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Aaditaa
Department of Clothing and Textiles, College of Home Science, G.B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand, India

Shahnaz Jahan
Department of Clothing and Textiles, College of Home Science, G.B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand, India

Correspondence
Aaditaa
Department of Clothing and Textiles, College of Home Science, G.B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand, India

Identification characteristics of *Ficus glomerata* Fibres

Aaditaa and Shahnaz Jahan

Abstract
Fibre identification is a process by which fibres are treated with different chemical reagents to observe the characteristics like staining, colour and solubility. Fabrics are made up of particular type of fibre, so the fibre identification help textile producers in many ways such as identifying type of fibres, its care instructions and labeling of material. In this study, *Ficus glomerata* Fibres are treated with different chemical reagents to observe its solubility, appearance and change in colour. The microscopic examination has also been done by using Scanning Electronic Microscope (SEM). The results of study revealed that *Ficus glomerata* Fibres shows a complete disintegration in some reagents while in some reagents it disintegrates partially and gives specific colour staining. In microscopic examination it was observed that fibres were cylindrical in shape with rough edges.

Keywords: colour, fibre identification, *Ficus glomerata* fibres, SEM, solubility

Introduction
Today, the textile industries are changing with the passage of time by applying new advanced modern techniques which not only includes the production process and finishing technologies but also the introduction of new innovative unconventional fibers over the conventional fibers because the world market now has gone global and have a very high demand of fibers and fabrics. The unconventional fibers have distinct structure and properties which is well accepted by the consumers and also helps in meeting out the demand of the global market.
Existing unconventional fibres which are used are hemp, kenaf, bhimal, sunn, jute etc. The new source of unconventional fibre is '*Ficus glomerata*' fibres which is extracted from the stems of *Ficus glomerata* plant and is commonly known as 'gular'. The unconventional fibres are now widely used for making products along with conventional fibres.
There are wide varieties of fibres available, the identification of these fibres is difficult to be done by eye and hand as certain. The textile producers are utilizing new technologies for fabric construction in order to diversify their products and offering wide applications in different areas. These new technologies are making fibre identification more difficult.
There are various fibre identification techniques which are technical and non technical used by textile technologists. The non technical test i.e. feeling tests and burning test are easy to perform and provide quick identification under certain circumstances. Burning test is more reliable then feeling test. Limitations of these tests are that they are not reliable and are not able to confirm the type of fibre of a group. These tests only give identification of the group to which fibre belongs but not able to identify the type of fibre.
The technical test consists of microscopic test and chemical test. The microscopic test is done using microscope with a magnification of minimum 100 powers which is able to give the internal structure of the fibre so that it can easily be distinguished from other fibres (Khan *et al*., 2017) [4]. The chemical test consists of stain test and solvent test in which chemicals and solvents are used for identifying fibres by evaluating the change in colour of fibre and solubility of fibres in chemicals.
Therefore, this research deals with the identification characteristics of *Ficus glomerata* fibres by using technical tests i.e. chemical and microscopic test.

Materials and Methods
Fibres were extracted from the stems of *Ficus glomerata* plant which is available abundantly in the forests of Uttarakhand. After the extraction of fibres scouring was done which was carried out by using caustic soda boil method given by Chattopadhyay (2002) [1].

In this process fibres were treated with alkaline solution of sodium hydroxide of concentration 2 per cent in combination with a detergent at a temperature of 100^0C, keeping the material to liquor ratio (MLR) as 1:50. After scouring the fibres were neutralized with acetic acid (2ml/litre) and washed thoroughly with cold water. The scoured fibres were dried in shade.

Then the fibre identification was done through technical test including chemical and microscopic tests on both untreated and treated fibres in order to identify the characteristics of *Ficus glomerata* fibres in both treated and untreated forms.

In chemical test, the fibres were treated with various acidic, alkaline chemicals and solvents, then the effects of these chemicals were observed on the untreated and treated fibres. Then both the change in colour, solubility and appearance in the fibre as well as solution were observed at room and boiling temperature.

The procedure given by Hollen and Saddler (1968) [3] was carried out to show the effect of various chemical reagents on the treated and untreated fibres. In this test, the fibre samples were treated with acids, alkalis and various other solvents like acetone, benzene etc. Effect of both concentrated and dilute, acid and alkalis were studied. The fibre samples were taken in the clean test tube and after that the chemical was poured in the test tube in such a way so that the specimen was completely soaked in the chemical. The stirring was done for 5 minutes an observations were taken at 29^0C (room temperature) as well as at 100^0C (boiling temperature). The change in colour and solubility of the fibre samples in the chemical reagents were recorded at both room and boiling temperature.

