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Effect of Alkaline Treatment on Physical properties of *Hibiscus syriacus* fiber

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ABSTRACT
The alkaline treatment is a common method used to remove the non-cellulosic substances from surface of the fiber. Therefore, in the present study Hibiscus syriacus fibers were treated with various concentrations (5g/l, 10g/l, 15g/l and 20g/l) of sodium carbonate. After treatment, the physical properties i.e. tenacity, fineness and elongation of treated and untreated fibers were evaluated. It was found that as the concentration of sodium carbonate increased, more non-cellulosic materials such as lignin, fat, waxes and other impurities were removed from the surface of the fibers. As a result, the treated fibers exhibited less strength and more elongation as compared to untreated Hibiscus syriacus fibers. Fineness of the fibers was also improved.
Key words: *Alkaline, Hibiscus syriacus, Non-cellulosic, Physical properties, Sodium carbonate*

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INTRODUCTION

There is an increasing environmental awareness throughout the world and therefore, the natural plants, their fibers and products attract the researchers as well as consumers. They have various applications in textiles, composites, handicrafts, packaging, etc [1, 2]. Many natural plant fibers such as hemp, flax, jute, etc. are already being using in various fields because of their advantage over the synthetic fibers. Some of their advantages are as they are abundantly available, low cost, light weight, non-toxic, recyclable and biodegradable as compared to synthetic fibers (3, 4, 5). Plant fibers are extracted from different parts of the plant namely bast fibers are extracted from the stalk of the plant such as hemp, jute, etc., seed fibers like cotton and kapok and leaf fibers such as Sisal and pineapple and grass fibers i.e. bamboo and napier (6). *Hibiscus syriacus* plant has a great potential to extract the fibers from the stem of the plant and still it did not much received attention from researchers till date (Fig. 1). It is a species of flowering plant in the family Malvaceae and a national flower of Korea (7) and commonly known as Rose of Sharon in North America and Rose Mallow in United Kingdom. It is hardy, upright deciduous shrub and a multipurpose plant used for medicines for curing various diseases (8). *Hibiscus syriacus* fibers can be extracted from various methods such as chemical, microbial, dew, water and enzymatic retting. Out of these, water retting method is the most commonly used method. The water retting method is wet process method in which the fibrous bundles which are present in the outer layers of the stalk are separated from woody portion by breaking down the complex material such as pectins, lignin and other gummy material (9, 10).

Fig. 1 *Hibiscus syriacus* Plant

The water retting process depends on various factors such as water temperature, locality, season, weather conditions, thickness of stalks and quantity of straw in relation to volume of water (11). Natural fibers having some natural impurities i.e. lignin, fat and waxes as well as other impurities such as dust and mud which are added during water retting process, might affecting the properties of natural fiber. Therefore it is necessary to remove these impurities from the fiber surface and the process of removing the impurities from the fibers is known as scouring. Fibers have their own scouring procedure and this varies from fiber to fiber (12, 13).

Therefore, keeping in view of natural products, the *Hibiscus syriacus* fibers were extracted from water retting and further treated with various concentration of sodium carbonate. The objective of the research was to study the effect of various concentration of sodium carbonate on the physical properties including tenacity, elongation and fineness of the *Hibiscus syriacus* fibers.

MATERIALS AND METHODS

Extraction of *Hibiscus syriacus* fibers

Experiments were carried out to extract the fiber from *Hibiscus syriacus* plant using water retting method. The stems of the *Hibiscus syriacus* plant were procured from the Garden Section, G.B. Pant University of Agricultural and Technology, Pantnagar. The cut stems were tied separately in small bundles for water retting. The stagnant water retting was done by the method given by (14). The water retting was carried out for 12 days in the month of April-May. The fiber from the *Hibiscus syriacus* stems were drawn by hands while washing and dried in air. Thereafter, the retted fibers were further treated with sodium carbonated.

Alkaline treatment

The alkaline treatment is a common method used to remove the non-cellulosic substances from the surface of the fiber (15). The retted *Hibiscus* fibers were treated with slightly modification in the method that was given by (16) using various concentrations of solution of sodium carbonate viz. 5 g/l, 10 g/l, 15 g/l and 20 g/l, in separate beakers and in the presence of detergent (lissapol D, 2g/l). The material to liquor ratio taken was 1:50 and heated for 60 minutes at 80°C. After scouring, the treated fibers were washed in hot water and then with cold water. Fiber samples were neutralized with 2ml/l solution of acetic acid for 10 minutes and washed with running water. Dried in air. Combing of the untreated and treated fibers were done manually by combing brush and samples were evaluated for their physical properties i.e. tenacity, fineness and elongation.

Testing of physical properties

The tenacity, elongation and fineness of the untreated and treated fiber were determined by using Fafegraph M in joint operation with vibromat M. This is a semi automatic micro processor with controlled tensile strength tester based on the principle of constant rate of extension.

