IOSR Journal of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861. Volume 2, Issue 6 (Jan. - Feb. 2013), PP 10-13
www.iosrjournals.org

Studies on Tensile Properties of Some Plant Fibers

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Abstract: *The linear density of the raw and degummed plant fibers such as ginger (zingiber officinale), turmeric (curcuma longa) and java galangal (alpinia galangal) fibers has been determined by the use of a Vibromat M. The stress-elongation curves for the fibers were drawn by using a Tensile Tester with electric strain gauges 'Fefegraph' for each of the specimen fiber; at temperature 250 C and 65% R.H. Various tensile parameters have been calculated from the stress-elongation curve obtained by using the Tensile tester with electric strain gauges 'Fefegraph'; and the linear density by a 'Vibromat M'. It is observed that the tenacity is linearly related with the linear density. From various investigations it has been concluded that all the plant fibers in present investigation are hygroscopic in nature and the hygroscopicity does not change due to irradiation and degumming.*
Key words: *zingiber officinale, curcuma longa, alpinia galangal, vibromat M, fefegraph, hygroscopicity.*

I. Introduction:

Tensile tester is an important device to study the tensile properties of fibers. More information about the fiber properties can be obtained by recording the stretch-elongation diagram. With this aim, the tensile tester with electric strain gauge 'Fefegraph' is used. To determine the linear density another device 'Vibromat M' is used.

The basic principle in 'Vibromat M' is that the capacity of a capacitance-transducer has changed with the change of linear density. It is a very speedy instrument and the measurement of linear density of the fiber specimen is carried out in the single filament form. Fefegraph is a very sensitive instrument and is used to measure the tensile strength of fibers in the form of single filament.

Sample preparation:

Ginger, turmeric and java galangal plants, from various parts of the chosen regions, have been collected. The fibers are extracted from stems of these plants. One part of the raw fibers of these plants were immersed in a mixture of Alcohol and Benzene (ratio 1:1) for six hours. These were then washed with distilled water and dried at room temperature. These are then divided into three parts, two parts of which are boiled with 2% and 6% NaOH solutions separately. These fibers are then again washed with distilled water and dried at room temperature. These four types of fibers were made as bundles. A small bundle of such finely prepared fibers was taken and about 3 cm. long pieces were cut from the bundle.

Experimental arrangement and Measurement:

Single filament of the fiber were carefully separated from this cut pieces. Such a filament was placed vertically between the grip and the horizontal bar of the Vibromat M, and then the window was closed. The filament was taken as straight as possible in order to get rid of errors in their original lengths. To make the fiber straight, a very small weight was suspended from the lower end of the fiber.

After measuring the linear density by Vibromat M, the specimen was transfered to the Fefegraph and was placed in between the two grips of it which were then fixed.The filament was taken as straight as possible in order to get rid of errors in their original length. A force-transducer and strain-transducer are employed to feed the instantaneous force and the corresponding stress-elongation curve is recorded in graphical form with the help of a strip-chart recorder and also the value of breaking load and breaking elongation were recorded from a digital meter.

The application of force on the specimen was carried out by the instrument up to the breakage of the filament. As soon as it breaks, the instrument automatically stops and sets for next operation.

The measurements were repeated for at least 20 times with 20 different filaments for a certain fiber specimen and an average stress-elongation curve has drawn.

From the average value of stress-elongation curve, the different values of breaking load and breaking elongation obtained from Fefegraph and corresponding linear density from Vibromat M; the tensile parameters were calculated.

II. Results and discussion:

The different tensile parameters of raw and degummed fibers such as ginger, turmeric and java galangal (at 25^0C and 65% RH) are shown in tables 1, 2 and 3 respectively.

From the tables it is observed that average tenacity of ginger is highest and that of java galangal is lowest. Further, the tenacity of ginger and java galangal fibers increases due to degumming. In case of turmeric fiber, the tenacity icreases due to alcohol:benzene and 6% NaOH deguming. The decrease of tenacity of some plant fibers after degumming had also been found by Thakur et. al., the change of tenacity may be due to the change of moisture content consisting in the fiber and the change of degree of crystallinity after degumming. When turmeric fiber is degummed by alcohol : benzene and 6% NaOH moisture content increases and allow molecular slippage which causes fiber breakage and lower down the fiber strength. .

