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Experimental Procedures of Fiber Extraction from Spathodea Campanulata (African Tulip Tree) for Cord

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ABSTRACT

Spathodea campanulata is a plant which grows mainly in the tropical regions of Africa. In Ghana, the bark is used for medicinal and dyeing purposes. After extracting medicine or dye from the bark of Spathodea, the remnants are mostly dumped indiscriminately in the environment resulting in the blockage of drains which can cause flooding or water stagnancy which leads to breeding of mosquitos. The purpose of this study therefore is to produce cords from fibers extracted from the *Spathodea campanulata* tree bark based on experimental tests conducted. Testing procedures revealed that, the retted fibers after washing weighed 29g (for using plantain peels), 31g (for using cow dung) and 31g (for using caustic soda) from an initial weight of 93g after crashing and drying the fibers. Twisting in the wet state helped the fibers to bond readily hence cord remained smother, twisted or untwisted. Further test procedures were conducted to check the tensile strength, water absorbency flammability and effects of sulphuric acid. The result reveals that the cord has low flammability, high water absorbency, brown colour and ability to withstand diluted sulphuric acid which is the strongest acid. Experimental results presented in the study proved the viability of producing cords from the fibers of *Spathodea campanulata*. It is therefore recommended that the Youth Employment Agency (YEA) should encourage the youth by providing them with financial support to explore more innovative ways of recycling Spathodea into useful products as a means of employment.

Keywords: Spathodea campanulata; fiber extraction; cords; bio-degradable; experimental; flammability.
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1. Introduction

Ghana as a country with tropical climate is very rich in thick rain forests that produce various kinds of plants for both domestic use and foreign exports (Akpalu and Parks, 2007). Plants from the forests of Ghana serve purposes such as timber for furniture and construction works, food crops,

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medicine and to name a few (Duah-Gyamfi etal, 2014). Among the medicinal plants is *Spathodea campanulata* which is widely known as Fountain tree, African tulip tree or Nandi flame (Compendium, 2019). Among the Ewe ethnic group in Ghana, Spathodea campanulata is called *Adewudatsi* (meaning a plant for dyeing traditional hunting apparel) or *Adatsigo* (meaning tears pod) or Dundun.

Spathodea campanulata plays a very important role in traditional herbal medicine for the treatment of different kinds of ailments mostly in the African homes; nonetheless, the Indo-Chinese also use the flowers in healing ulcers (Perry and Metzger, 1980). According to Dadzeasah (2012), the Spathodea plant is locally known to the Ghanaian as a medicinal plant used for the treatment of various disorders to the point of being considered as a universal remedy. Extensive exploration done on the plant for its medicinal value has proven highly positive across the globe. (Makinde etal, 1988). According to a traditional herbalist in the Volta region of Ghana (Personal Communication, January 2017), Spathodea campanulata is used comprehensively in traditional herbal medicine extraction in curing such diseases as malaria, headache, stomachache and a special type of traditional dye for dyeing warriors wear which is displayed during festivals and funeral ceremonies of royals, elders and warriors in communities such as Ho, Sokode, Akoepe, Adaklu, Ve, Kpando and to mention a few.

Unfortunately, the bark after its use for medicine or dye extraction is dumped haphazardly into the environment as waste (Lokesh & Swamy 2013). This waste from the Spathodea bark sometimes ends up at dumping sites close to waterways. In the event of rain, there is the likelihood that the waste will easily be carried away together with other wastes by the flowing water thus impeding the free flow of water and eventually causing flooding or water stagnancy which leads to breeding of mosquitos (Masruri, 2017). There is a high possibility that this may lead to the outbreak of cholera and malaria.

An experimental study conducted by Masriri (2017) reveals that the spathodea waste is fibrous thus this research to extract and convert the fibers into cords that can be used to produce artefacts such as doormats, bags, flowerpot holders and to mention a few. The experimental research method was adopted to hold the dependent variables under control. The processes of stripping, retting and twisting were used to extract the fiber from spathodea bark. Cow dung, caustic soda and plantain peels were used as retting agents to the extract fiber from spathodea. The preliminary findings of the study reveal that the bark of spathodea has the potential to be used for the production of fiber. The significance of this study therefore is to extract fibre from spathodea in order to add up to the fiber sources that exist and to serve as a means for recycling the spathodea waste into useful products.

