.96 for the 100% viscose, 33/67 polyester/viscose, 50/50 polyester/viscose, 67/33 polyester/viscose and 100% polyester yarns respectively. This clearly indicates that it is more appropriate to use the values of lowest static tenacity over the average static tenacity for predicting the spun yarn behaviour during the post spinning operations.

The static breaking elongation values are the highest for ring spun yarns followed by rotor and air-jet spun yarns; where as the dynamic breaking elongation is higher for the rotor spun yarns compared to the ring spun yarns. In line with the observed similarity between the trends of lowest static tenacity and dynamic tenacity, the trends of static breaking elongation corresponding to the lowest static tenacity with the dynamic elongation are similar.

Table 6. Lowest static tenacity and corresponding breaking elongation of spun yarns

Yarns	Lowest static tenacity (cN/tex)			Static elongation% Breaking elongation % corresponding to the lowest static tenacity		
	Ring	Rotor	Air-jet	Ring	Rotor	Air-jet
100% viscose	10.0	6.7	5.0	6.2	10.7	3.5
33/67 polyester/viscose	13.4	8.2	5.4	9.5	9.6	2.3
50/50 polyester/viscose	13.0	8.4	5.9	7.4	8.9	3.5
67/33 polyester/viscose	13.7	8.2	6.4	7.7	9.0	3.2
100% polyester	17.0	9.4	8.6	5.8	6.7	4.6

From the above findings it is evident that lowest static tenacity could be an appropriate measure in representing the dynamic tenacity. The values of dynamic tenacity are found to be lower than that of the lowest static tenacity for all the polyester/viscose blended spun yarns. During the post spinning processes, the length of yarns subjected to tension are very long; much longer than the 500 mm gauge length used in the static tensile testing. The static tenacity represents the strength of the weakest link in a yarn length of 500 mm. The dynamic tenacity represents the strength of the weakest link in a yarn of 200 m. So the dynamic tenacity values are much lower than static ones (Table 5 and Table 1).

Conclusions

The ring spun yarn has the highest dynamic strength and weavability values followed by the rotor- and air-jet- spun yarns. The dynamic yarn elongations are the highest for the rotor spun yarns followed by the ring and air-jet spun yarns. The dynamic elongation of the ring, rotor and air-jet blended spun yarns don't follow any specific trend with the change in the proportion of polyester fibers. The weavability improves with the increase in the proportion of polyester fibres in the yarns, except the air-jet spun yarns. The yarn diameters and fiber helix angles influence the dynamic elongation of spun yarns.

The dynamic tenacity has very high correlation with the weavability compared to the average static tenacity. The dynamic tenacity is closely related to the lowest static tenacity. This study indicates that the average static tenacity does not predict the actual performance of spun yarns in the post spinning processes. The weavability or the post spinning performance of spun yarns could be assessed well either by the dynamic tenacity or the lowest static tenacity values.

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Application of Taguchi based Utility theory for multi-response optimization (MRO) in machine made tufted carpets

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Abstract

This present study highlights the application of Taguchi based Utility theory concept for multi-response optimization in quality characteristics of machine made tufted carpet. In this study, Tufting speed (N), Stitch Rate (SR), Gauge size (G) have been considered as process parameters of machine made tufted carpets, for optimizing quality characteristics such as Abrasion Wears (mg) tuft withdrawal force (Kgf). In initial phase of experimentation, Taguchi L9 orthogonal array based run order is taken for preparing samples on Modra Mtuft machine. Lower the better criteria for Abrasion Wears and higher the better criteria for tuft withdrawal force, are desirable to achieve better quality of carpets. The study aims at evaluating the most favorable process environment followed by an optimal parametric setting for improved quality and productivity. One of the most important mechanical properties of carpet is pile strength and thickness loss in terms of tuft withdrawal force and abrasion wear respectively. The study proposed the optimization for aforementioned performance characteristics by determining the optimal setting. Multi-responses characteristics have been aggregated with the help of Utility theory and converted in a single response i.e. Overall Utility value (U), finally optimized by using Taguchi Philosophy. The aim is also to identify the significant factor and their effect on quality characteristics. The results obtained thereof have been compared with the predicted results followed by confirmatory test.

Keywords: Utility theory, Abrasion wear, Taguchi, Gauge, stitch rate, Tuft withdrawal force.

Introduction

In today's competitive world, customers are demanding better quality products with fast and reliable deliveries. To meet this demand, new manufacturing technologies are developing rapidly, resulting in new products and improvements in manufacturing processes. Machine-made rugs also are sometimes called power-loomed rugs. When you see the words "Wilton Woven" to describe a rug, this means that they are made on machine-operated Wilton looms. These rugs are usually made in Europe, often Belgium, and are made from the same fine wools that are used for hand-knotted rugs. Synthetic rugs are made in the same way Wilton Woven rugs are, except that they are made from synthetic fibers such as rayon, nylon and polypropylene blends. These rugs have a latex backing that is sprayed on. Typically, synthetic rugs are very durable and are good for high-traffic areas. Machine-made rugs can withstand high traffic, and will begin to wear out after 12 to 20 years of use. Carpet is a common three dimensional indispensable floor covering in today's homes and offices. The first carpets characterized by pile surfaces were probably cured animal skins laid on the dwelling floors of early hunters. Those floor coverings served many of the functions that floor coverings serve today - protection from hard and cold floors, providing a pleasing tactile surface, and decoration. Many pioneer researchers have studied about the wear and abrasion, compressibility behavior of carpets and rugs but very limited work have been carried out in the area of multi objective optimization of quality and productivity characteristics of machine made carpet. Multiple attribute decision making (MADM) is used to deal with the problems of finding a desirable solution from a finite set of feasible alternatives assessed on multiple attributes. The present research aimed to develop a quantitative analysis framework to evaluate optimal parametric combination.

Verma et. al1 applied Fuzzy embedded Taguchi approach for multi response optimization in machining of glass fibre reinforced composites. It has been observed from drilling experiments that PCA-fuzzy (integrated with Taguchi method) has provided better result as compared to WPCA (Weighted Principal Component Analysis) based Taguchi method. Process parameters viz. spindle speed, feed rate, and depth of cut have been considered to investigate multiple process responses viz. Material Removal Rate (MRR), surface roughness (Ra), tool-tip temperature (maximum temperature generated during machining at tool-tip) and resultant cutting force whilst turning of GFRP (epoxy) composite specimens.

Laughlin et.al[2] analyzed the compression performances of loop-pile and cut-pile tufted carpet samples of different fibre content and pile weight under cyclic loading. They have determined a mathematical relationship between the compression force per unit weight of pile yarn and the percent compression of the pile with different fibre materials. However, they found no major difference in the relative compression stress-strain behavior of the carpets before and after exposure to 100000 revolutions of the Tetra pod Walker.

Berkalp[3] investigated the mechanical properties such as wear and abrasion resistance, impact loading .Wear resistance, of carpets produced from acrylic, wool propylene fibers in two different pile heights and loop density has been observed. It was found that weft thread density, raw material and loop height had statistically important effect on wear resistance.

Erdogan[4] observed the durability performances such as thickness loss under mechanical loading, thickness loss after short and long term static loading, snagging load and appearance changing, of 12 machine carpets.

Thilavagathi et al.[5] Studied about the acoustic properties and sound insulation of natural fiber (banana, bamboo and jute) nonwoven fabrics blended with polypropylene for four wheeler vehicles. They found that a bamboo/polypropylene nonwoven provided the highest sound absorption coefficient for all levels of sound frequencies.

Kucuk et. al.[6] studied the sound absorption properties of various nonwoven fabrics and effect of bonding, thickness, fiber composition and air permeability. They found that thermal bonded nonwoven fabrics made from a blend of natural and synthetic fibers provided better sound absorption properties than a commercial needle-punched nonwoven fabric made from meta-aramid fibers..

Yilmaz et al.[7] analysed various properties of needle-punched nonwoven fabrics and effects of porosity, fiber fineness, and layering sequence on sound absorption performance. Their results indicated that air flow resistivity increased with decrease in fiber diameter and porosity. A strong relationship between the layering sequence and air flow resistivity was also observed. In this study the interaction effects of process parameters were not considered.

Verma et al.[8]developed an optimization module embedded with fuzzy logic tools to assess the effects of machining variables such as spindle speed, feed rate and depth of cut on machining performance evaluation characteristics mainly material removal rate and surface roughness in turning of GFRP composites.

The quality of carpet is characterized by several characteristics; hence it is not easy to achieve all the properties simultaneously, in terms of mechanical and physical aspects. A limited amount is research work is carried out on quality and productivity improvement of machine made carpet. A detailed literature survey has been carried out in the area/areas relevant to the present work including machine made carpet parameters selection and its optimization; it has been found that the work is not sufficiently flourished. Research gap still exists for in-depth understanding in respect of selection of optimal parametric conditions for achieving best durability and compression performance for machine made carpets. Although a large number of research works have been published in the area of carpet quality, there have been limited attempts to optimize carpet quality by taking several objectives. Therefore, in this paper, an attempt has been made to optimize the quality parameters of acrylic machine made carpets by using Taguchi based Utility concept technique. Also to develop an efficient and integrated optimization module module which can systematically avoid/overcome various assumptions/limitations of existing Taguchi based optimization approaches

Experimentation

Modra M-Tuft is a tufted carpet making machine in which all the system is controlled by the software and design is feed by Ned Graphics software. The **MTUFT range** of machines is an innovative solution for product development of tufted carpet. The M-Tuft has set the benchmark for **performance** and **flexibility**, whilst **saving** clients time and money. Maximum Speed Straight Stitch is up to 20 per second, maximum sample width of 1 mt. and maximum pile height of 19 mm.