Further it is also observed that the tenacity of ginger, turmeric and java galangal fibers degummed by 2% NaOH is more than that degummed by 6% NaOH. This is due to increase of moisture content that may decrease at higher concentration of NaOH.

Table 1 : Tensile paramaters of raw and degummed ginger fibers (25^0C and 65% RH)

Specimen	Av. linear density (denier)	Av. elongation (%)	Av. force (gram)	Av. tenacity (gm/den)	Work of rupture (gm×cm)	Initial modulus (gm/den)	Work factor
Ginger (raw)	14.53	4.77	85.25	5.21	2.54	1.23	0.49
Ginger (d_1)	12.78	6.89	90.11	7.12	3.43	1.04	0.47
Ginger (d_2)	14.12	8.11	94.05	6.19	3.81	0.91	0.45
Ginger (d_3)	16.85	7.91	97.87	5.49	4.01	1.05	0.48

Table 2: Tensile parameters of raw and degummed turmeric fibers (25^0C and 65% RH)

Specimen	Av. linear density (denier)	Av. elongation (%)	Av. force (gram)	Av. tenacity (gm/den)	Work of rupture (gm×cm)	Initial modulus (gm/den)	Work factor
Turmeric (raw)	9.65	5.62	49.55	5.04	1.24	1.05	0.51
Turmeric (d_1)	10.12	6.28	54.82	4.78	1.56	1.01	0.49
Turmeric (d_2)	9.70	6.24	56.78	5.62	1.38	1.10	0.52
Turmeric (d_3)	10.78	8.42	45.59	4.42	1.27	0.91	0.55

Table 3: Tensile parameters of raw & degummed java galangal fibers(25^0C and 65%RH)

Specimen	Av. linear density (denier)	Av. elongation (%)	Av. force (gram)	Av. tenacity (gm/den)	Work of rupture (gm×cm)	Initial modulus (gm/den)	Work factor
Java galangal (raw)	14.12	3,34	69.30	4.31	1.56	1.89	0.56
Java galangal (d_1)	20.81	4.12	102.57	4.67	2.20	1.02	0.49
Java galangal (d_2)	20,21	5.56	123.35	6.73	3.62	1.15	0.46
Java galangal (d_3)	18.42	5.04	105.34	5.67	2.39	0.93	0.45

[d_1 - degummed by alcohol and benzene,
d_2 - degummed by 2% NaOH,
d_3 - degummed by 6% NaOH.]

The stress elongation graphs of different raw and degummed fibers are shown in figures 1, 2 , 3 and 4.