2. Review of related literature

2.1 Spathodea Campanulata

Spathodea as described by (Sowjanya et al 2013) is a monotypic genus in the flowering plant family Bignoniaceae. It contains a single species, Spathodea campanulata. It is commonly known as the Fountain Tree, African tulip tree, Pichkari or Nandi Flame. It is a tree that grows between 7–25 m (23–82 ft) tall and is native to tropical dry forests of Africa (Mbosso etal, 2016). The generic name derived from the Greek word 'spathe' (blade), from the shape of the corolla. The specific name means pertaining to a Campanula, a name coined in 1542 by Fuchs for the type of corolla with a broad rounded base and a gradually expanded tube corresponding to the sound bow of a church bell (Global Invasive Species Database, 2021).

2.2 Cultivation of Spathodea campanulata

It is propagated by the seeds and cuttings. The light seeds have thin and transparent film surrounding them making it very easy for the wind to carry as far as it travels resulting in the wide spread of the plant. According to Global Invasive Species Database (2021), Spathodea campanulata is an indigenous tree that existed naturally in the tropical regions of Africa but has in present times found its way to foreign lands with tropical climate, where it is either grown for beautification or checking erosion. In Ghana, according to (Osei-Bonsu & Anim-Kwapong, 1998) there is no extensive cultivation of the plant but rather the existing ones naturally grow in the forests and surroundings of human dwellings through the dispersal of its seeds mainly by wind. Brindha et al. (2012) also supports the claim made by Global Invasive Species Database (2021) that, Spathodea campanulata is native to Africa but has now spread to various parts of South America and India where it is mainly cultivated for ornamental purposes, paper production and checking soil erosions.

2.3 Uses of Spathodea campanulata

The Spathodea plant is used in African traditional medicine as well as ornamentation and checking soil erosions. Its wood forms a good source for the paper industry and charcoal burning while the bark is used to treat ulcer and skin related diseases as well gastro intestinal disorders (Brindha et al., 2012). Acording to Dadzeasah (2012) "a brew made from the bark, leaves and flowers of this tree is used for treating various illnesses" in Ghana. The spathodea bark is used during the celebration of the Asogli Yam festival in Ho Ghana to dye the traditional smock called Adewu, a smock which people wear for the celebration to protect themselves against any external spiritual attacks. (Gbadegbe and Mensah, 2013).

Some farmers also use the bark to bind firewood, bamboo and many other things that can be bound from their farms to the house. The bark and leaves are widely used in traditional medicine in Ghana for healing wound, especially burns. Makinde etal (1988) affirmed that the bark and leaves are good for treating malaria as they show a wide range of antibacterial activity including anti-malaria activity.

2.4 Physical and microscopic features of Spathodea bark

According to Brindha et al. (2012), the surface of the outer bark is gray coloured with thick scales of uneven shapes and circular cushion shaped spots (Figure 1a). The inner bark surface is smooth, shining and cream in colour (Figure 1b). Noticeable features can be seen on the outer zone of two or three successive dark wavy zones alternating with light bands and Inner zone with faint parallel vertical bands.

a - Spathodea outer bark b - *Spathodea* inner bark

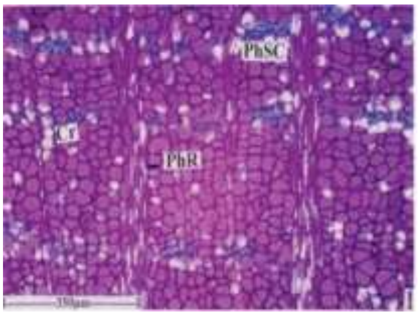
Figure 1a, b: Physical Features of Spathodea bark.

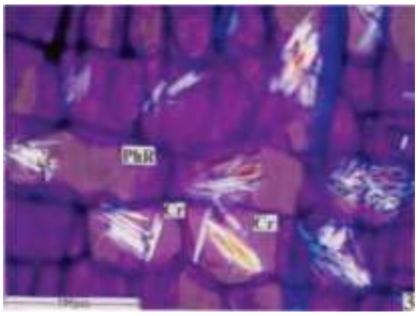
The bark shows a characteristic outer zone of compound periderm or Rhytidome. Inner portion of secondary phloem comprises dead and non- collapsed phloem. Rhytidome includes 2 or 3 successive zones of homogeneous, suberized tabular phellem cells alternating wide including dead phloem as shown in Figure 2a, b. Outer zone of collapsed phloem consists of dilated curved rays, thin tangential bands of sclerenchyma, dark, thin tangential lines of crushed sieve elements and the inner zone of non-collapsed phloem comprises narrow rays, wide intact sieve tubes with simple sieve plates.

