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Eco Friendly Extraction and Physico-Chemical Characteristics of *Cissus Quadrangularis* stem fiber

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Abstract*: Cissus quadrangualaris plant yield fibers and all the parts of this plant can be utilized in many applications. In recent days, textile industries are widely using plant fibers for numerous applications acquired from lots of resources. The advantage of natural fibers is their continuous supply, easy and safe handling, and biodegradable nature. The usage of enzymes in the textile industry consents the development of eco-friendly technologies in fiber processing and tactics to improve the final product quality. In the present work, natural cellulosic fibers were extracted from Cissus quadrangualaris plant using an eco-friendly method (amylase enzyme). The physico-chemical, thermal and mechanical properties of Cissus quadrangualaris fibers were reported in this paper. Further, the properties of CQSF ensured that it can play an imperative role in the textile manufacturing industries.*

Keywords: *Natural fibers, Cissus quadrangularis,Physical properties,Chemical Properties and Contact angle.*

INTRODUCTION

In the present era of environmental consciousness, more and more material are emerging worldwide, as a result of the increasing concentrating to the development of materials from natural and biodegradable sources. The most of the manufacturing industries are showing lot of interest in developing eco-friendly products and the use of natural fibers in industries is increasing day to day. [1, 2]. Natural fibers are eco-friendly; lightweight, strong, renewable, low density, non-toxicity, low cost and biodegradable. [3].Researchers and scientists are looking forward for the new fibers investigated the physico-chemical, mechanical, and thermal properties of natural new cellulosic fiber-like *Abelmoschusesculentus* stem fiber, *Eichhornia crassipes* fiber, *P. juliflora* bark fiber, *Phoenix reclinata*, snake grass fiber, *Acacia leucophloea* bark, and so on, using physical and chemical analysis. . [2, 4, 7, 9-11].

Cissus quadrangularis plant belongs to the Vitaceae family having a wide ecology. [13]. CQ Plant can be found in the tropical regions of India, Africa, Arabia, and South Asia. [14]. *Cissusquadrangularis* is a climber reaching to a height of 2.5 m and has quadrangular sectioned branches with internodes of 1.5-1.8 cm width and 10-15 cm long. The extract of *Cissusquadrangularis* plant contains ethanol, which has shown anti-osteoporotic activity, which slows down or rather stop the mineral loss, thereby preventing bone fractures in the Ovariectomized rat model. [13, 16]. It's also reported that nano particles can be extracted from the CQ plant. [17].

Cissus quadrangularis Plant has been concluded that it possesses good medicinal properties and has performed to generate novel textile applications [15]. In addition to its medicinal value it is also rich in both the fiber from root and stem. It has also been reported that *Cissus quadrangularis* had good potential for natural fiber production and also such fibers are used for textiles and various applications. [7,13].The increased consciousness of environmental distresses related to the use and disposal of textile industry used chemicals dumping into landfills, water or discharge into the atmospheric air are stimulated for the use of enzymes in finishing of textile materials. Herein, our novel study has focused and framed with the physical and chemical properties of *Cissus quadrangularis* stem fibers extracted with the help of amylase enzyme to explore its increase in properties for textile applications.

2. Methodology:

2.1 Materials:

The healthy and matured *Cissusquadrangularis* stems were collected in sterile bags from komarapalayam, Namakkal district, Tamilnadu,India. *Cissusquadrangularis* the only vegetable crops significance in the *Vitaceae* family, ayurvedic medicinal purposes and layering of the plant again. A native of the plant is Africa, Arabia, South-east Asia, Sri Lanka and hotter parts of India .[14].

2.2 Extraction of *Cissusquadrangularis* stem *fiber:*

The Natural retting process was adopted for extraction of fiber from *Cissusquadrangularis stem* fiber. The fiber was separated by using traditional combing process done with a metal brush to remove fleshy surface layer of the stem and long uniform fiber were obtained [6].The separated enzyme treated CQSF are shown in Fig.1 and taken as samples for further investigations. Through enzymes retting of stem fibrous plants, the degumming of the fiber from the woody core happens. That means the pectin disbands from the bundles of fiber. This process shortens the degumming process and improves the excellence of the fibers for textile process[19].