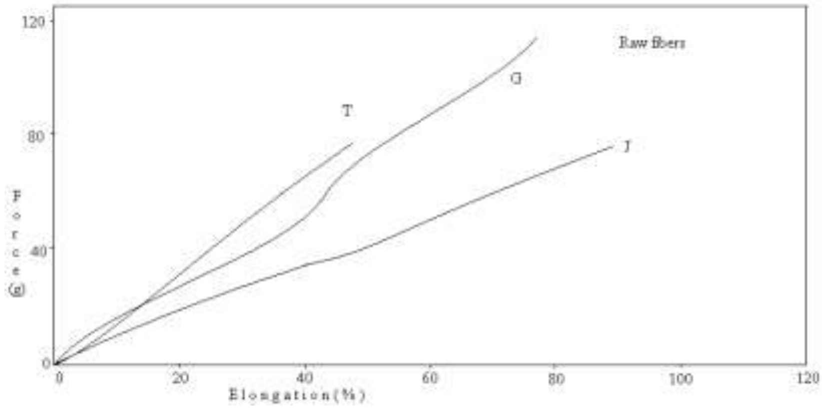

Fig. 1

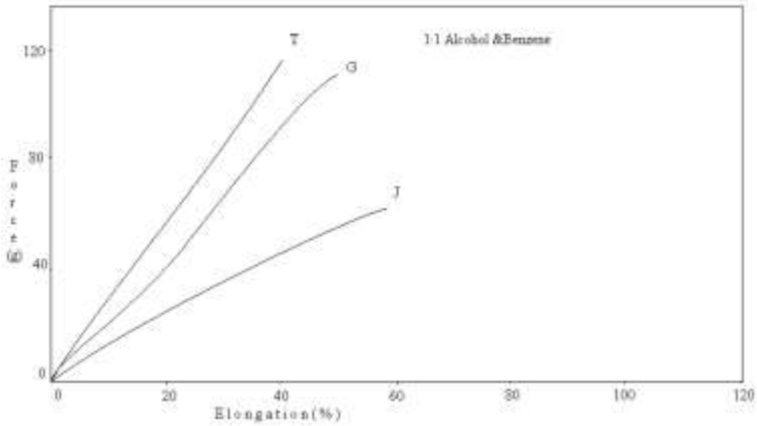

Fig. 2

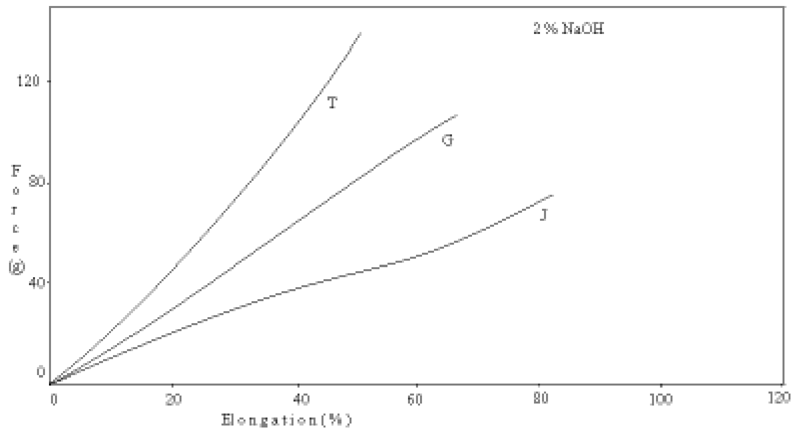

Fig. 3

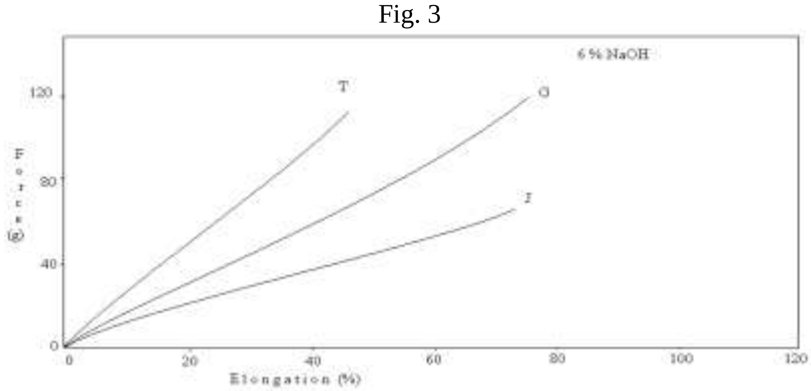

Fig. 4

(T – turmeric, G – ginger , J – java galangal)

III. Conclusion:

From the study of the tensile properties it is observed that the tenacity has changed due to irradiation and chemical treatments. For some cases it is improved while for others it is deteriorated. The elongation %, one of the important tensile properties of textile fibers, is increased for all the above fibers after irradiation and degumming trials. From the different data of tenacity and denier of all the fibers it is inferred that the quality of ginger fiber degummed by 2% NaOH is the highest. It is also observed that the tenacity is linearly related with the linear density. From various investigations it has been concluded all the plant fibers in present investigation are hygroscopic in nature and the nature of hygroscopicity does not effect much due to irradiation and degumming.

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