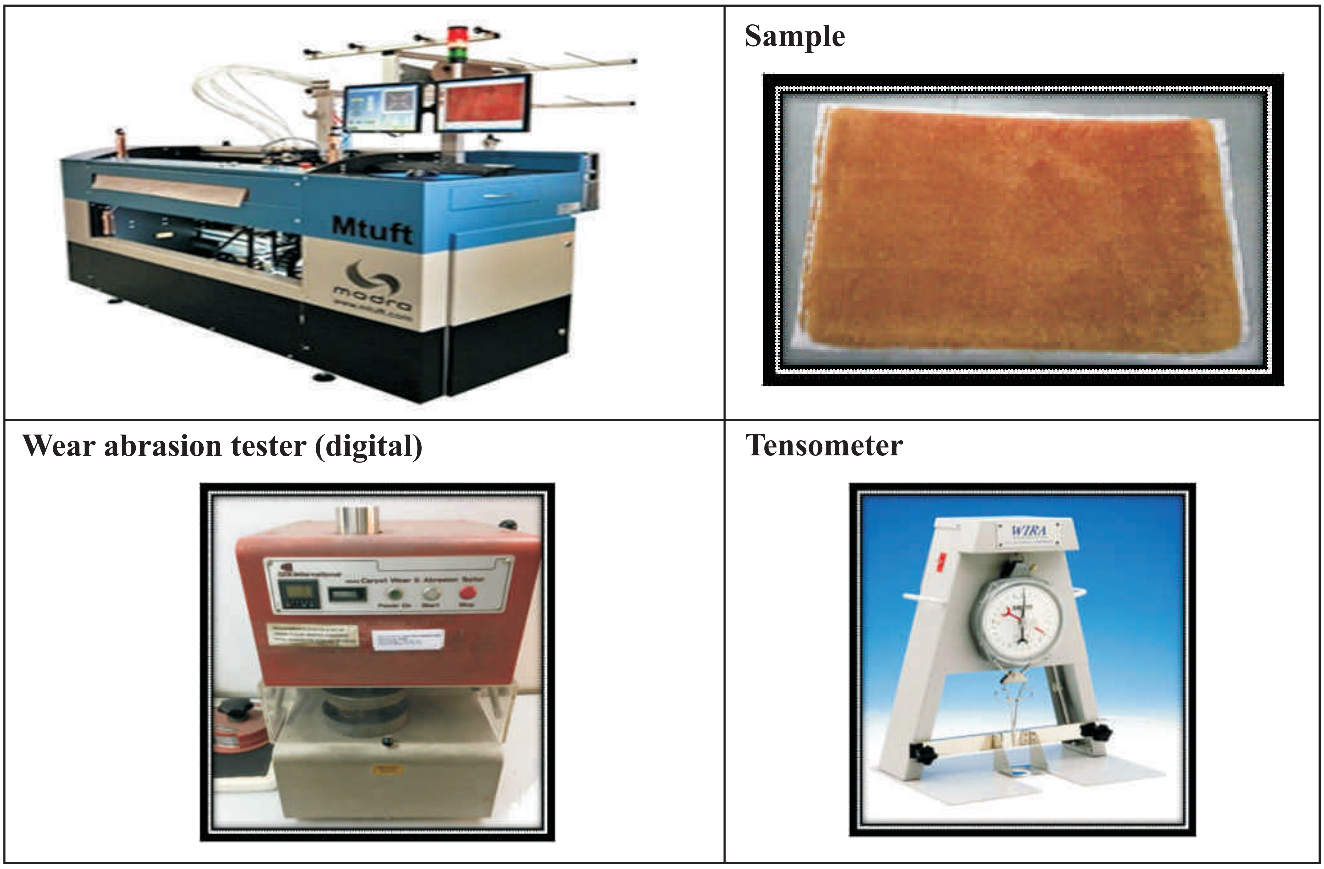
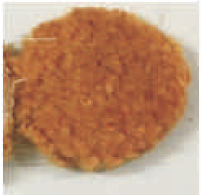
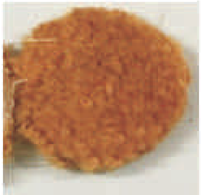
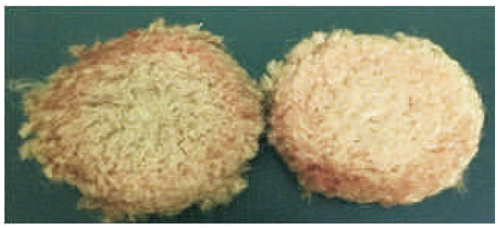


Figure 1: Experimental setup and apparatus used

Test sample image before the test	Test sample image after the test
 	

Methodology

In the current study, the experiment has designed using L9 orthogonal array. Then the experiments have been conducted accordingly and the results are recorded as well. The results are analyzed by using utility concept for conversion of multi response problems in to single response.

Utility Theory

Utility theory has been used to convert individual response features i.e. Abrasion wear (mg) and tuft withdrawal force (Kgf) in the present case, into corresponding preference number called individual utility degree. The utility theory can be applied to solve multi objective optimization problems. The concept behind this theory for solving the optimization problem can be stated as: If Xi represents the effectiveness of the ith attribute among n number of attributes, and then the combined utility function can be expressed as:

$$U(X_{1,} X_2,................,X_n) = f(U_1(X_1), U_2(X_2),..............,U_n(X_n)) \quad (1)$$

where Ui(Xi) represents the utility of the ith attribute.

The overall utility function of the independent attribute can be determined as the summation of individual utilities and can be expressed as follows:

$$U(X_{1,} X_2,................,X_n) = \sum_{i=1}^{n} U_i(X_i) \quad (2)$$

The attributes are assigned weights according to their priorities. The overall utility function after assigning weights to the attributes can be expressed as:

$$U(X_{1,} X_2,................,X_n) = \sum_{i=1}^{n} W_i U_i(X_i) \quad (3)$$

Here Wi represents weight assigned to the ith attribute. The sum of the weights for all the attributes should be equal to 1.A preference scale for each attribute is determined for the evaluation of the utility values. Two arbitrary preference numbers 0 and 9 are assigned to the just acceptable and the best value of the quality characteristic respectively. The preference number Pi can be expressed on a logarithmic scale as follows:

$$P_i = A \times \log\left(\frac{X_i}{X_i^{'}}\right) \quad (4)$$

Here is the value of attribute and x_i'is just an acceptable value of attribute.

Where the constant value A can be found by the condition that if xi=x* then pi=9.

Therefore, $A = \frac{9}{\log \frac{X^*}{X_i'}}$ (5)

Where represents the best value

The overall utility can be expressed as follows:

$$U = \sum_{i=1}^{n} W_i P_i \quad (6)$$

Subject to the condition $\sum_{i=1}^{n} W_i = 1$

Irrespective of response types (lower is better, nominal is the best and higher is better) recommended by Taguchi, the highest value of overall utility provides the optimum result.

Taguchi Optimization Philospy

Dr. Genichi Taguchi, a Japanese management consultant developed an efficient methodology to optimize quality characteristic and is widely being applied now-a-days for continuous improvement and off-line quality control of any manufacturing/production process or product. Taguchi's concepts are as follows:

- Quality should be designed into the product and not inspected into it.
- Quality is best achieved by minimizing the deviation from the target. It is immune to uncontrollable environmental factors.
- The cost of quality should be measured as a function of deviation from the standard and the losses should be measured system-wide.

Results and Discussion

Taguchi's orthogonal array design of experiment is an economic as well as effective method to examine effects of the process parameters through limited number of experiments. The present study focuses on evaluating the effects of process parameters such as Tufting speed (N), Stitch Rate (SR), Gauge size (G), each has been varied at three discrete levels (as shown in Table 1). Process responses considered are Abrasion wear (mg) and Tuft withdrawal force (kgf). In this experimentation, L9 orthogonal array has been used as shown in Table 2. Interaction effects of process parameters have been assumed negligible. A snapshot of Machine tufted carpets (acrylic) has been provided in Fig. 1. Table 3 represents the experimentally observed values of aforementioned response characteristics. Table 4 shows the preference number value or individual utility values and table 5 represent the overall utility index (U) and their corresponding S/N ratios. This shows the optimal parametric setting are as represented in figure 3. The response tables for S/N ratio of overall utility index (Ui) are shown in table 6, from this it is observed that the Tufting speed (N) is most significant factor for overall utility index (Ui) and then Stitch Rate (SR)third one is Gauge size (G),. It is very important to control these significant factors to improve the quality and productivity of machine made carpets. The confirmatory test has been performed on obtained setting which shows the satisfactory results.

Table 1: Process parameters

Factors	Unit	Level 1	Level 2	Level 3
Tufting speed (N)	[RPS]	10	12	14
Stitch Rate (SR)	[/10cm]	31.5	39.4	47.2
Gauge (G)	[inch]	1/12	1/10	1/8

Table2: Design of Experiments (L9 Orthogonal Array)

Exp. order	Run Tufting (N)	speed Stitch (SR)	Rate Gauge (G)
1.	10	31.5	1/12
2.	10	39.4	1/10
3.	10	47.2	1/8
4.	12	31.5	1/10
5.	12	39.4	1/8
6.	12	47.2	1/12
7.	14	31.5	1/8
8.	14	39.4	1/12
9.	14	47.2	1/10

Table 3: Experimental data

Sample No.	Abrasion wear (mg)	Tuft withdrawal force (kgf)
Sample No.1	8.7	1.76
Sample No.2	6.4	1.75
Sample No.3	7	1.86
Sample No.4	8.5	2.20
Sample No.5	13.9	1.81
Sample No.6	9.7	1.69
Sample No.7	4.3	1.96
Sample No.8	7.9	2.23
Sample No.9	6	1.75

	Abrasion wear (mg)	Tuft withdrawal force
1	-11.0551	77.83528
2	-8.1325	77.39303
3	-8.89492	82.25774
4	-10.801	97.2941
5	-17.6628	80.04651
6	-12.3258	74.73956
7	-5.46402	86.6802
8	-10.0386	98.62084
9	-7.62422	77.39303

Table 5: S/N Ratio of overall utility values

Sl.No.	**Overall utility Index(U)**	**S/N RATIO**
1	-11.0551	30.4723
2	-8.1325	30.7891
3	-8.89492	31.2889
4	-10.801	32.7190
5	-17.6628	29.8808
6	-12.3258	29.8850
7	-5.46402	32.1723
8	-10.0386	32.9263
9	-7.62422	30.8526

Table 6: Response Table for Signal to Noise Ratios Larger is better

Level	**N**	**SR**	**G**
1	30.85	341.79	31.09
2	30.83	31.20	31.45
3	31.98	30.68	31.11
Delta	1.16	1.11	0.36
Rank	1	2	3

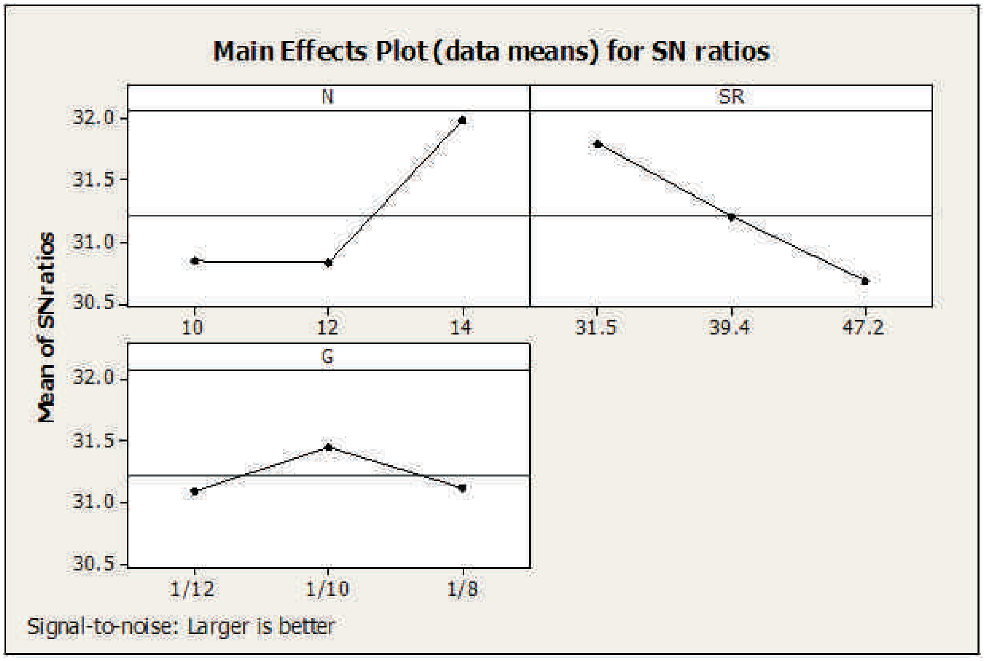


Fig. 3: Evaluation of optimal setting: S/N ratio plot of overall utility (U)