a - Periderm layers b - Dead phloem seen in between periderm layers

Figure 2a, b: Microscopic Features of Spathodea bark

Tangential longitudinal and Radial longitudinal sectional views: Phloem rays- multi-seriate wide, high, non-storied homocellular. Sieve tube with simple horizontal sieve plates as indicated in Figure 3a, b shows calcium oxalate crystals of spindle shaped and prismatic types abundant in the rays and phloem parenchyma cells.





a - Phloem Ray and Phloem Sclerenchyma   b - Crystals and phloem Ray cells enlarged

Figure 3a, b: Tangential longitudinal and Radial longitudinal sectional views.

2.5 Chemical composition of Spathodea campanulata

The Spathodea campanulata bark is composed of the elements (Brindha et al., 2012) analyzed in Tables 1-3.

Table 1.

Elemental Analysis of Spathodea bark.

SI No.	Name of the Minerals	Quantity
1.	Organic Carbon (%)	1.82
2.	Total Nitrogen (%)	1.12
3.	Total Phosphours (%)	0.36
4.	Potassium (%)	3.89
5.	Total Sodium (%)	0.18
6.	Total Calcium (%)	3.25
7.	Total Magnesium (%)	2.56
8.	Total Sulphur (%)	0.32
9.	Total Zinc(ppm)	1.02
10.	Total Copper (pmm)	0.11
11.	Total Iron (pmm)	56.23
12.	Total Manganese (pmm)	5.36
13.	Total Boron (pmm)	0.08
14.	Total Molybdenum(pmm)	0.08

(Source: Brindha et al, 2021)

Table 2.

Major Phyto constituents.

SI. No	Name of the Phytoconstituents	Quantity
1.	Alkaloids ($mgkg^{-1}$)	1.92
2.	Flavonoids ($mgkg^{-1}$)	2.50
3.	Tannin ($mgkg^{-1}$)	0.35
4.	Lignin ($mgkg^{-1}$)	0.29
5.	Glycosides ($mgkg^{-1}$)	0.05
6.	Serpentines ($mgkg^{-1}$)	0.05
7.	Terpenoids ($mgkg^{-1}$)	0.03
8.	Saponins ($mgkg^{-1}$)	0.01
9.	Phenols ($mgkg^{-1}$)	0.12

(Source: Brindha et al, 2021)

Table 3.
Major nutrients.

Sl. No.	Nutraceuticals	Values
1.	Carbohydrates (mg kg^{-1})	1.36
2.	Protein (mg kg^{-1})	0.32
3.	Fats (mg kg^{-1})	0.03
4.	Energy (K Cal g^{-1})	5.69

(Source: Brindha et al, 2021)

2.6 Bast fiber

All fibers that come from the stem or bark of the plant are termed bast fibers. They are usually longer and stronger as compared to the other plant fibers as asserted by Paridah et al. (2011), but do not readily come in their natural states as fibers. The fibers are held together in tissues that would have to be degraded in order to disintegrate the individual fibers.

The process of this degradation to separate the fibers is called retting. The fiber in exploration by this research can be found in the bark of Spathodea Campanulata thus qualified to be considered as a bast fiber as literature defines. According to Mwaikambo (2006) bast fibers are obtained from the stems of various dicotyledonous plants and are also referred to as 'soft' fibers to distinguish them from leaf fibers. Dicotyledons are plants with two seed leaves cotyledons.

Botanically the term bast (bark) is synonymous with phloem, the food producing tissue of vascular plants. It is also used to denote fibers obtained from the cortex and pericycle in addition to the phloem. Bast fiber bundles are composed of elongated thick-walled ultimate cells joined together both end to end and side by side and arranged in bundles along the length of the stem. Bast fiber bundles are removed from the parent material by the decorticating process, which consists of removing from the stem, the 'cortex' comprising the bast and outer bark. The separated fibers are then washed in water and dried. Moir and Plastina (2009) listed some examples such as sisal, jute, flax, just to mention a few, in the bast category of fiber classification. All these fibers go through the retting processes for the separation of the fibers which are usually held together by tissues that perform various functions in the plant's life. Because these tissues that originally form part of the plant stem are useless and not needed as part of the fibers, they must be gotten rid of, thus the retting is done so as to render them usable.