Fig.1 (a) CQ Plant, (b) CQ enzyme retting process, (c) Enzyme retting extracted CQSF.

2.3. Characterization of CQSF

2.3.1 Chemical Properties:

The chemical compositions such as cellulose, hemicellulose, lignin,Wax,Moisture content of the CQSF were determined at South Indian Textile Research Association (SITRA, Coimbatore, India) laboratory by the standard test procedures.The determination of the lignin content is carried out in accordance with Klason method. The sample is crushed and extracted with dichloromethane before being hydrolysed in a 72% solution of sulphuric acid. Lignin is the only insoluble component, which separates from the fiber and quantified.

The cellulose content is measured according to Kurshner and Hoffer's method. The samples are crushed and extracted with dichloromethane, and then a mixture of ethanol and 95% nitric acid is added. The cellulose that corresponds to the insoluble fraction of the samples is weighed. The determination of hemicelluloses is carried out according to the standard NFT 12-008. The samples are heated in hydrobromic acid. The hemicelluloses is transformed into furfural, and the latter is extracted by distillation and measured by spectrophotometry.

The wax content in the CQSF is determined by following the method developed by Conrad. The CQSF samples are crushed and subjected to soxlet extraction using ethanol for 6 h. The resulting solution containing sugar, wax and other alcohol-soluble substances are transferred to a separating funnel. Chloroform is added to extract the wax from the alcohol solution. Purified water is then added and separate layers of chloroform and alcohol are formed. After separation, the chloroform evaporated from the solution, leaving a waxy residue. After extraction, the dried residue and the CQSF samples are weighed, and the wax content is expressed in terms of the original weight of the CQSF samples.

2.4. Physical Properties of CQSF

2.4.1. Fiber Length

Twenty *Cissusquadrangularis stem* fibers were identified for its length manually using a calibrated metal scale. The fibers were stretched on the flat table and straighten with care to avoid elongation while measuring. The results are expressed in centimeters.

2.4.2. Fiber Diameter

FESEM photograph of the individual *Cissusquadrangularis stem* fibers were used to identify the fiber diameter.

2.4.3. Moisture Reagain and Moisture Content

The moisture regain and moisture content of the *Cissusquadrangularis* stem Fiber is analyzed manually using BIS and ASTM D 629 methods. The predetermined amount of fiber (A) is conditioned in oven at 1050 C and the constant mass of the fiber is obtained (B). Thus moisture properties are calculated from the measured values using (1) for moisture regain and (2) for moisture content.

Moisture regain = A – B / B X 100 (1)

Moisture content = A – B / A X 100 (2)

2.4.4. Fiber Fineness

The fineness or linear density of cut staple fiber was determined by following the procedure recommended by Committee D-13, A.S.T.M.,

A small tuft of 500 to 1,000 *Cissus Quadrangularis* stem fibers was selected made parallel and free of short fibers by hand combing. The fineness of CQSF was then held under tension to remove crimp and cut to a length preferably longer than 22.5mm. Groups of 0.5mg fibers were weighed simultaneously to the nearest 0.002mg. Linear density was calculated using the formula given below.

D = 9000M/ (L X N) Denier

Tex = D/9 tex

Where D - Linear density, Denier; M - Fiber mass measured on the balance, mg; L - Fiber length measured with a ruler, mm; N - Number of fibers weighed and the mean value was calculated

2.4.5. Visual and Hand Evaluation

In visual and hand evaluation of *Cissusquadrangularis stem* fibers, the observation of fiber shape, color, surface texture are visually evaluated

2.4.5.1. Physical shape

The *Cissusquadrangularis stem* fiber is analyzed a long, round and generally taper to a point, having one side thicker. The fibers from the lower side of the stem are particularly finer.