Conclusions

The aforesaid case experimental study proposes an efficient optimization module in relation to multiple quality characteristics such as Tuft withdrawal force (kgf), Abrasion wear (mg) in machine made tufted carpets. The aim is to obtain the most favorable process environment for improving overall process performance yield. The following conclusions may be drawn from the results of the experiments and analysis of the experimental data in connection with correlated multi-response optimization in quality characteristics of machine made tufted carpets. To optimize these multi response optimization problem, utility theory was introduced, which converted the multi objective optimization problem in to a single objective optimization problem. The process parameter combination having highest overall utility value was taken as optimal parameters. Finally the optimal parameter combination obtained through Taguchi approach; considering the higher is better criteria upon the overall utility indexes. From above study it was proved that the utility based Taguchi approach is capable of providing effective environment in order to minimize Abrasion wear (mg) and to maximize the Tuft withdrawal force (kgf). The proposed utility based Taguchi approach can be recommended for continuous quality improvement and off-line quality control of a process/product. The Taguchi approach to design of experiments is an effective strategy in product and process optimization. The approach of Taguchi method is able to improve the process performance when optimum parameters setting used in the process give better output performance in terms of quality and productivity.

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Studies on Seam Strength behavior of Nonwoven fabric

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Abstract

With the innovations and developments in field of textile and fashion technology, fabric such as the nonwoven textile materials has also started finding its application into the fashion and apparel products. Joining of the plies of fabric essential for garment manufacture is an important factor and it has been a point of interest for many researches. There exist different ways to join the plies of nonwoven fabric e.g., thermal bonding, ultrasonic seaming, laser enhanced bonding, adhesive bonding etc. Thermal bonding methods work best with the thermoplastic fiber or with an assembly at least 60% of thermoplastic fibers. The joint formed by these methods may not comfortable in case of apparel and not produce as much flexibility and elongation as conventional sewing method. Joining of nonwoven plies with conventional sewing machine is an economic and simple way to produce stitched products for many applications. In the present study effect of different sewing parameters such as stich density, seam allowance, seam types on breaking strength of joined spunlaced nonwoven made of different fibres has been examined. Statistical techniques has been used to analyse the main effect and interaction effects of different parameters on seam breaking strength. Stitch density, seam types, fibre types, followed by seam allowance appeared to be most important factors.

Keywords

Sewing thread, seam allowance, spunlace nonwovens, stay tape, stitch density, stitch length.

Introduction

The nonwovens are broadly defined as sheet or web structures bonded together by entangling fiber or filaments mechanically, thermally or chemically. The nonwoven fabrics are flat, flexible, porous sheet structures that are produced by interlocking layers or networks of fibers, filaments, or film-like filamentary structures. Hydro-entangling or spun lacing, hydraulic-entanglement and water jet needling are synonymous terms describing the process of bonding fiber or filaments in a web by means of high-velocity water jets. The interaction of the energized water with fibers in the web and the support surface increases the fiber entanglement and induces displacement and rearrangement of fiber segments in the web (Mechanical Intertwining or bonding of fibers by water jets)[1].

The nonwovens are being used in various applications, namely they can be used as disposable materials such as baby diapers, feminine care products, medical drapes and gowns, cleaning wipes etc. At the same time they can find their suitability in durable applications also. Which may include various technical applications such as protective apparel, shoes, linings, floor coverings, filtration, geotextile, automotive and agriculture etc. Since long the nonwovens used in apparel were used only as fusible interlinings, reinforcements for shirt collars and cuffs, or front interfacings for suits. They were considered as disposable and rigid fabrics. This phenomena has changed drastically in recent years due to the research and development in the properties of nonwoven fabrics.

Primarily nonwoven fabrics were utilized in only technical applications whereas only a very less amount nonwoven fabrics was utilized for apparel applications. Nonwoven materials offer a number of advantages over traditional woven, knitted fabrics, cost savings being the most important, due to its direct conversion of fiber to fabric, high volume of production, less labor compliment, reduction in number of process for fabric production. This difference in cost can place the nonwoven as a candidate for replacement of traditional fabrics for fashion apparel applications [2]. In recent years the nonwoven industry has grown exponentially, offering a wide variety of products to many diverse markets. Further, some studies have been done on the market disposable nonwoven outfits but with little success due to undesirable properties. Since last few years, with innovative developments in the nonwoven technologies, this unconventional fabric produced with better drape, hand, durability, comfort, stretch and recovery, has now also started finding its application into the fashion apparel products too [3,4]. Unlike woven and knitted fabrics nonwovens does not tend to unravel the raw edges of the garment did not require finish. Automatic cutters and industrial sewing machines are be used for this purpose. Commercially nonwoven fabrics are joined by various techniques such as i.e. ultrasonic seaming, thermal bonding, laser bonding, adhesive bonding and conventional sewing machine. Except sewing all other methods of joining involve there should be at least 60% of thermoplastic fiber content for joint [5, 6].

Construction of apparel is most commonly done with sewing by needle and thread to join the plies together. Sewing of the nonwoven by traditional methods of stitching can be done on the lockstitch machines. Stitching creates holes in the fabrics which can impair the strength and affect its sealing properties [7]. Still the effects of sewing parameters such as the type of seam, stitch density, influence of fibre types on the tensile properties of joined fabric layers are be of considerable interest. Only a limited number of studies have been done on seam strength of nonwoven fabrics or reported in literature. In the present work the spunlaced (hydro-entangled) webs of different constituent fibres were combined and joined using traditional lockstitch mechanism to investigate the seam strength behaviour of stitched nonwoven fabrics in terms of these parameters.

Material and methods

Materials

Three different categories of parallel laid hydro-entangled nonwoven fabrics comprised of different fibers (100%PET, 100%Viscose, P/V blended [50/50], Figure 1) were procured from the local industry and used for the experimentations. The technical specifications of the constituent fibres and the set of process parameters used for the production of the nonwoven fabrics are given Table 1 and Table 2.

The two ply sewing thread used for stitching all the samples, was a 100% cotton yarn of linear density 20 Tex. The same yarn was used both as needle and bobbin threads. Technical information about the sewing thread used are given in Table 3. Stitching of the samples were done on the Brother lock stitch machine. Two kinds of common superimposed seams, e.g., SSa and SSab were chosen (Figure 2, 3) so the effect of seam type can be observed. Simultaneously the stitch density and the seam allowances were varied at different levels, so as bring out the interaction effects of these factors.

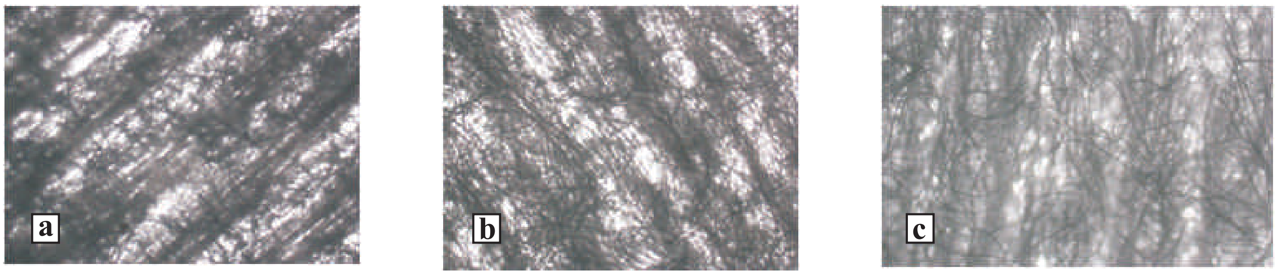


Figure 1. Microscopic view of a-100% Polyesterb-100% Viscose c-50/50 P/V blendnonwoven sample

Table 1 Specification of the constituent fibres

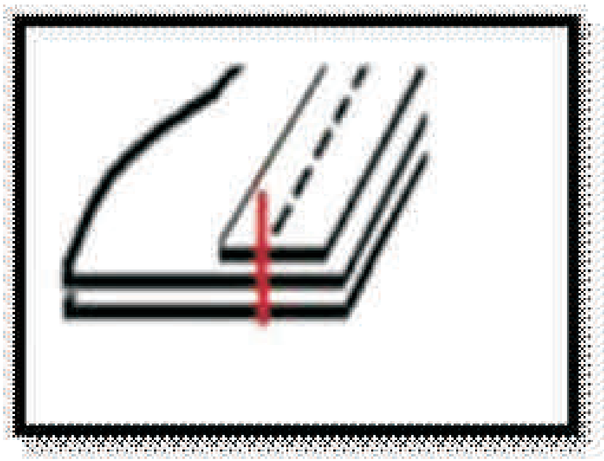
Nonwoven fabric code	Fiber content in nonwoven	Fiber linear density	Fiber Length
A1	PET 100%	*1.4dtex*	41*mm*
A2	Viscose 100%	*3.3dtex*	38 *mm*
A3	Polyester/Viscose (50/50)		

Table 2 Nonwoven Fabric Specification

Nonwoven fabric code	Nonwoven structure	Initial fabric thickness T0 (mm)	GSM	Compressional parameter(?)
A1	Parallel laid	0.55	80	0.1485
A2	Parallel laid	0.45	80	0.0698
A3	Parallel laid	0.50	80	0.0979

Table 3 The Sewing thread specification

Type	100% cotton
Tex size	20
Ply	2
Tenacity (cN/Tex)	38.7
Elongation%	3.9%



a. Seam type SSa

b. Seam type SSab

Figure 2. The two different seam types SSa and SSab

Methods

Taking the advantage of the nonwovens non fray properties, the samples were stitched with lock stitch, with no need to secure raw edges of the specimen. The stitched nonwoven samples were prepared by varying seam type, seam allowance, stitch density, nonwoven type at three levels. A four factor general factorial experimental design plan was used to prepare nonwoven samples, as given in Table 4. The samples were prepared on Brother lock stitch machine at 2000 RPM with needle size 90 nm and lock stitch (301) type is used for seaming.