The stem that contains the fibers is usually softer and flexible when fresh and wet but becomes hard when dry and may not be usable anymore because separation of the fibers becomes very difficult if not impossible. The breaking down of the plant tissues to separate the fibers also makes the fibers more flexible and pliable, condition favourable for the processing of the fibers into yarn and eventually fabric.

2.7 Textile fiber properties

All textile fibers must possess some basic qualities so as to qualify for the production of textile products. Not all fibers in nature can be used for textiles since some are too short and others not flexible or strong enough for twisting into yarns for example corn silk or wood slivers. Humphries, (2009) argues that, textile fibers must have certain properties which means they must be flexible, thin (but not too thin), long (enough), cohesive, and strong (enough). She further explained that, for a fiber to be spun into yarn where they are drawn out and twisted, it must have sufficient length, strength, and cohesiveness (fiber-to-fiber friction). Many seed fibers, she stated, are too short, weak, and slippery to spin into yarn for example, kapok can be used only for stuffing. All these properties are highly required in a fiber to make spinning possible and easier.

Flexibility of a fiber is its ability to bend easily without breaking and this helps in the twisting process during spinning so that they do not break when they are bent to any angle. The sufficient length of a fiber helps in the over-lapping of the ends in order to inter-lock one another during the spinning process. With fibers that do not reach the required length, spinning cannot be possible because their ends are too short to inter-lock one another to form a continuous thread, whereas the cohesiveness (fiber-to-fiber friction) enables the individual fiber to hold onto one another as the twisting is done.

The ability of this study to extract fiber from the bark of the spathodea plant for cordage as a substitute for jute cord in the production of some utilitarian products addresses the problem of lost economic value of the plant. Substitution of jute with Spathodea campanulata in the production of craftwork also addresses the problem of over-dependency on imported jute to Ghana. According to the instrumentalists' theory, a work of art is valuable only if it serves the purpose for which it was made (Svoboda, 2015). This means that this study as per the argument of the instrumentalist can be termed valuable only if it serves the purposes of providing a substitute fiber for jute in the production of artefacts so as to cut the use of jute cords. This study can therefore be said to contribute to knowledge because literature reviewed so far reveal that no study has been conducted on the extraction of fiber from spathodea for the production of artefacts.

3. Methodology

This study employed the experimental research to guide all the experiment processes. According to Ross and Morrison (2004), experimental research referred to as "treatments," demanded designs using standardized procedures to hold all conditions constant except the independent (experimental) variable. This standardization ensured high internal validity (experimental control) in comparing the experimental group to the control group on the dependent or "outcome" variable.

In this research, standardized procedures were used to hold all conditions constant which ensured that the outcomes are confidently comparable to the experimental groups. The experimental research was used as a guide in following standardized procedures to hold all conditions constant except the independent (experimental) variable so as to ensure high internal validity in comparing the experimental group to the control group on the dependent variable such as the results from the three retting methods. Figure 4 shows the graphical representation of the processes undertaken to extract, ret and twist the fibers into cords which are further tested.

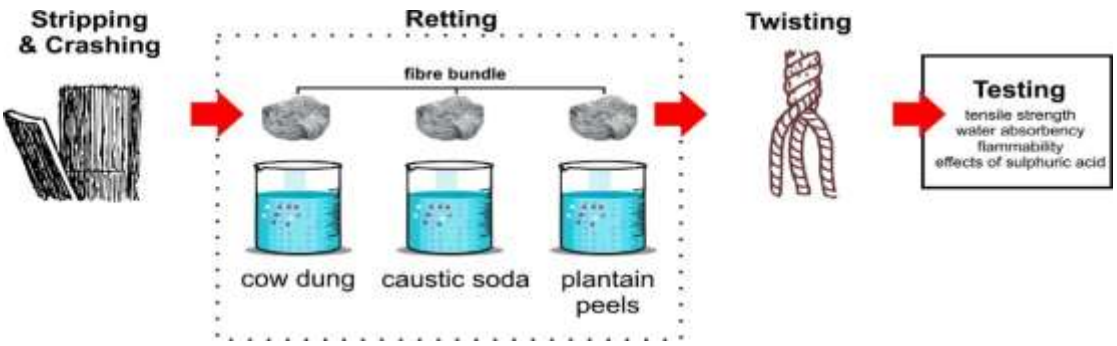


Figure 4. Graphical representation of the processes undertaken.