In microscopic test of fibre identification, Scanning Electron Microscope (SEM) was used to identify the structure and microscopic appearance of treated and untreated *Ficus glomerata* fibres. Microscopic appearance include longitudinal and cross sectional view of the fibres.

The SEM has attached digital camera with a range of 10X to 3,000,00X zoom. To study the longitudinal view of the fibres, slides were prepared by mounting the specimen (fibre) on a metal stub and thereafter, the specimen was coated with gold (24 carat). The prepared slide was magnified in 1000X zoom and the photograph was clicked.

The sieve was used for viewing cross-sectional shape of the fibres. The sieve had several holes spaced at regular intervals. The fine roving of the specimen (Combed fibres) was inserted in one of the hole of the sieve. The roving was cut across the diameter of the specimen with the help of sharp blade on the front and back surface of the sieve. The sieve was put over stub and coated with gold. The hole on the sieve with the specimen was magnified in 2500X under microscope. The photograph was taken at the point where the cross section shape was observed clearly.

Result and Discussion

The effect of chemical reagents on untreated and treated *Ficus glomerata* fibres are as follows.

Nitric acid (HNO_3)

It is evident from the results shown in Table 1 that on treatment with dilute nitric acid both untreated and treated *Ficus glomerata* fibres turns light brown in colour and shows partial disintegration at boiling temperature.

In case of concentrated nitric acid, fibres turn dark red brown in colour at room temperature whereas at boiling temperature fibres dissolved completely and solution becomes dark red brown in colour. This is might be due to fact that nitric acid is strong mineral acid with high corrosiveness, which hydrolyzed the glycosidic linkages of the cellulose molecules and resulting in full dissolution of fibres. The above stated fact is in accordance with the study of Sadov *et al* (1973). They stated that cellulose molecules are highly susceptible to acids and glycosidic linkages of cellulose molecules are rapidly hydrolysed on treatment with strong acids.

According to Cook (2005) [2], when the bast fibres are treated with weak acids which are dilute in nature they are less affected but they are strongly affected when treated with hot dilute and concentrated acids.

Sulphuric acid (H_2SO_4)

It can be concluded from Table 1 that untreated and treated *Ficus glomerata* fibres were not affected by the dilute sulphuric acid at room temperature but partially disintegrate when put at boiling temperature. Both untreated and treated fibres acquired black colour when treated with dilute sulphuric acid.

In case of concentrated sulphuric acid both untreated and treated fibres were completely disintegrates at room temperature as well as at boiling temperature. The solution of both the fibres turns into black colour. This may be due to the fact that, sulphuric acid is highly corrosive mineral acid which hydrolyse the glycosidic linkages of cellulose molecules of *Ficus glomerata* fibres.

Hydrochloric acid (HCl)

When both untreated and treated *Ficus glomerata* fibres were treated with dilute hydrochloric acid, the fibres showed no effect at room temperature as well as boiling temperature, as indicated in Table 1. But on treating fibres (treated and untreated) with concentrated hydrochloric acid, both the fibres were insoluble at room temperature and turned light yellow in colour on boiling. The above results are in accordance with the statement of Cook (2005) [2], He also reported that bast fibres are insoluble in concentrated hydrochloric acid at low temperature.

Formic acid (HCOOH)

Both untreated and treated *Ficus glomerata* fibres showed no effect at room temperature whereas at boiling temperature both the fibre samples acquired light brown colour. This may be due to the reason that, being a simple carboxylic acid the effect of formic acid on *Ficus glomerata* fibres was very mild.

Sodium hydroxide (NaOH)

In case of dilute sodium hydroxide, both untreated and treated *Ficus glomerata* fibres were insoluble and show light yellow colour at room temperature and on boiling fibres turned dark yellow in colour. The results reveal that both untreated and treated *Ficus glomerata* fibres get swelled in concentrated sodium hydroxide and acquired light yellow colour at room temperature. On boiling, the fibres show partial disintegration and turn orange in colour. The result obtained is may be due to fact that at higher concentration of sodium hydroxide interfibillar swelling of fibres might have occurred. In accordance with above justification Kornereich (1966) [5] stated that on treatment with high concentration of sodium hydroxide cellulose fibres tend to swell.

Table 1: Effect of chemical reagents on *Ficus glomerata* fibres.