All the joined nonwoven fabrics samples were tested for tensile properties, such as, breaking force and breaking extension, using the strip test methods, following the procedures as described by Mozafary et al [8]. In the present study the initial testing of the samples were carried out as per ASTM D 1683 test methods. The sewn samples were raptured very quickly along the seam line, resulted too low values of the breaking strength and it was decided not to carry out the tests as per this standard. Finally a procedure similar to the strip test method, and according to the work of Mozafary [8] was decided to follow, which resulted in more consistent values of breaking strength. The test specimens were prepared by cutting the spunlaced nonwoven fabric, with sharp scissors, of dimension 350 mm by 100 mm in the lengthwise direction. The supplied nonwoven being a parallel laid fabric it resulted consistent breaking strength in that direction only. All the tensile tests were performed on Universal Tensile Tester.

All the sample were conditioned in ambient laboratory environment for at least 48 hours. Five specimens of all the samples were tested for breaking strength and extension on Universal Tensile Tester (Figure 4) in standard laboratory condition. Breaking force for seam strength of samples was tested on CRE tensile testing machine at guage length 100mm and extension rate was adjusted at 100 mm/min [8]. The ANOVA of Breaking force (Newton) and elongation (%) was done using Design Expert software (Table 5) to bring out significance of main effects and interaction effects of material, seam and stitching parameters on breaking strength and elongation.

Table 4. Plan of sample preparation

Type of nonwoven (Three types)	Stitch density (stitches/cm) (Three levels)	Seam allowance (mm) (Three levels)	Seam type (Two types)
Viscose	2	2	SSa
Polyester	3		SSab
Polyester/Viscose		6	
(blended)	4	10	
Blend			

A B

Figure 3 Samples prepared with (B) and without stay tapes (A)

Figure 4 Tensile testing of sewn nonwoven samples: failure at the seam is visible

Results and discussions

Analysis of variation of seam strength is presented in the Table 5. The ANOVA table shows that effect model is significant. Mean of five readings per cell was used and the residual mean square is used an unbiased estimate of the population variance. Main effect of all the factors (A-Fibre Type, B-Seam allowance, C-Stitch density, D-Seam type are significant) has been found to significant. Stitch density alone contribute to about 24% of the total sum of squares. Contribution of seam allowance and seam type can be observed to be less. The AC interactions (Table 5), i.e. interaction of fibre types with stitch density appeared to be the most significant.

Table 5: ANOVA table for the Seam breaking strength

Response 1 Seam breaking strength

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F
Model	226020.29	45	5022.67	43.64	< 0.0001 significant
A-Fibre Type	109390.06	2	54695.03	475.21	< 0.0001
B-Seam allowance	13496.43	2	6748.22	58.63	< 0.0001
C-Stitch density	54824.84	2	27412.42	238.17	< 0.0001
D-Seam type	2922.22	1	2922.22	25.39	0.0010
AB	944.47	4	236.12	2.05	0.1797
AC	39248.77	4	9812.19	85.25	< 0.0001
AD	1071.94	2	535.97	4.66	0.0456
BC	565.40	4	141.35	1.23	0.3716
BD	2.07	2	1.04	0.01	0.9910
CD	626.63	2	313.32	2.72	0.1254
ABC	823.31	8	102.91	0.89	0.5609
ABD	291.09	4	72.77	0.63	0.6535
ACD	841.79	4	210.45	1.83	0.2168
BCD	971.27	4	242.82	2.11	0.1713
Residual	920.77	8	115.10		
Cor Total	226941.07	53			

Common characteristics of seaming is that they must have a suitable strength and elasticity, extensibility to withstand load during its useful life and prevent brakeage in seam region. The amount of stresses to which the seam of a textile material are subjected depends on its application and position of seam. As a general observation during the experimentation it was found that too low and too high stitch density is detrimental for sufficient joining strength of apparel. Too many holes or too few stitches create problem and results poor seam strength. Adequate number of binding points are required to provide uniform stress transfer from one piece of material to another, thus preserving the overall integrity of the assembly.

Effect of the seam allowances

The seam allowance is the area between the edge of the fabric and the stitching line as the two pieces of fabric being stitched together, this is shown in the Figures 2 and 3. The Figure 6 shows the effect of seam allowance for different types of nonwovens. Similar trend line can be noticed for all the types of fabrics. It can be observed that as the seam allowance is increased from 2 mm to 6 mm, seam breaking force increases considerably with seam allowance, but with further increase in seam allowance from 6 mm to 10 mm breaking force does not rise appreciably. Increase in seam breaking strength in this case, can be due to the fact that more number of fibres are available that resist to slippage on application of stress and thus contribute to the strength. Further increase in seam allowance beyond 6 mm in this case may be considered unnecessary. The effect of seam allowance has been found to more prominent at higher stitch density.

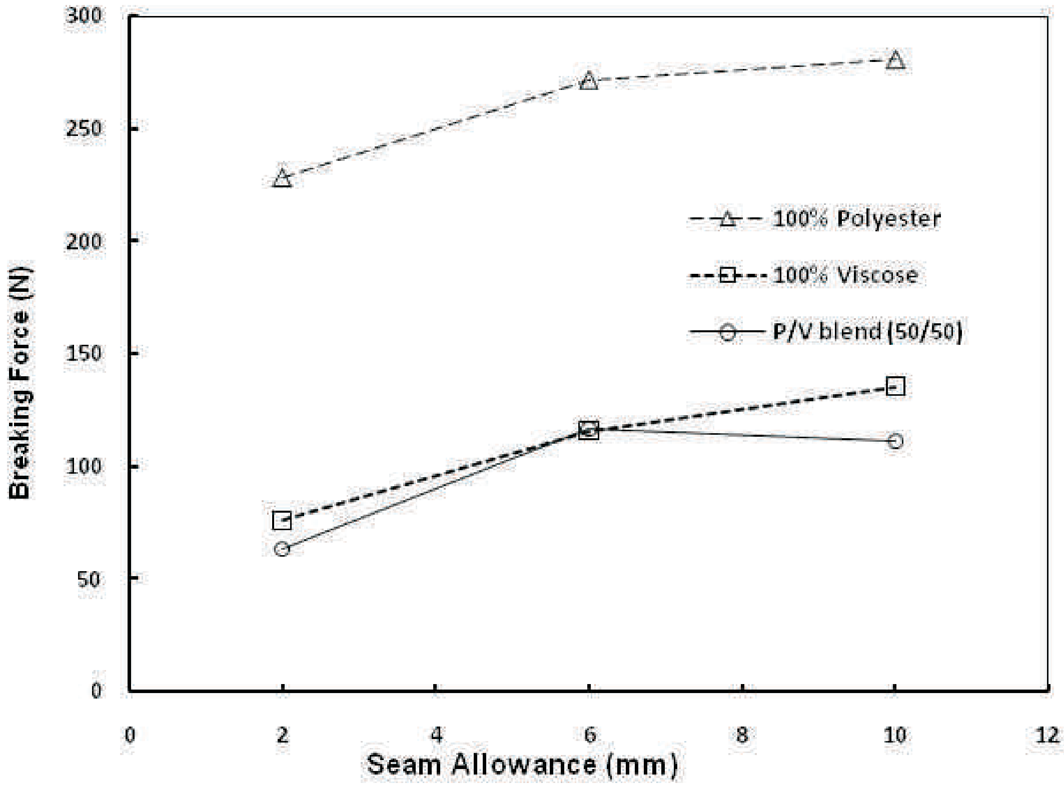


Figure 6 Effect of seam allowance on Breaking Strength

Effect of the seam type

The effect of stay tape attached to seam line of the assembly is shown in the Figure 7. It shows that adding a stay tape increases breaking strength of the stitched fabric, and the effect is markedly prominent in case of the 100% viscose and polyester nonwovens. This is because the attachment of stay tape to the seam line of assembly provides an additional layer and it is reinforcing the seam area, improve strength, and maintain shape and prevent stretching. In general a stay tape is often required as a reinforcing element to increase the seam strength. For the same sewing yarn tension a greater thickness of the nonwoven fabric layers are being stitched and thus resulted in better binding of the component fabrics. The width of the stay tape is limited upto the seam allowance that is left, and cannot seen from the front side of the assembly.

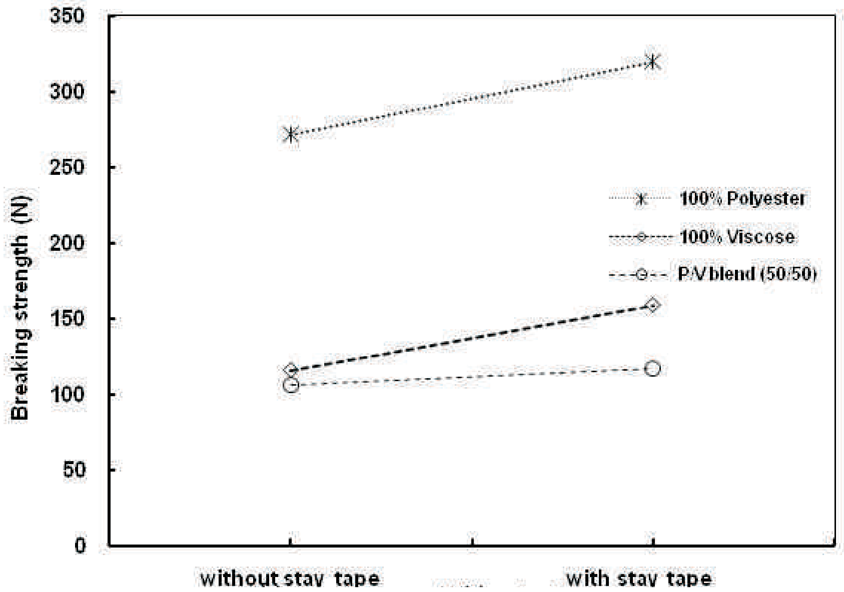


Figure 7 Effect of stay tape on Breaking Strength

Effect of stitch density

The effect of stitch density been shown in Figure 8. It can be observed form the Figure that increase in the stitch density resulted in better seam strength in case of all the types of fabrics. Maximum increase in seam strength could be observed in case of 100% polyester fabric. More the number of stitches per unit length greater is the positions where the fibres in the fabric is gripped by the sewing thread. The variation in stitch density affect the seam breaking strength and if other factors remain unchanged, then seam strength normally increases with stitch density up to a point where the concentration of needle hole starts to weaken the material. Higher stitch density results in higher breaking force but when fabric strength becomes lower than the seam strength, fabric failure before seam failure makes the assembly unrepairable.