3.1 Stripping

A sharp wooden pole of about two inches in diameter and four feet long was used to cut portions of the tree bark. The inner bark (Figure 5a) called the cambium layer which contained the fibers was stripped from the outer bark. The separation of the cambium layer from the outer bark (Figure 5b) made it flexible for further processing. These fibers were crashed, dried and weighed (93g) before used for the retting processes in the different solutions.

a - Inner bark (Cambium layer) b - Outer bark

Figure 5a, b: Parts of the *Spathodea campanulata* fibers

3.2 Retting

3.2.1 Preparation of the plantain peels solution for retting

Plantain peels were cut into smaller pieces to speed up drying of the peels for crashing into powder. The sliced plantain peel was spread out under the sun for the evaporation of moisture before crashing into powder. The drying took about five hours. The dry plantain peels were then crashed into powder in a mortar with the help of a pestle and sieved.

The dry plantain peels in their initial state could not easily mix with water to form a solution hence the need to be converted into a state that makes the mixing possible in the shortest possible time. 20g of fine plantain peels was weighed for a proportional 1 liter of water. The fibers were immersed in the plantain peel solution and left for three days for retting to take place. The retted fiber was rinsed to wash off the rotten binding tissues in the barks. The fiber weighed 29g after retting, washing and drying.

3.3 Preparation of the cow dung solution for retting

Freshly dropped cow dung (Figure 6) at a cattle grazing site in Sokode (a community in Ho) where it was collected and used as the retting agent for sample two. The fresh cow dung was spread out on a board to dry for easy processing which included crashing, sieving and weighing.

Figure 6. Fresh and dry cow dung.

The dry cow dung was crashed into powder for sieving. The dung was obtained in lumps form that had to be crashed into powder for sieving and weighing. 20g of the sieved cow dung was weighed to prepare the solution for retting. This quantity was mixed with 1-liter volume of water. The fiber was fully immersed in the cow dung solution and left for three days for retting to take place. The retted fiber was rinsed to wash off the degraded matter in the fiber, dried and weighed. The weight read 31g at this stage which means that there was a decrease of 4g in the 35g weight before retting.

3.4 Preparation of the caustic soda solution for retting

20g of caustic soda was weighed for 1-liter volume of water. The fibers were immersed into the caustic soda solution and left for three days for retting to take place. The retted fiber was rinsed to wash off the degraded matter from the fiber, dried and weighed. The fibers weighed 27g after retting, washing and drying.

3.5 Twisting

The manual processes of hand twisting and braiding of the extracted Spathodea fibers into cords of varied sizes were experimented to adopt the appropriate process for Spathodea cord production. The Z-twist was adopted for twisting the Spathodea fiber in both dry and wet states and it was identified that twisting in the wet state was better than in the dry state hence selected for Spathodea cordage. Twisting in the wet state helped the fibers to bond readily to one another. When released from twisting, the cord remained twisted and did not untwist as in the case of the dry twisted fiber. The wet twisted cords are smoother and well twisted as compared to the dry twisted fiber.

3.6 Testing the properties of the Spathodea cords

The test sought to compare the properties of the Spathodea fiber with the jute fiber and analyze these properties to determine the strengths and weaknesses of the fibers in comparison with each other. The following activities were carried out in checking the tensile strength, water absorbency, flammability and effects of sulphuric acid.

4. Results and discussion

4.1 Experimental results from the retting process

Experimental results revealed that the samples for the three different methods maintained the same levels of measurement as they were subjected to equal treatments; crashing, boiling and drying at the initial stages. They all had an initial weight of 100g (one hundred grams) and maintained an equal weight of 93g (ninety-three grams) after crashing. This means that they all lost a weight of 7g (seven grams) each. After the samples were boiled and dried, they all lost additional weight of 58g (fifty-eight grams) pegging the final weight before retting at 35g (thirty-five grams). This means that, the three samples lost a total weight of 65g (sixty-five grams) each after crashing, boiling and drying.

