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Physico Chemical Properties of Regenerated Fibres - Bamboo and Tencel

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ABSTRACT

Textile industry is a major pollutant as it has a higher level of dependence on pesticides and chemical fertilizers. As consumer demands for a better standard of living are increasing day by day, scarcity of resources acts as barrier for an improvised and user friendly environment. Thus there is a need to introduce new regenerated fibres namely bamboo and tencel which inherently possess good absorbent behaviour and antimicrobial property which are user and environment friendly. In the present study an attempt has been made to study the physical and chemical behaviour of bamboo and tencel fibres and their behaviour when subjected to chemicals. Bamboo and tencel yarns were procured from Coimbatore. Being regenerated in nature fibres were obtained by manually untwisting the yarns and obtained fibres were subjected to analysis of chemical composition, effect of solubility percentage on subjecting bamboo and tencel fibres using different chemical reagents and the microstructure was analysed using the projection microscope. Results revealed that, bamboo fibres depicted striations in its longitudinal view and more serrated edges in cross sectional view while tencel possessed higher striations with smoothened edges making the fibre more lustrous and soft to handle. While being cellulosic in nature both the fibres were highly susceptible to both the test acids while both the fibres were completely insoluble in solvents and in case of alkalies little amount of fibres tend to dissolve in test alkalies. Whereas, both the fibres attained higher cellulose and hemicellulose content adding strength to the cell wall hence making the fibre stronger.

Keywords: *Bamboo, Tencel, Regenerated fibres*

INTRODUCTION

Natural fibres are the heart of eco-fashion movement which seeks to create sustainable garments essential at different stage of life cycle. The use of natural fibres *viz.*, cotton, silk, jute, bamboo and tencel are on rise and are being explored towards a broadened world of fashion. Nowadays environmental issues are becoming the major factors during the selection of consumer goods. Thus utilization of natural fibres can reduce the environmental hazards thus sustaining the life span of the fibres, making it worth using. Natural fibres being biodegradable are nowadays considered as solemn option to synthetic fibres for use in various fields.

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Bamboo and tencel are one of the regenerated fibres wherein the former is extracted using wet spinning technique with bamboo leaves while later from wood pulp. Bamboo fibre resembles cotton in unspun form which has a puffball of light airy fibres. Bamboo fibres possess good amount of breathability which is due to the presence of micro gaps and micro holes in its cross-sectional view facilitating better ventilation and absorption. On the other hand, tencel fibre has a high crysatllinity along the axis of fibre length. Tencel imparts good strength when in wet condition, easy processing of yarn with varied counts and fabric production. Due to its good amount of absorbent nature it is easy to dye to deeper shades of vibrant colours (Borbley, 2008).

Physical and chemical properties of the fibre explain the visual appearance and its tendency to withstand when treated against different chemicals. Hence in the present study an attempt has been made to study the physico chemical properties of regenerated fibres *viz.*, bamboo and tencel.

MATERIALS AND METHODS

The study was conducted during the period 2016-2018 in Department of Textile and Apparel Designing, College of Community Science, UAS Dharwad. Bamboo and tencel yarns of 20s and 30s were procured from Pallava textiles, cotton mill, Mangarangam palayam, Tamil Nadu. The methodology was divided into three sections which are discussed below.

a. Microstructure

The microscopic appearance of the fibre is an important criterion that helps to know the basic structure of the fibre both longitudinal and cross sectional. This microstcture helps in identifying and explaining about the behavior and properties of the fibre. As bamboo and tencel are regenerated cellulose, fibres were obtained by untwisting the yarns manually and were captured at 10 X magnifications in projection microscope at AICRP-CT, UAS Dharwad.

b. Chemical composition

Bamboo and tencel fibres were tested for cellulose (%), hemicelluloses (%), lignin (%), ash (%) and fat content (%) at Biochem research and testing labrorartry, Dharwad.

Cellulose

Cellulose, a major structural polysaccharide in plants, is the most abundant organic compound in nature and is composed of glucose units joined together in the form of the repeating units of the disaccharide cellobiose with numerous cross linkages. It is also a major component in many of the farms wastes (Goering & Vansoest, 1995).

Hemi-cellulose

Hemicelluloses are non-cellulosic, non-pectic cell wall polysaccharides. They are regarded as being composed of xylans, mannans, galactans and arabinogalactans. Hemicelluloses are categorized under 'unavailable carbohydrates' since they are not split by the digestive enzymes of the human system (Goering & Vansoest, 1995).

Lignin

Lignins are phenolic polymers present in the cell walls of plants which are responsible together with cellulose, for the stiffness and rigidity of plant stems. Lignins are especially associated with woody plants, since upto (30 %) of the organic matter of trees consists of lignin. Lignin acts as a physical barrier against invading pathogens (Goering & Vansoest, 1995)

c. Solubility of bamboo and tencel fibre in acids, alkalies and solvents

It gives an indication of the extent to which the polymers of fibre may react with common degrading agents such as acids, alkalies, solvents, laundering agents, atmospheric pollution *etc*. (Vilensky, 1987). AATCC Test method 20-1990 was followed for analysing the solubility of bamboo and tencel fibre.