2.4.5.2. Color

Color of the *Cissusquadrangularis stem* fiber ranges from off-white, which is depending upon the processing technique and the processing time used for fiber extraction. The retted fiber was darkened, which can be discolored with a naturally looking light yellowish color, which is due to bacterial action.

2.4.5.3. Texture

The *Cissusquadrangularis* fibers were strong and durable and it's stiff, harsh, coarse and hard-surfaced, which is typical characteristic of all the stem fibers. However when fibers are wet, they become flexible, smooth and slippery.

2.4.5.4. Luster

The *Cissusquadrangularis* fibers are brighter in appearance and one has a reason to believe that this is due to the fact that they have the even surface and cross-sectional shape. A fiber with an regular cross-section scatters light in all directions, resulting in a good appearance with high lights. Whereas properly extracted fibers appear lustrous.

2.4.5.5. Burning Test

The *Cissusquadrangularis* fiber sample was brought near the flame, it burnt brightly. In the flame the fiber continued burning readily with a yellow-bright flame and continued burning even after removal of flame. The smell of burning *Cissusquadrangularis* fiber is like burning paper. The *Cissusquadrangularis* fiber becomes very fragile when exposed to high temperature of up to 110 ^{o}C. The burning behavior of Agave Americana fibers is

2.4.6. Contact angle

The contact angle is the angle, conventionally measured through the liquid, where a liquid/vapor interface meets a solid surface for the present study, the wetting behavior of CQSF was characterized, according to the dynamic contact angle method, using a Krüss K14 tensiometer. The sensitivity of the microbalance is ± 0.1µg. The other end of the fiber was immersed into a liquid filling the glass container mounted on the movable table (elevator). While the elevator was moved, the balance recorded the weight of the fiber as a function of the position of liquid on the fiber surface. The final depth of immersion of the fiber in the liquid was 1mm. The measurements were carried out at a rate of 1mm/min and at ambient temperature. Ten measurements were done in each case. From the test, the force versus position loop was recorded and the force was converted to the contact angle using the Wilhelmy equation. The surface energy of the fiber was reported.

3. RESULTS AND DISCUSSION

3.1. Chemical Composition of CQSF

The properties of natural fibers are based on their chemical composition. The chemical compositions of the natural fibers were highly influenced by the region, maturity of the plant, soil characteristics, and extraction methods.[6].The chemical composition of *cissus quadrangularis* stem fibre (See Table I).

Chemical Constituents %	***Cissus Quadrangularis* Stem Fiber**
Cellulose Content	75.86%
Hemicellulose	6.84%
Lignin Content	12.86
Wax Content	1.00
Ash Content	1.55

Table showed that *cissus quadrangularis* stem fibre has a cellulose content of 75.86% which ensures good mechanical properties. The hemicellulose content is quite low (6.84%) when compared with other natural fibers. Higher levels of hemicellulose lead to disintegration of cellulose microfibrils which decrease the fiber strength. Lignin constitutes 12.86% which is moderate, and it is well known for its negative influence on fiber structure and its morphology.The wax content is low at 1.00% and ash content is 1.55% which is good, as higher levels can lead to smooth fiber surface morphology and reduce the bonding capacity of the fiber. The chemical compositions of other natural cellulosic fibers are compared from the available data and tabulated in Table II. [2,13].

Table I: Chemical Properties of *CQSF* in comparison with other natural cellulosic fibers

Fiber Name	**Cellulose**	**Hemicellulose**	**Liginin**	**Wax**	**Ash**
Cissus quadrangularis	**75.86**	**6.84**	**12.86**	**1.00**	**1.55**
Abelmoschus esculentus	67	15.4	7.1	7.1	-
Prosopis juliflora	61.65	16.14	17.11	0.61	5.2
Acacia leucophloea	68.09	13.6	17.73	0.55	0.08
Kenaf	53.14	14.33	8.18	0.8	2-5
Perotisindica	68.4	15.7	8.35	0.32	4.32
Acacia planifrons	73.1	9.41	12.04	0.57	4.06
Sidarhombifolia	75.09	15.43	7.48	0.49	4.07
Sansevieria zeylanica	76.12	9.32	4.28	0.43	1.36
Sansevieria ehrenbergii	80	11.25	7.8	0.45	0.6