These results proved that the variables for all the three samples were held constant. They all underwent equal crashing, boiling and drying. Notable changes began to emerge in one sample immediately retting began. There were significant physical changes such as change in colour and texture of the Spathodea bark when immersed into the caustic soda solution whilst the plantain peel and the cow dung solution did not show any physical changes when the sample was immersed.

The caustic soda solution was colourless until the sample was immersed and the solution gradually changed from colourless to brownish red until the solution became saturated. The cow dung and plantain peel solutions took the colour of their solute which did not have immediate physical effect on the samples when immersed. The sample in the caustic soda solution became softer unlike the other two samples at that point.

After three days of retting when the samples were taken out of each of the solutions, washed, dried and weighed to determine if there were subsequent changes in weight, it was revealed that, the weight of the caustic soda retted fiber decreased from 35g (thirty-five grams) to 27g (twenty-seven grams) meaning, there was a weight loss of 8g (eight grams). The plantain peel sample decreased from 35g (thirty-five grams) to 29g (twenty-nine grams) which indicates that there was a weight loss of 6g (six grams) and finally the weight of the cow dung sample decreased from 35g (thirty-five grams) to 31g (thirty-one grams) showing a weight loss of 4g (four grams).

The results for all the three samples indicated that all the retting methods had impact on the bark at different rates. It was realized that the highest impact record was for the caustic soda sample hence the selection of it by the researcher for extracting fibre from the Spathodea campanulata bark. The weight lost was an indication that the tissues binding the fibers together were degraded and washed off and highest weight lost proved the most effective agent which could degrade larger amount of the tissues.

4.2 Resultant effect in twisting spathodea fibers into cords

The Spathodea fiber was twisted in its wet and dry states (Figure 7). The Spathodea fiber in the wet state showed a better result as compared to twisting in the dry state. The wet twisted cord did not unwind when released after twisting unlike the dried one. The researchers after considering the advantages and the disadvantages of twisting the fiber in both the wet and dry states decided to employ the wet twisting.

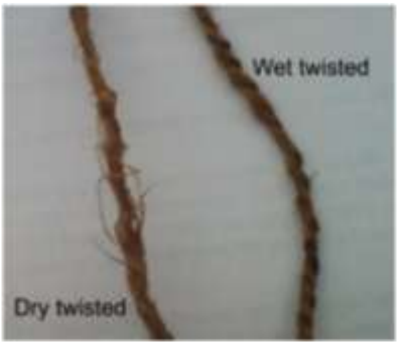


Figure 7. Twisted cords in the wet and dry states.

4.3 Result from the testing procedures

4.3.1 Tensile strength

Table 4 reveals the stress-strain test using the manual tensile strength machine. It shows the corresponding load to every extra 0.2” (zero point two inches) the cord was stretched over. The cord was stretched over a total distance of 1.4” (one point four inches) which carried a maximum load of 100N (one hundred Newton). The tensile strength of the dry Spathodea cord was 18,189.14E (eighteen thousand, one hundred and eighty-nine point one four Young’s Modulus). The elongation of the cord in the dry state was 17.5% (seventeen point five percent) whilst its elasticity was 35650.71E (thirty-five thousand, six hundred and fifty point seven one Young’s Modulus)

Table 4.

Tensile strength Result of the Dry Spathodea cord.

Dry Spathodea cord				Diameter (inch)			0.2
				Area (inch^2)			0.031415927
Load	length	Deflection	Strain	Stress	Elongation	Elasticity	Tensile Strength
0.00	8.00	0.00	0.00	0.00	0.00		#DIV/0!
8.00	8.20	0.20	0.02	254.65	2.50	10185.92	10185.92
14.00	8.40	0.40	0.05	445.63	5.00	7639.44	8912.68
23.00	8.60	0.60	0.08	732.11	7.50	11459.16	9761.50
35.00	8.80	0.80	0.10	1114.08	10.00	15278.87	11140.85
51.00	9.00	1.00	0.13	1623.38	12.50	20371.83	12987.04
72.00	9.20	1.20	0.15	2291.83	15.00	26738.03	15278.87
100.00	9.40	1.40	0.18	3183.10	17.50	35650.71	18189.14

Table 5 reveals the stress-strain test using the manual tensile strength machine. It shows the corresponding load to every extra 0.2" (zero point two inches) the cord was stretched over. The cord was stretched over a total distance of 2.4" (two point four inches) which carried a maximum load of 110N (one hundred and ten Newton). The tensile strength of the wet Spathodea cord was 11,671.36E (eleven thousand, six hundred and seventy-one point three six Young's Modulus).