S. No.	Chemical	Untreated		Treated	
		At room temperature	On boiling	At room temperature	On boiling
1.	Dil. Nitric Acid	Fibres turns light brown red in colour	Fibres turns light brown red with partial disintegration	Fibre turns light brown red in colour	Fibres turns light brown red with partial disintegration
2.	Conc. Nitric Acid	Fibre turns dark brownish red in colour with partial disintegration	Fibres get completely dissolve and solution became dark red in colour	Turns dark brownish red in colour with partial disintegration	Fibres get completely dissolve and solution becomes dark red in colour
3.	Dil. Sulphuric acid (72%)	Color of fibres turns black	Fibre colour turns black with partial disintegration.	Colour of fibres turns black	Fibres turn black in colour with partial disintegration.
4.	Conc. Sulphuric acid (34%)	Fibres dissolved completely and solution turned to dark black	Fibres dissolved completely and solution turned to dark black	Fibres dissolved completely and solution turned to dark black	Fibres dissolved completely and solution turned to dark black
5.	Dil. Hydrochloric acid (34%)	No effect	No effect	No effect	No effect
6.	Conc. Hydrochloric acid (85%)	No effect	No effect	Fibres turns light yellow in colour and insoloulble	Fibres turns light yellow in colour and insoluble
7.	Formic acid	No effect	Fibres become light brown colour	No effect	Fibres become light brown colour
8.	Dil. Sodium hydroxide (34%)	Fibres are insoluble and turns light yellow in colour	Fibres are insoluble and turns dark yellow in colour	Fibres are insoluble and turns light yellow in colour	Fibres are insoluble and turns dark yellow in colour
9.	Conc. Sodium hydroxide (97%)	Fibres get swelled and turned to light yellow in colour	Fibres get swelled, disintegrated partially and turned to orange in colour	Fibres get swelled and turned to yellow in colour	Fibres get swelled disintegrated partially and turned to orange in colour
10.	Phenol	Fibres dissolved completely and red crystals were formed	Fibres dissolved completely and solution turns red	Fibres dissolved completely and red crystals were formed	Dissolved completely and solution turns red
11.	Acetone	Fibres turns red in colour	Fibres turns red in colour	Fibres turns red in colour	Fibres turns red in colour
12.	Benzene	Fibres turns light red in colour	Fibres turns light red in colour	Fibres turns light red in colour	Fibres turns light red in colour

Phenol (C_6H_5OH)

The untreated and treated *Ficus glomerata* fibres when treated with phenol at room temperature form red crystals. But at boiling temperature the *Ficus glomerata* fibres dissolves completely and the solution turns red in colour.

Acetone ($(CH_3)_2CO$) and Benzene (C_6H_6)

The results depicted in Table 1 shows that both untreated and treated *Ficus glomerata* fibres were insoluble in acetone and benzene and they acquired light red colour at room temperature as well as at boiling temperature. It is also reported by Hollen and Saddler (1968) [3] that cellulosic fibres have resistance towards organic solvents.

Microscopic Test

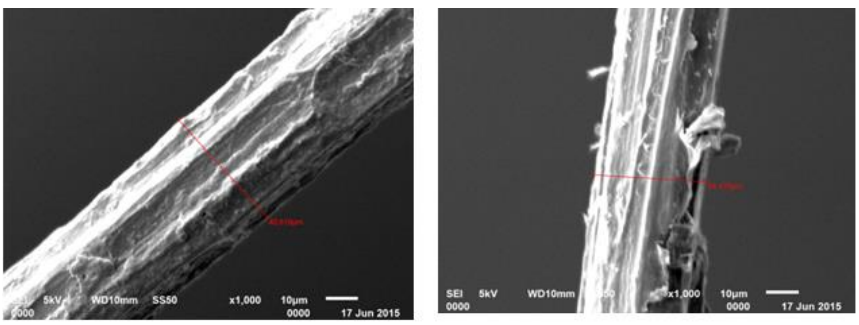
The longitudinal and cross-sectional shapes of the untreated and treated *Ficus glomerata* fibres were observed under scanning electron microscope. The fibres were magnified at 3,000,00 X zoom and the photographs of fibres are shown in Fig.1 and Fig.2.