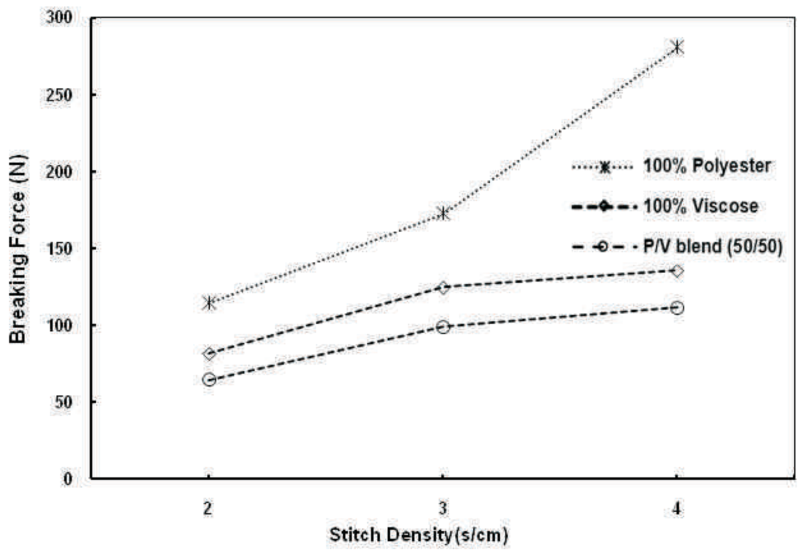


Figure 8. Effect of stitch density on Breaking Strength

Effect of fibre type:

The clothing material characteristics also play a critical a role in influencing the seam strength of the stitched fabrics. Blending of polyester with viscose showed, i.e., the blended nonwoven fabric performance is much poorer. The 100% Polyester fabrics showed the best results however. Frictional characteristics of the fibres, crimp and its rigidity and the type of entanglement created in the original fabric will decide the tensile and seam strength characteristics of the joined fabrics.

Conclusions

Hydro-entangled nonwoven stitched samples were prepared by varying (stitch density, seam allowance, seam type) and constituent fibers [polyester, viscose, Polyester/Viscose (50/50) blend]. Tensile tests of all the joined samples were carried out in laboratory and statistical analysis was done using ANOVA technique to bring out the effects of the factors influencing the seam strength. Constituent fibres, Stitch density and seam allowance appeared to be the most important parameters affecting seam tenacity. Almost for all the samples of different fibre types and their blends seam breaking force increased with increasing stitch density. Increasing stitch density too further caused damage of the fabric along the seam line and resulted fabric breakage along the seam line. All the samples having stay-tape attached to the seam line of specimen resulted in improved seam strength due to better reinforcement. It can said where the requirement of high strength is priority, joints with the stay tape, a moderate seam allowance and optimum stitch density should be preferred.

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Conductive polymer based electro-conductive nonwovens

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Abstract

Research on electro-conductive textiles based on conductive polymers such as Polyaniline (PAn), Polypyrrole (PPy), Polyacetylene (PAc), Polythiophene (PTh), and their derivatives has been increased in the recent years due to their high potential applications in various fields. These conductive polymers have electrical conductivity ranging from 1 Scm-1 to 10-4 Scm-1 which is just below the metallic copper. By application of these polymers onto porous and bulky textile surface, novel textile composites can be obtained which are strong, flexible, light weight and highly electro-conductive. These textile composites are suitable for applications such as heating pads, EMI shielding, sensors, anti static materials, etc. In this article a concise review on the methods of applications of conductive polymers onto textile surface,merits and demerits of these methods, properties of electro-conductive textiles and their potential applications are reported.

Keywords : Conducting polymers, polypyrole, Insitu polymerisations

Introduction

Metals can conduct electricity as they have free electrons in their conduction band which can travel across atoms in the lattice. The insulating polymers have localized electrons in the covalent bonds of their intrinsic structure. So they are incapable of providing electrons as charge carriers or a path for other charge carriers to move along the chain. Electrically conducting polymers such as (PAn), Polypyrrole (PPy), Polyacetylene (PAc), Polythiophene (PTh), etc. have in common a significant overlap of delocalized ?-electrons along the polymer chain. These polymers become conductive upon partial oxidation or reduction, a process commonly referred to as doping [1], similar to that of traditional semiconductors in which conductivity depends on the injection of electrons or holes. When an electron moves into a hole, it leaves behind a vacated hole and so on, thereby enabling charge to move. As observed by Heeger, who won Nobel Prize for finding out Polyacetylene as excellent conductive material, these polymers also behave in the same fashion as traditional semiconductors in conducting electric charges. The maximum conductivity of these polymers so far obtained is just below that of metallic copper as shown in Figure 1. But these conducting polymers have inferior mechanical properties [2-3]. The textile materials are light in weight, flexible, strong and easily fabricable. So, they are used in many applications other than as clothing materials. But textiles are restricted in electrical applications because of their high electrical resistivity, which is of the order of 1012 ? or more. The use of conductive polymers in conjunction with textile materials would have the positives of both the textiles and the conducting polymers. Electrical resistance of these textile materials can be varied by controlling process parameters during preparation. These materials allow current to flow through the fabric without incorporation of any metals. Such property can make it suitable for easy fabrication of smart fabrics, which do now face many problems with the metallic components. Other interesting applications of the conductive textiles are static control, Electromagnetic Interference (EMI) shielding, flexible heating pad, sensor, and many more [4].

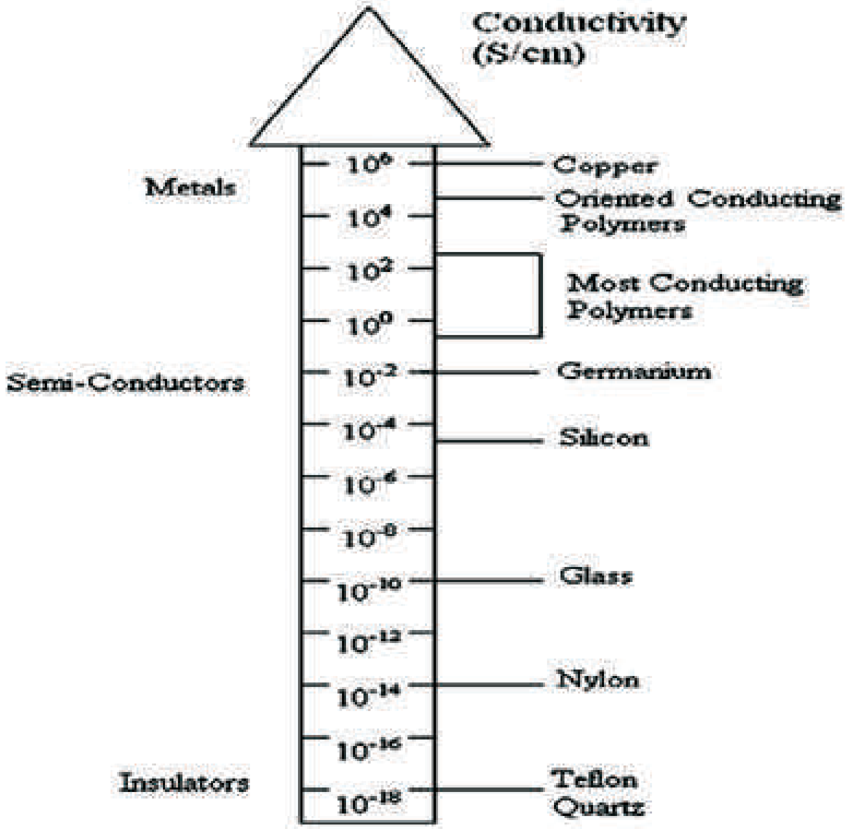


Figure 1. Conductivity ranges of insulators, metals and conducting polymers [1]

Conducting polymers

Research of electro-conductive textiles based on conductive polymers such as Polyaniline (PAn), Polypyrrole (PPy), Polyacetylene (PAc), Polythiophene (PTh), etc. has increased in the recent years due to their high potential applications in various fields. [5]. Conjugated structures are characterized by repeated units in which atomic valence is not satisfied by covalent bonds. The valence electrons of adjacent carbon hetero-atoms (atoms other than carbon and hydrogen) significantly overlap and form double bonds that give rise to ?-bonds. The ?-electrons are de-localized over large segments of the polymer chain, which are responsible for the electronic properties of the conductive polymers. The essential feature of the conducting polymers is that it provides p-bands of delocalized molecular orbital within which full range of semiconductors and metal behavior can be achieved through the control of the degree of band filling. Chemical structures of some of the commonly known conductive polymers are shown in Figure 2. Among conducting polymers, polyaniline, polypyrrole and polythiophene have received wide spread attention because of their good environmental stability and conductivity. The hetero atoms such as -N- or -S- present in the polymer chain play an important role in the unique conduction mechanism. Conducting polymers are difficult to process to form fibre or filament due to the extensive delocalization of π-electrons. So, different conducting composites are producerd by blending conducting polymers with conventional insulating polymers/materials so that the conducting composites retain the mechanical properties of the conventional polymers and electrical conductivity of the conducting polymers.

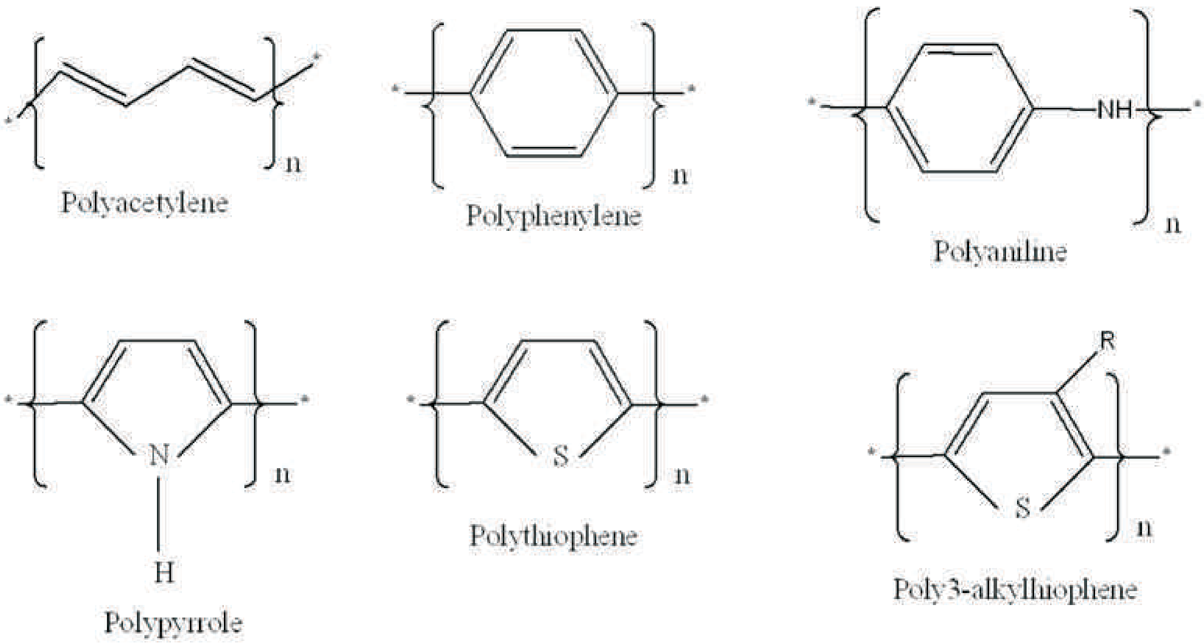


Figure 2. Chemical Structure of Conductive polymers [2]

Application methods of conductive polymers onto textiles

A key requirement of synthesis of conducting polymers is that the conjugated nature of the polymer should be conserved during the synthesis process. Due to strong interaction within polymer chain they are insoluble and do not melt. Hence, they are difficult to spin to filaments or fibres. Again, lack of thermal stability make them unsuitable for hot molding process. So, they are very difficult to apply onto textiles. In-situ polymerization methods are found most suitable techniques in this regards. Electro-conductive textiles can be prepared by using in-situ chemical, electro-chemical and vapor phase polymerization processes [6-8]. It has been observed by some researchers that porous and bulky textile structures are more favorable for higher polymer add-on and better conductivity [22]. So, if porous and bulky nonwoven structures such as spunlace and needlepunched fabrics are used as substrate of in-situ polymerization then highly electro-conductive textiles will be prepared for various potential applications.