The elongation of the cord in the wet state was 23.08% (twenty-three point zero eight percent) and elasticity was 48383.10E (forty- eight thousand, three hundred and eighty - three point one zero Young's Modulus).

Table 5.

Tensile strength Result of the Wet Spathodea cord.

Wet Spathodea cord				Diameter (inch)			0.2
				Area (inch^2)			0.031415927
Load	length	Deflection	Strain	Stress	Elongation	Elasticity	Tensile Strength
0.00	8.00	0.00	0.00	0.00	0.00		#DIV/0!
2.00	8.20	0.20	0.02	63.66	2.44	2546.48	2546.48
3.00	8.40	0.40	0.05	95.49	4.76	1273.24	1909.86
5.00	8.60	0.60	0.08	159.15	6.98	2546.48	2122.07
8.00	8.80	0.80	0.10	254.65	9.09	3819.72	2546.48
9.00	9.00	1.00	0.13	286.48	11.11	1273.24	2291.83
13.00	9.20	1.20	0.15	413.80	13.04	5092.96	2758.69
19.00	9.40	1.40	0.18	604.79	14.89	7639.44	3455.94
28.00	9.60	1.60	0.20	891.27	16.67	11459.16	4456.34
38.00	9.80	1.80	0.23	1209.58	18.37	12732.40	5375.90
52.00	10.00	2.00	0.25	1655.21	20.00	17825.35	6620.85
72.00	10.20	2.20	0.28	2291.83	21.57	25464.79	8333.93
110.00	10.40	2.40	0.30	3501.41	23.08	48383.10	11671.36

4.3.2 Water absorbency

In table 6, 10g (ten grams) of the sample was tested. The Spathodea cord absorbed 17g (seventeen grams) of water forming 170% (one hundred and seventy percent) of its initial weight.

Table 6.

Weights of sample.

Sample	Initial weight	After absorption	Weight gained	Percentage
Spathodea	10g	27g	17g	170%

4.3.3 Flammability test

Table 7 below displays the flammability test results for the sample. The Spathodea sample took eight seconds (8seconds) to ignite when held to the flame and burned for a total duration of forty seconds (47 seconds).

Table 7.

Flammability test result.

Sample	Ignition time	Burning duration
Spathodea	8 second	47 seconds

4.3.4 Effect of strong acid

Table 8 illustrates the results from the experimental procedures using sulphuric acid with different time duration.

Table 8.

Different concentrations of Sulphuric acid.

Serial	Sulphuric acid concentration	Duration	Physical Effect
1	Undiluted	Five minutes	Changed colour Began to dissolve Lost fiber strength
2	5Mdm^{-3}	One hour	No change in colour Did not dissolve Lost no fiber strength
3	3Mdm^{-3}	One hour	No change in colour Did not dissolve Lost no fiber strength
4	1Mdm^{-3}	One hour	No change in colour Did not dissolve No loss of fiber strength

5. Conclusion and policy implication

In conclusion, the results of this study indicated that fibers can be extracted from Spathodea campanulata and twisted into cords. The properties test proved that Spathodea cord has the strength to withstand high tension hence may be used as conveying belts or for fastening heavy logistics. It can also be used in the production of some utilitarian products such as bags, hat, doormats, and to mention a few. The high tensile strength of the Spathodea fiber makes it durable, such that wares it may be used to produce can last longer.

It is hoped that, with the right government policies and investments in the indigenous spinning industry, the quantity and economic standard of the indigenes will be improved in Ghana. It is, therefore incumbent on government, academia and the appropriate agencies to facilitate research into appropriate tools that will aid the spinning of spathodea into yarn instead of the crude hand spinning technique. It is recommended that, public education, awareness creation and enforcement of the best and sustainable waste management practices be intensified to avert the problems posed by waste in our communities. The Youth Employment Agency (YEA) with support from financial institutions should as a matter of emergency encourage the youth by providing financial support to those with innovative ideas on recycling waste in our communities as a means of employment. Finally, it is recommended that the Spathodea fiber which has been proven to be potent for cordage be accepted and used nation-wide by the craftsmen in the production of their wares.

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