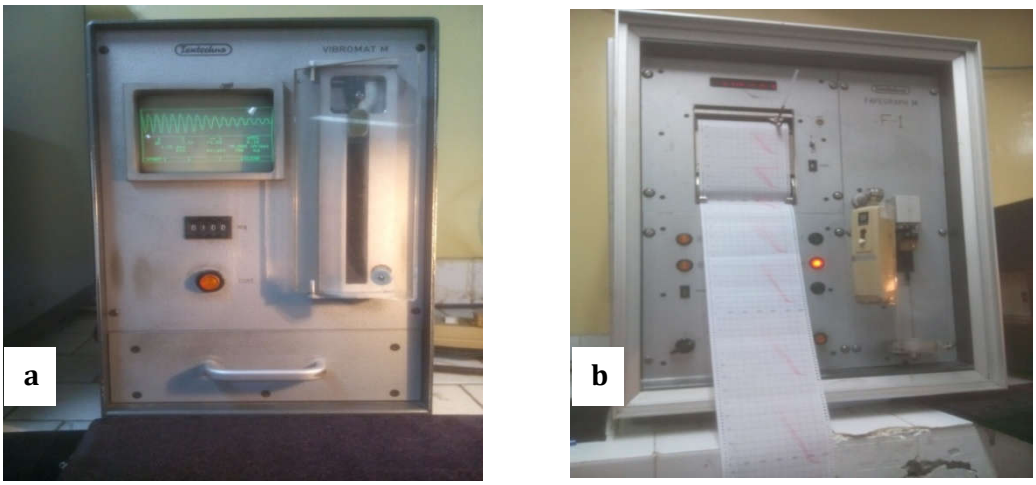

Fig. 2: (a) Vibromat M (Fiber tenacity and elongation tester) (b) Fafegraph M (Fiber fineness tester)

Statistical analysis

The mean value of the collected data was presented in Table 1 and one way analysis of variance was used to analyse the significant difference among each physical properties of the extracted fibers by using SPSS at 5% level of significant.

RESULT AND DISCUSSION

In this paper, physical properties including tenacity, elongation and fineness of the untreated and treated fibers were tested to study the effect of concentration of sodium carbonate. The untreated fiber exhibited 1.6% elongation, 2.98g/denier tenacity and 16.71denier fineness. The results pertaining to the physical properties of the alkaline treated fibers are presented in Table 1 and samples are shown in Fig 3.

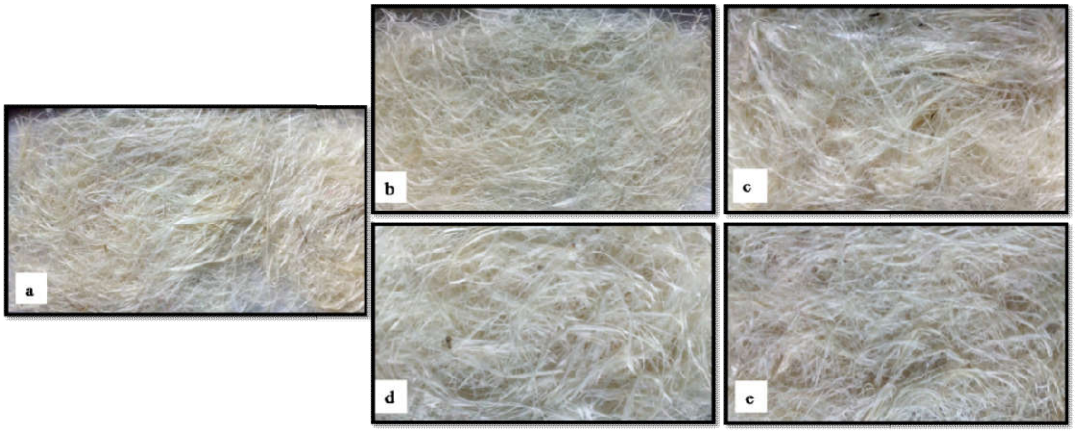

Fig. 3. - Fiber samples: (a) Control or retted fiber, (b) 5g/l Na_2CO_3 treated sample, (c) 10g/l Na_2CO_3 treated sample, (d) 15g/l Na_2CO_3 treated sample and (e) 20g/l Na_2CO_3 treated sample

Effect of various concentration of Na_2CO_3 on tenacity and elongation of the *Hibiscus syriacus* fiber

It is clearly shown in Table 1 that as the concentration of sodium carbonate increased from 5g/l to 20g/l, strength of the treated fibers decreased and elongation progressively increased as compared to untreated fibers. This may be due to the fact that, as the concentration of sodium carbonate was increased, more impurities might have been removed from the fiber surface. During alkaline treatment, Na_2CO_3 solutions easily penetrate into fibers and efficiently reduce non-cellulosic substances and impurities (16). The above results are in accordance with the finding of (17, 18). They reported that the alkali treatment removes non-cellulosic impurities, wax, lignin as well as hemicellulose of fiber.