In-situ chemical polymerization

The chemical polymerization is very simple. One of the key requirements of this process is that the monomer should be soluble. For chemical polymerization, solutions of monomer and a suitable oxidant (e.g. FeCl3) are mixed together and subjected to constant stirring for prolonged duration. As a result oxidative polymerization occurs and polymers form in bulk. The coating of different materials with conducting polymers, i.e. polyaniline, polypyrrole, polythiophene, and their derivatives, is possible by means of in-situ chemical polymerization [9-12]. The in-situ chemical polymerization can be performed in single bath or a double bath process. For single bath process monomer and oxidant solutions are mixed in a single beaker and simultaneously textile substrate is immersed into it as shown in Figure 3. For double bath process the textile substrate is treated with monomer solution first and then monomer enriched substrate is immersed into oxidant solution or vice versa as shown in Figure 4. As polymerization start some polymers deposit on the textile substrate due to adsorption and some present in the solution in bulk. As a result the color of the substrate as well as solution changes to greenish black which is the color of the polymer [13]. In comparison to other in-situ polymerization methods this method is simplest. Experimental set-up is very simple It is suitable for laboratory preparation and as well as for mass production of conductive textiles. Only requirement is that PPy should have some affinity to the textile

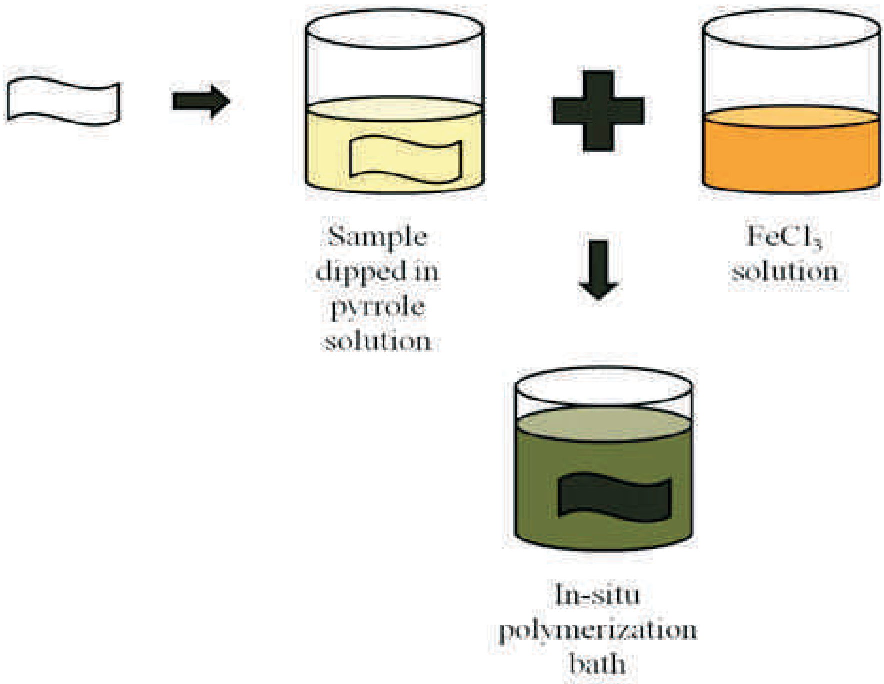


Figure 3. In situ chemical polymerization single bath process

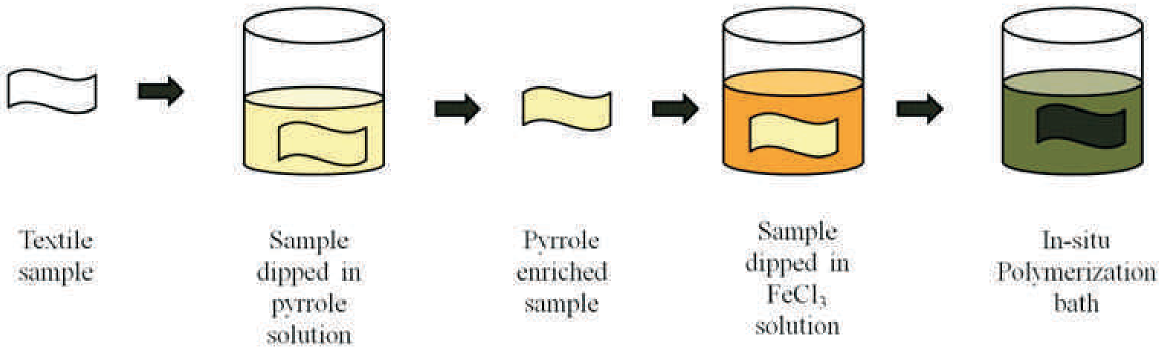


Figure 5. In situ chemical polymerization double bath process

In-situ electro-chemical polymerization

Electrochemical polymerizations are usually performed in a one-compartment cell where two electrodes such as anode and cathode are connected with external power supply. The cell is provided with monomer solution with suitable electrolytes and dopant as shown in Figure 5. Most of the cases electrolytes act as dopants also. Electrochemical oxidation of monomer results in polymer films deposited on anode surfaces. If anode surface is covered with a textile substrate then polymers will deposit on it [14]. The polymerization rate and yield depends upon the material of electrode, types of solvent, electrolyte, supply voltage, temperature, time etc. This method has been mainly used to obtain information about the redox processes involved in the early stages of the polymerization reaction, and to examine the electrochemical behavior of the polymeric film after deposition.

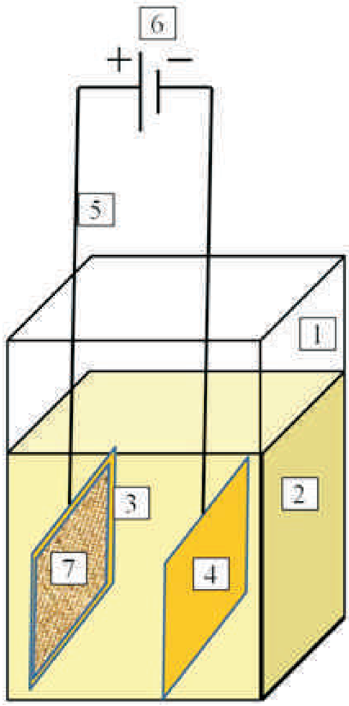


Figure 5. Schematic diagram of experimental set-up for electrochemical polymerization: (1) polymerization bath, (2) electrolyte solution, (3) anode, (4) cathode, (5) electrical wire (6) power supply[14]

In-situ vapor phase polymerization

Chemical vapor phase deposition of conducting polymers is a suitable process for producing electro-conductive textile in two steps following. Impregnation of textile is done in an aqueous solution of oxidant and dopant and followed by drying. After that the fabric is exposed to monomer vapor for in-situ polymerization. Vapor phase prepared fabrics show a high uniform polymer coating on the fibre surface. As a result variability in surface resistivity minimized and fastness to light and washing improved. But controlling of the add-on% is difficult and equipment set-up is complicated as shown in Figure 6 [15].

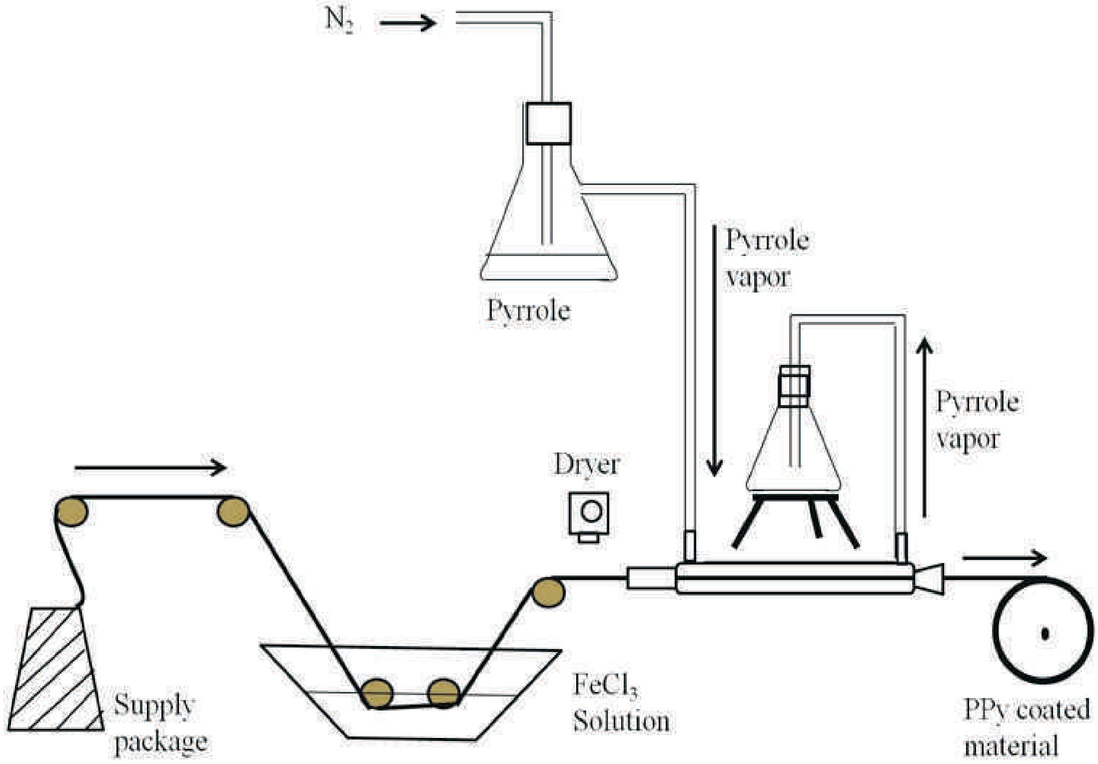
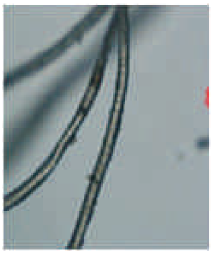


Figure 6. In-situ vapor phase polymerization

Electro-conductive nonwovens prepared by in-situ polymerization

The in-situ deposition of PPy on textile substrate by chemical polymerization occurs by adsorption at the liquid-solid Interface. This phenomenon of adsorption at the liquid-solid interface is also widely used by the textile industry in processes such as dyeing, finishing, wastewater treatment etc. Nature of the textile substrate may influence the in-situ deposition of PPy on its surface [18-19]. It has been observed that few of these conductive polymers are successfully coated on various textile substrates by in-situ polymerization methods. Morphology of polypyrrole coating on different textile fibres are shown in Figure 7.