a) Longitudinal view

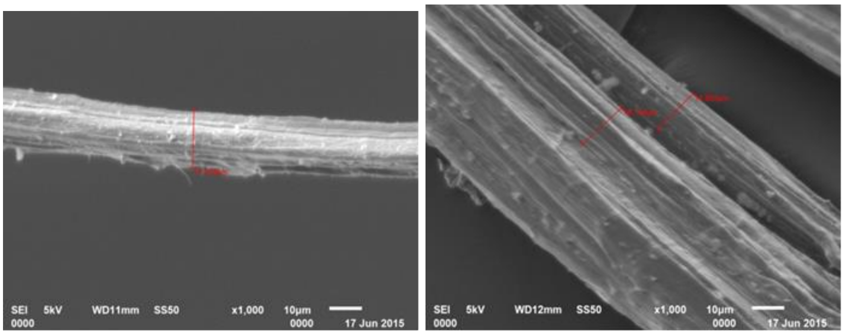
In case of untreated fibres there is no proper separation of fibres because of the presence of lignin content. But in case of treated fibres it was observed that, the fibres are separated properly on treatment with sodium hydroxide which removes the lignin present in the fibres. The Fig.1 shows that fibres were cylindrical in shape having rough edges. Nodes were also observed at few places on the surface of treated fibres.

b) Cross-sectional view

The cross-sectional view of *Ficus glomerata* fibres shown in Fig. 2 depicts that untreated and treated fibres were irregular in shape. It was observed that untreated fibres had serrated edges whereas treated fibres had smooth edges. The diameter of the untreated fibres (53.22µm) was more than the treated fibres (29.75µm), this may be due to the improper separation of untreated fibres from the fibre bundles due to presence of lignin and after treatment with sodium hydroxide the fineness or diameter of the fibre increases because of the removal of lignin content of the fibres. The sodium hydroxide treatment also smoothens the fibre which improves its overall properties such as lustre, fineness etc.

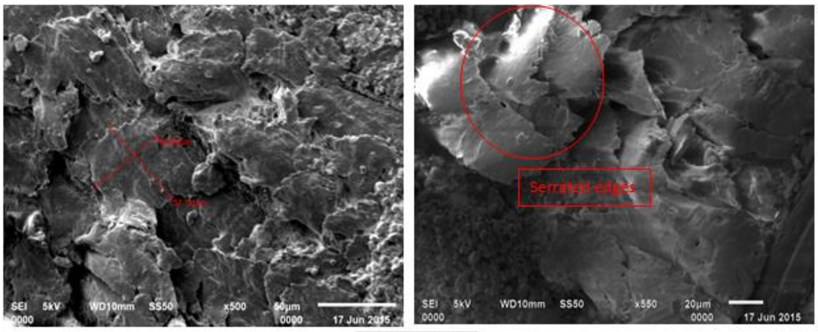


Untreated

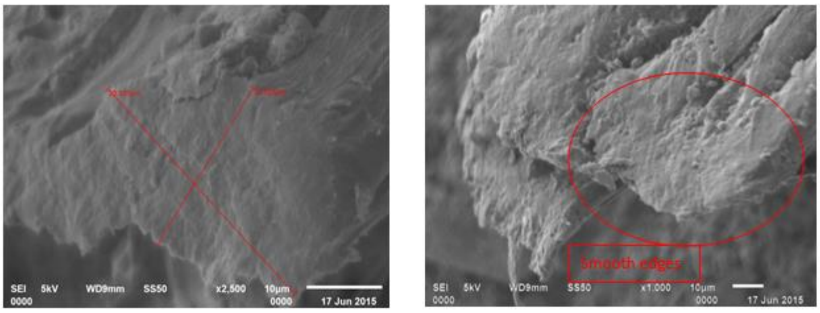


Treated

Fig 1: Microscopic appearance of *Ficus glomerata* Fibres (Longitudinal View)



Untreated



Treated

Fig 2: Microscopic Appearance of *Ficus glomerata* Fibres (Cross-sectional view)

Conclusion

This study highlights the importance of incorporating the identification techniques for fibers in the textile industries with a blend of local and expert knowledge in such a manner so that these identification techniques will provide reliable information regarding the properties of fibers. In this study, we demonstrated different identification techniques that could be helpful in identifying the *Ficus glomerata* fibres on the basis of color of fibre, solutions and the solubility in various chemicals. The identification techniques which are provided in this paper shows a good agreement as in case of chemical based identification and in case of SEM based identification. Hence, this approach shows itself to be well suited for the textile industries that they can apply these techniques in their industries as it not only give fiber identification but also helps in optimizing resource use of fibre and ensure knowledge about the material made from fibres. Therefore, the fibre identification tests provide reliable information about *Ficus glomerata* fibres characteristics and will be helpful for textile producers in knowing the end uses of fibres in various fields.

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