Table 1: Physical properties of untreated and treated *Hibiscus syriacus* fibers

Na_2CO_3 Concentration		Elongation (%) (Mean± S.E.)	Tenacity (g/d) (Mean± S.E.)	Fineness (denier) (Mean± S.E.)
C1	**5g/l**	1.82^{a}±0.95	2.73^{b}±0.11	13.56^{b}±0.16
C2	**10g/l**	1.86^{a}±0.12	2.47^{ab}±0.14	12.10^{a}±0.27
C3	**15g/l**	1.93^{a}±0.11	2.25^{a}±0.11	11.82^{a}±0.37
C4	**20g/l**	1.99^{a}±0.08	2.17^{a}±0.14	11.48^{a}±0.29
F value		0.508	3.866	10.537

Data followed by same letter within column are not statistically different according to Duncun post hoc test (p>0.05) at 5 % level of significance

Effect of various concentration of Na_2CO_3 on fineness of the *Hibiscus syriacus* fiber

It is evident from the Table 1 that fineness of the fibers also improved as the concentration of sodium carbonate was increased. The fibers treated with 20g/l concentration of sodium carbonate had maximum fineness having 11.48±0.29 denier followed by the fibers treated with 15g/l (11.82±0.37 denier), 10g/l (12.10±0.27 denier) and 5g/l (13.56±0.16 denier) concentration of sodium carbonate. This may be due to the reason that, increase in concentration of sodium carbonate helped in removal of impurities from the fibers which resulted in separation of the individual fiber from the fiber bundles and this might have made them finer. Alkali is enough to remove the non-cellulosic substance such as lignin, fat and waxes etc from the fibers surface and provide clean fine fiber (19, 20).

Table 2: One way analysis of variance

ANOVA (Elongation)					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.286	3	.095	.508	.678
Within Groups	12.768	68	.188		
Total	13.054	71			
ANOVA (Tenacity)					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3.359	3	1.120	3.866	.013
Within Groups	19.694	68	.290		
Total	23.053	71			
ANOVA (Fineness)					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	45.380	3	15.127	10.537	.000
Within Groups	97.621	68	1.436		
Total	143.001	71			

Table 3: Duncan post hoc test (p>0.05)

Duncan (Elongation)			**Duncan (Tenacity)**				**Duncan (Fineness)**			
S.No.	N	Subset for alpha = 0.05	S.No.	N	Subset for alpha = 0.05		S.No.	N	Subset for alpha = 0.05	
		1			1	2			1	2
C1	18	1.823	C4	18	2.173		C4	18	11.48	
C2	18	1.856	C3	18	2.246		C3	18	11.819	
C3	18	1.927	C2	18	2.465	2.465	C2	18	12.104	
C4	18	1.986	C1	18		2.728	C1	18		13.562
Sig.		.314	Sig.		.130	.147	Sign.		0.145	1.000

Note: C= Concentration of sodium carbonate

Statistically, F-value (Table 2) computed from one way analysis of variance indicated that the significant difference was observed in case of tenacity and fineness of the fibers treated with different concentrations of sodium carbonate. Further Duncun post hoc test (Table 3) revealed that:

In case of tenacity, significant difference was observed when fibers treated with 5g/l and 15g/l or 20g/l concentration of sodium carbonate. Non-significant difference was observed

when fibers treated with 5g/l and 10g/l concentration of sodium carbonate. Again, non-significant difference was also observed when fibers treated with 10g/l, 15g/l and 20g/l concentration of sodium carbonate.

In case of fineness, significance difference was observed when fibers treated with 5g/l and 10g/l, 15g/l or 20g/l concentration of sodium carbonate. Non-significant difference was found when the fibers were treated with 10g/l, 15g/l and 20g/l concentration of sodium carbonate.

However, both one way ANOVA (p-value) and duncun post hoc test revealed that non-significant difference was found in case of elongation when fibers treated with different concentrations of sodium carbonate. Therefore it can be concluded that, lower concentration of sodium carbonated can be preferred for scouring of *Hibiscus syriacus* fibers because at lower concentration alkaline solution do not significantly affect the tenacity of the fibers.

CONCLUSION

It can be concluded that after processing the fibers, impurities are removed and due to this, fineness and elongation of the fiber improves. So *Hibiscus syriacus* fibers became finer and thus can have various uses in textile products such as table mats, magazine holder, chair cover, hand bags etc. Nonwoven fabric can also be develop either through needle punching method or thermal bonding method.

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