Fibres	Cotton	Silk	Wool	Polyester	Nylon
Before treatment 20X mag.					

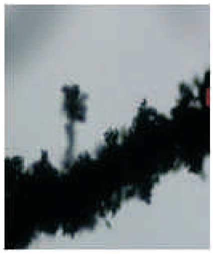
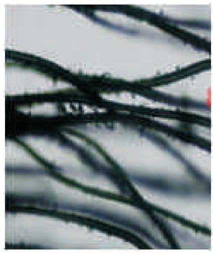
Fibres After treatment 20X mag.					

Figure 7. Textile fibers: before and after polypyrrole coating

Neddlepunched nonwoven, spunlace nonwoven and woven fabrics, all made of 100% polyester fibres, are prepared electrically conductive by in-situ chemical polymerization of pyrrole with p-toluene sulfonic acid dopant. Alkali hydrolysis of polyester fabrics was done before in-situ polymerization for better fixation of polypyrrole on polyester surface. The average surface resistivities were found to be 1013.08 Ω, 1099.72 Ω, and 1434.12 Ω, respectively for neddlepunched, spunlace and woven fabrics.

Applications of conductive polymer coated electro-conductive textiles

Conductive polymer coated nonwoven textiles are light-weight, flexible and durable unlike metals. Moreover, most important merit of these conductive polymers is that their level of conductivity can be tailored as per requirement by changing the processing condition and doping level which is not possible for metals. This alternation of conductivity of conductive polymers as well as textiles makes them suitable for various potentials applications such as heating pads or garments, EMI shielding, strain sensor, pH sensor, anti-static material, transistors and many more. The electro-conductive fabrics exhibit linear voltage-current relationship at low voltage range like an Ohmic conductor as shown in Figure 8. The electro-conductive fabrics displays exponential rise in surface temperature under the application of DC voltage in the form of, $T=ae^{bV}+c$, where T is the measured temperature, a, b and c are coefficients, exponent and constant respectively as shown in Figure 9. The electro-conductive fabrics would heat up quickly and reach to a stable temperature which was very suitable for application as heating garment or heating pad for therapeutic use as shown in Figure 10.

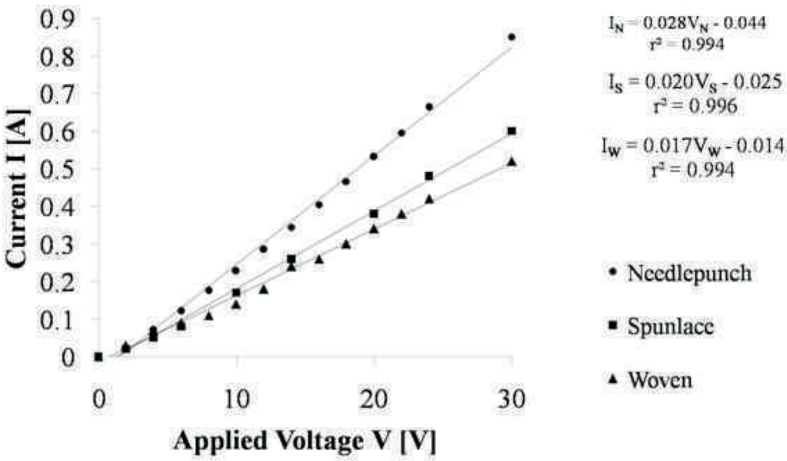


Figure 8. V-I characteristics of electro-conductive textiles

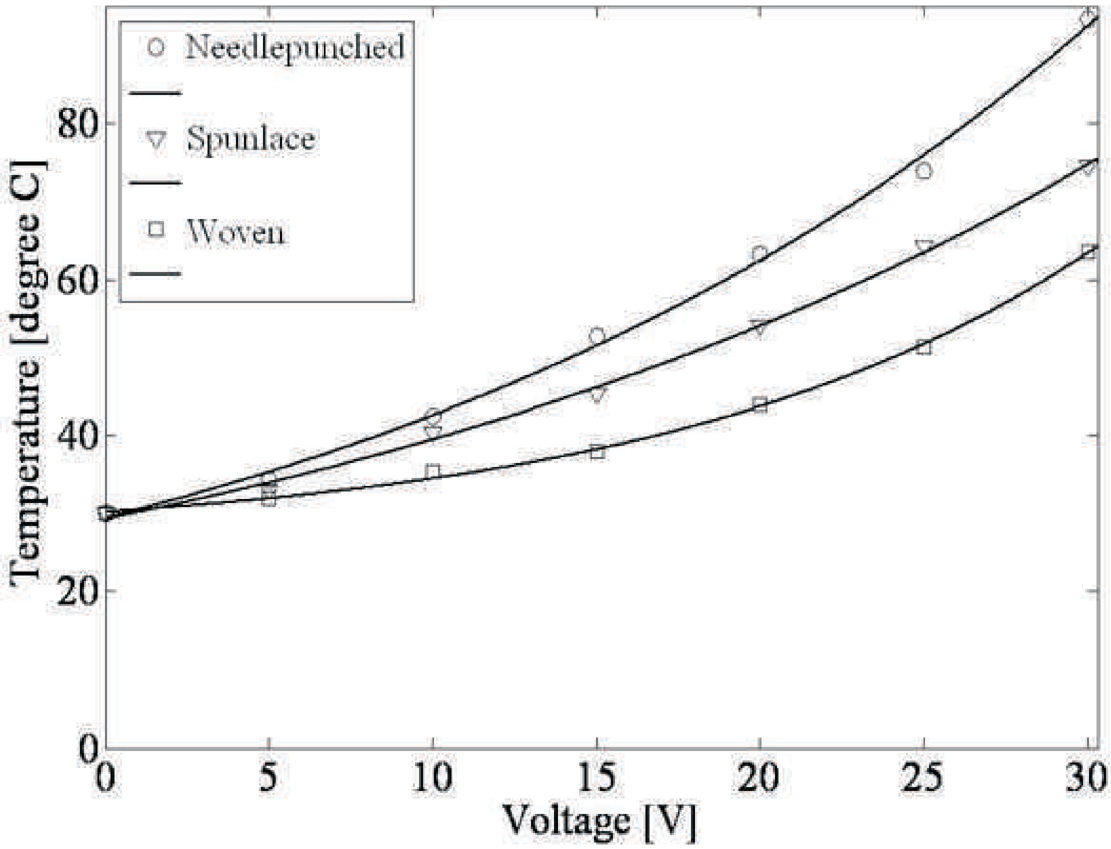


Figure 9. Voltage-Temperature behavior of electro-conductive textiles.

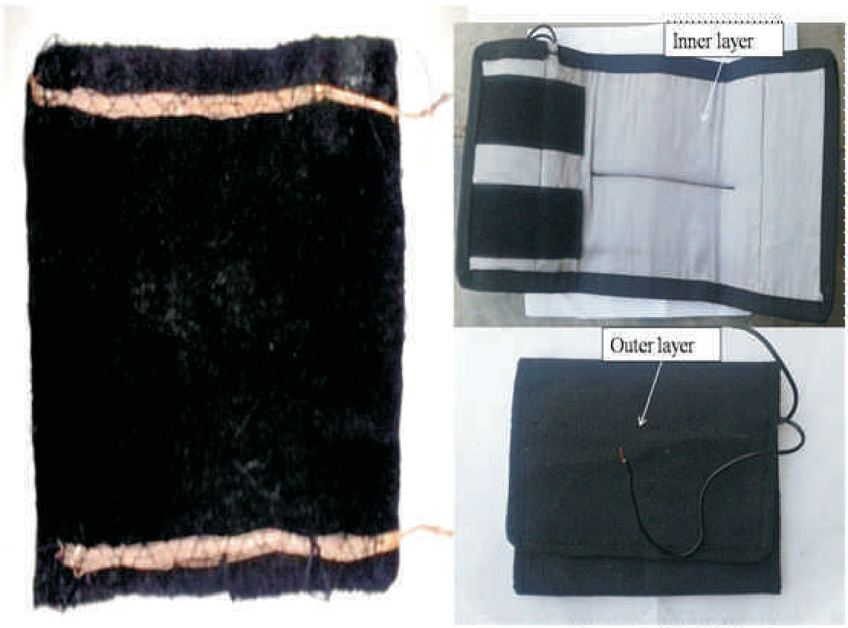


Figure 10. Heating pad made of PPy coated needlepunched nonwoven

It is found that conductive polymer coated textiles shield electro-magnetic radiation by absorption as well as reflection. These textiles of high conductivity show reflection dominant EMISE and that of low conductivity showed absorption dominant EMISE. Electromagnetic response for PPy treated textiles, with a surface conductance between 10 and 11000 ohms/sq suggests numerous applications in stealth technology, camouphlage and similar military applications. Continuous transport belts are used in coal mines, sanding belts by these types of composites. Here static dissipation is of great importance and PPy coated textiles have shown exceptional performance under continuous flexing conditions[29]. As tensile strain of twist is imposed/imparted on the PPy coated cotton yarn its resistivity decreases gradually. This behavior of the yarn makes it suitable for applications as a strain/shear sensor[22]. The electrical conductivity of these textiles changes depending upon the pH of the environment or presence of reactive gases. This behavior makes them suitable for applications as pH or gas sensor [30].