3.2. Physical Properties of *Cissus quadrangularis* stemFiber

The length of the *Cissus quadrangularis* fibre depends upon the plant selected for extraction. *Cissus quadrangularis* stem Fiber has the length vary from 40 cm – 55 cm and diameter of 109.2µm. The moisture regain and moisture content of the *Cissus quadrangularis* stem Fiber is found to be 12.18 % and 9.15 % respectively. *Cissus quadrangularis* stem Fiber has the fineness of 20 tex which shows the fibre is least bulk. (See Table III).

Table III Mechanical properties of *Cissus quadrangularis* stem fiber

Single Fiber Length(cm)	40-55cm
Single Fiber Diameter(µm)	109.2µm
Fiber Fineness(tex)	20 tex
Moisture Content (%)	9.15%
Moisture Regain (%)	12.18%

3.3. Contact angle analysis of CQSF

The contact angle measurement of *Cissus quadrangularis* stem fibre of the investigated CQSF is displayed in Figure 2. The irregular shaped graph of the tensiogram due to hysteresis indicates that the wetting force of the liquids in both advancing and receding phases varies randomly from one position to another on the fibre surface. That can be assumed due to high roughness and chemical contamination of the *Cissus quadrangularis* fibre surface. The contact angle result was found to be 123^{o}and this value of CQSF is hydrophobic surface.

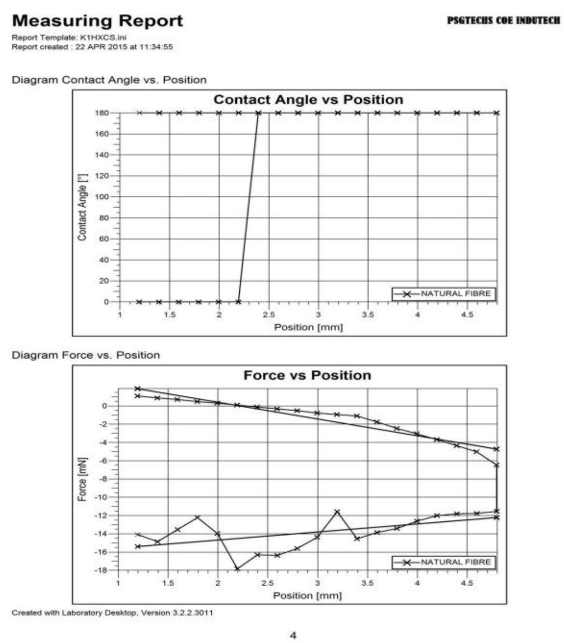

Fig.2. Contact angle analysis of CQSF

CONCLUSION

Cissus quadrangularis fibres have been produced innovative sustainable extraction methods, not involving chemical treatments for being used in different applications. This material is renewable, biodegradable and very ecological. In fact, it requires very small amount of water to grow and neither insecticides nor pesticides are needed. To produce ultimate fibers, we must look for an appropriate method of extraction. In this paper, a eco friendly method of extraction that gives cellulosic fibers without any damage was investigated, where cellulosic fibers are found in; this contains cellulose,wax, lignin and hemicellulose. The ultimate fibers from esparto grass have a length between 40 - 55 cm and a diameter 109.2 µm. They have showed that ultimate fibers are very long with interesting features and the process of *Cissus quadrangularis* fiber results in an excellent quality of fibers. The obtained results could be considered promising for the use of *Cissus quadrangularis* stem fibers showed that it could be a potential alternative to synthetic fibers for high value textile,composite, and other fibrous applications and use of these fiber for different useable products in order to improve its value.

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