- Acids: Sulphuric acid (H_2SO_4) and hydrochloric acid (HCl) [25, 50 and 100 %]
- Alkalies: Sodium hydroxide (NaOH) and sodium carbonate (Na_2CO_3)
- [10, 20 and 30 %]
- Solvents: Methanol (CH_4O), and acetone $(CH_3)_2CO$ [100 %]

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Procedure

Chemicals of required concentrations were prepared. 10ml of the test solution/chemical was added to 1 g of the fibre sample in a 50 ml beaker. Fibre samples were stirred occasionally for 30 minutes. The treated fibre samples were removed, washed, squeezed and dried completely. The weight of the remainants was measured and the solubility percentage was calculated using the formula,

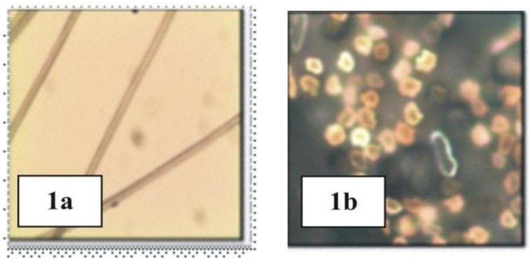
$$\text{Solubility (\%)} = \frac{A - B}{A} \times 100$$

Where,
A = Initial weight of the fibre
B = Final weight of the fibre

RESULTS AND DISCUSSIONS

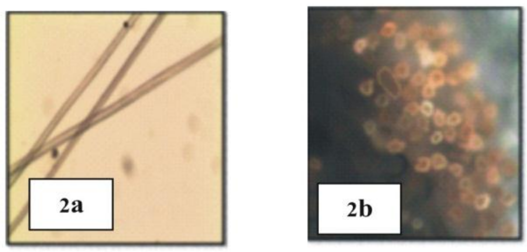
It is observed from fig 1a that, bamboo possessed a long cylindrical view with fewer striations which may be due to presence of less amount of cellulose (35.28%), imparting less strength to the cell wall of bamboo when compared to tencel. On the contrary it was seen in fig 2a tencel possessed higher striations (37.11%) as higher amount of cellulose makes the cell wall strong further making the fibre strong.

Whereas, from plate 1b and 2b it was seen that, cross sectional view of bamboo fibre had distinct serrated edges which may be attributed due to the higher amount of hairiness seen during fibre production stage. On the other hand tencel fibre had fewer amount of serrated edges which may be attributed because of fineness and lustrous nature of tencel fibre. Similar results were observed in study on investigation of regenerated bamboo fibre and yarn characterstics (Erdumulu & Ozipek, 2008).



1a. Longitudinal view of Bamboo fibre

1b. Cross sectional view of Bamboo fibre



2a. Longitudinal view of Tencel fibre

2b. Cross sectional view of Tencel fibre

Cellulose is a very important polysaccharide, which is abundantly available organic compound on earth making the outer cell wall tougher and stronger further adding strength. Hence Table 1 reveals the chemical composition of bamboo and tencel fibres and it was found that cellulose content was found to be higher in tencel fibre (37.11 %) compared to bamboo fibre (35.28 %) thus making tencel fibre stronger than bamboo fibre.

On the other hand lignin is very essential in the formation of cell wall especially in wood and bark materials as they add rigidity thus making it stiffer. Thus, bamboo fibre possessed higher lignin and ash content. While, fats (waxes) have a very little role in textiles as they belong to group of biological substances called lipids that do not dissolve in water. Therefore, fats were found to be present in very less quantity in both bamboo and tencel fibres.

Table 1: Chemical composition of bamboo and tencel fibres

Sl. No.	Chemical compositions (%)	Bamboo	Tencel
1.	Cellulose	35.28	37.11
2.	Hemicelluloses	20.66	21.23
3.	Lignin	18.35	17.95
4.	Ash	1.32	1.19
5.	Fat (Waxes)	0.05	0.06

It is indicated from Table 2 that, bamboo and tencel fibres were highly susceptible to sulphuric acid because bamboo and tencel fibres being cellulosic in nature gets deteriorated when subjected to higher concentration of acids. Besides, because of the less acidic nature of hydrochloric acid compared to sulphuric acid, loss of moisture content was observed in both the fibres resulting in weight loss but the fibres remained insoluble.

Further it is observed from Table 2 that the fibre mass of both alkalies tend to detoriate the single fibre strand and result in weight loss but bamboo and tencel are partially soluble in alkalies .This may be due to bulk doesn't allow fibres to completely get dissolved when subjected to alkalies. On the contrary solvents did not have any adverse effect on fibre structure, thus only 6 per cent of fibres were soluble in 100 per cent concentration of methanol and acetone.

Table 2: Effect of chemical reagents on solubility of bamboo and tencel fibres

Sl. No.	Fibres	Acids						Alkalies						Solvents	
		Sulphuric Acid (%) (H_2SO_4)			Hydrochloric Acid (%) (HCl)			Sodium Hydroxide (%) (NaOH)			Sodium Carbonate (%) (Na_2CO_3)			Methanol (%) (CH_4O)	Acetone (%) (C_3H_6O)
		25	50	100	25	50	100	10	20	30	10	20	30	100	100
1.	Bamboo	2.00	100	100	8.00	100	100	50.00	30.00	10.00	9.00	12.00	14.00	6.00	6.00
2.	Tencel	2.00	100	100	10.00	100	100	30.00	20.00	20.00	14.00	19.00	12.00	6.00	6.00

CONCLUSION

The demands of consumers are increasing as well as the requirements regarding new textile materials with new or improved properties which are essential for better comfort or industrial use. The versatility of bamboo fibre is an excellent substitute of cotton for manufacturing healthcare and hygiene textiles. While the excellent absorbent nature of tencel fibre makes a fibre stronger which acts as a good substitute for cotton. Due to the smoothened cross section view tencel tends to possess good luster which further enhances the functional properties of union fabrics woven with tencel yarns.

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