Table 1. EMI Shielding effectiveness of various conductive textiles

Material	Resistivity	Testing frequency	EMSE [dB]	References No.
PPy-coated fabrics	Surface resistivity 3 Ω/□	800 MHz	37.02	31
Ppy-coated polyester fabrics	Volume resistivity 0.2 Ω-cm	1500 MHz	36.6	32
PPy or poly (3,4-ethylenedioxy thiopene coated polyester woven fabric	Volume resistivity 0.3 Ω-cm	1500 MHz	36	33
PPy coated glass fabrics	Surface resistivity 460 Ω/□	2.4 GHz	21.16	34
PPy coated cotton fabric	Surface resistivity 1.18 MΩ/□	2500 MHz	01	35
Polyaniline-coated polyester fabrics	Volume resistivity 10-60 Ω.cm	101 GHz	21.48	36

Conclusions

By the application of conductive polymers onto textile materials the synergistic properties of both the polymer and textile materials can be obtained in terms of strong, flexible, light weight and highly electro-conductive textile composites which are suitable for potential applications such as heating pads, EMI shielding transistor, sensors, antistatic materials, etc. In-situ chemical polymerization is the simplest method among all the methods and it is suitable for laboratory preparation, as well as for industrial mass production of conductive textiles. When porous and bulky nonwoven fabrics such as needlepunched, spunlace etc. are made electro-conductive by the application of these polymers then novel electro-conductive composites are prepared. Unlike metals, these novel composite textiles are light-weight, flexible and durable which make them suitable for various applications such as heating pads or garments, EMI shielding, strain sensor, pH sensor, anti-static material, and many more.

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Multifunctional Properties of Neem - Azadirachta Indica

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Abstract

For medicinal and aromatic plants the clock has slowly, but surely, turned a full circle. The use of plants and plant-based preparations in eco-friendly natural finishes in textiles was the practiced from the very beginning since the budding ideas of their usage came to the thought of humans. Since then plants have been widely adopted for this purpose. Thereafter for several centuries the plant materials occupied a pre-eminent position in the trousseau of traditional textile applications.

It was only at the beginning of the second millennium that alchemic and mineral-based products also started appearing. The plants and herbals nonetheless continued to be widely used until the industrial revolution in Europe brought in synthetic products for various kinds of usages. These applications, because of their ease of preparation and administration, led to a slide in the popularity of plant and herbal-based products. Among other reasons responsible for this was a belief (which still persists to a large extent) that most of the plant based products/herbals are non-standard preparations and hence lack quality and efficacy. Noticeable batch to batch variations for the same products and lack of consistency further eroded to some extent the credibility of these products. [11, 13]

At the present time, however, the increasing environmental degradation due to a burgeoning synthetic products industry has rung alarm bells the world over. Several scientists in various countries are now engaged in discovering or rediscovering the usefulness of plants and herbals for value-added products. This quest for rediscovering the usefulness of plant materials has its basis in those leads or references which are mentioned in traditional systems as indigenous applications. [11,1,2]

About Neem

Neem, a large evergreen tree, commonly found throughout the Indo-Malaysia region, has been the subject matter of numerous scientific studies. Scientists the world over have carried out extensive work on its botanical, medicinal, industrial and agricultural usages. Practitioners advise the use of Panchang (five parts) of Neem, i.e. leaves, bark, fruit, flower and root, for various applications. The seed is another extremely useful part, especially for its oil. Extracts of various parts of Neem have proven medicinal properties - anthelmintic, antifungal, antidiabetic, antibacterial, antiviral, antifertility, etc. Use of neem as an insecticide and pesticide is also well documented. There is no gainsaying the fact that its economic and commercial value lies in every single part having a proven utility. [15, 10, 7]

Chemical Constituents of Neem

The earlier Indian chemists concentrated on the bitter principles of neem oil. At first the crystalline bitter compound nimbin was isolated. After the work on nimbin, interest in neem constituents became dormant except for the isolation of two new compounds, vilasinin and vepenin. With the discovery of the activity of the Neem compound that suppressed feeding in locusts the detailed chemistry of these received a new stimulus. Very exhaustive studies were undertaken, particularly on the known active compound azadirachtin. The most important compound isolated amongst was azadirachtin. Chemical structure of which is given as well.[8, 9, 14]

Part-Wise Utility of Neem Plant[9, 17, 18]

Bark

When peeled it has two different zones; the outer one is dry, scaly, darker in colour, and the inner one is smooth and brown in colour. For medicinal purposes, the inner portion of the bark should be used, preferably when it is fresh. Root bark is considered better, but is now very difficult to get, because of the damage that may be caused to the tree during collection. The outer portion of the bark is rich in tannins and is a stringent, whereas the inner region is rich in secondary metabolites.

Bark exerts a strong antimicrobial and astringent effect due to the presence of phenol compounds and tannins, which have a strong healing effect on the skin. For this reason it is an ingredient of preparations for pimples, piles, wounds, bleeding gums, etc.

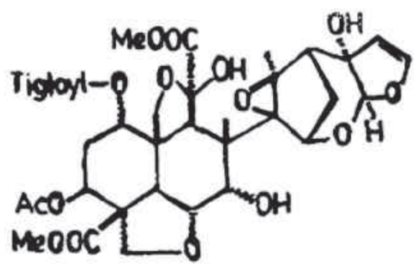
Sap From The Tree

It is said that after the tree reaches a hundred years of age, on a day which cannot be predicted, it begins to exudate nectar or sap from the crevices of the bark. The sap is thick, sweet in taste and fetid in smell. Great virtues are ascribed to this sap and it is said to be a panacea, particularly for leprotic ulcers and skin diseases of various etiology, particularly those which, as per the Ayurvedic concept, are associated with heat in the body.

Wood

A pestle and mortar made from neem wood is preferred for pounding herbs. The wood is rubbed on a wet stone to form a paste. This paste is used for dressing wounds.

Leaves



Azadirachtin

Leaves in the form of an infusion, a decoction by grinding with black pepper were also used. These preparations were often prescribed for skin diseases, inflammation etc. and recently for diabetes. To make the surroundings of the patient aseptic and humid, the head was placed on a pillow made from neem leaves and small branches were hung all around and on the windows. In serious cases, instead of a decoction, leaf juice was prescribed and the whole body was smeared with a paste of neem leaves with or without neem oil. For haemorrhoids, a paste of the leaves of neem and Neriummdicum, when applied, caused the shrinkage of inflamed tissues. For ulcers, neem paste acted the same way. Neem was also used for snake bites, particularly the bite of a Russell viper. It is said to destroy venom.

In the Siddha system (the traditional system practiced in some parts of south India), dried and cured neem leaves are used. The curing is said to make leaves more effective, more palatable and less toxic. These dry leaves are called Vaipilla, and a well-known Siddha medicated oil preparation is Vaipillatailam.

Scope of Neem Application in Textiles[3, 4, 5, 6, 7, 9, 16, 19]

Antibacterial

Neem preparations have been used as a disinfectant since ancient times. The leaf and bark extract when isolated were found to possess antibacterial and antimicrobial activity in an aqueous extract. This has already been researched by many scholars and successful outcomes have been achieved in this area.

Antifungal

In the case of infectious diseases, it is a common practice among some people to use neem with other ingredients as a fumigant. Some people hang leaves around the patients. The curative effect may probably be due to essential oils. An account of raw materials from neem, which can be used against fungi pathogenic to man. The bark and leaf extracts inhibited spore formation and were toxic against EpidermopytonflocossumMicrosporumcanis, and Trichophytonmentagrophytes. Petroleum ether extract showed some activity, which may be due to quercetin-a flavonoid. It can be concluded that neem extract exerted varying degrees of fungal toxicity which may be due to volatile sulphurous compounds or the limonoidgedunin.

Antiinflammatory And Antipyretic

In Ayurveda, Nimbadi Kashyam (a decoction of neem) is prescribed for various inflammatory conditions. Other neem preparations are also used as a poultice for external application in gout, rheumatism, arthritic pains, etc. An anti-inflammatory (rat paw oedema) and fairly good antipyretic effect with 75 percent methanol leaf and bark extract in rabbits was observed. An antipyretic effect is obtained from various fractions of 90 percent ethanol leaf and twig extract.

Analgesic Property

The ether-soluble fraction of ethanol extract of leaves gives a good analgesic activity in pain. In the traditional Indian ways of treating strains in joints of human beings neem leaves slightly warmed in water were wrapped around the joint with cotton bandage over it and showed successful analgesic characteristics this could be developed into a health care finish gauge or bandage and easily put to use still there are problems to retain this effect in bandages with shelf life long enough for their consumption.

Antiprotozoal

Neem has been tried against the malarial parasite and Trypanosoma. Neem preparations, particularly bark, have been esteemed for malaria for a very long time and it was concluded that it may be due to immune modulator activity in bark and an antipyretic effect in other parts of the tree. This property could be exploited for special functional clothing for patients suffering from malaria or as wide scale usage in clothing finishes in areas with high complaints of malarial infections.

Use in Skin Diseases

On the basis of the earlier studies, Nadkarni (1954) gave an account of various neem preparations used for skin diseases. Its major use was for external application in tetanus, leprosy, urtica, eczema, eryspelas, scrofula, ringworm, scabies, etc. but intramuscular administration was more effective.

An extract of dry leaves prepared with 70 percent alcohol was dissolved in propylene glycol. This preparation was applied in chronic skin diseases such as eczema, both acute weeping and acute chronic, ringworm and scabies. It can be concluded that the immune-stimulating property of neem may possibly be the reason for the recovery of patients with skin diseases. This extract could be modified with little research for developing wipes and padding cloths for specific skin disorders that herbal based rather than the popular allopathic gauges and ointments which have side effects as well on high dosage or inaccurate usage.

Wound-Healing (Muscle Regeneration) Property

A poly herbal cream containing neem bark was tried on burning wound sepsis, bacteria and fungi. It was found to have a wound-healing effect of neem. Neem oil is found to be without any side effects on the liver and kidney. It was non-irritating to skin and safe for external use. It showed very low toxicity when given orally, with no histo-pathological changes.

Repellent Characteristics

In India, for repelling insects or for so-called purification of air, premises are often fumigated with a mixture of neem leaves. It is observed that with smoke from dry leaves of neem, the landing and bit ingrates of mosquitoes were reduced considerably.

Conclusion

This resurgence and research has enormous economic and commercial implications. However, at the same time the public at large and also scientists are conscious of the fact that if indiscriminately commercially exploited, this plant wealth may not last long. This has given rise to a paradoxical situation where, on the one hand, the public wants 'green' products, be it for medicinal use, personal hygiene or for its palate, but on the other, dwindling resources make us wary of environmental denudation. A balance has to be struck between demand and supply and in our view it can be best taken care of by sustained and structured 'social forestry' programs with an emphasis on planting those species which are proven sources of eco-friendly applications.

If we dwell on this further, we find that this attitudinal change in the learned and lay public towards products originating from plant sources is basically because of a belief that 'green' products have distinct advantages over 'chemical' products. At this juncture, the importance of a plant like Neem comes to the fore due to its wide multifunctional characteristics and applications.

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