Retraction Notice

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☐ Editor with hints from
O Journal owner (publisher)
O Institution:
O Reader:
O Other:
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X were found to be overall invalid.

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☐ honest error
☐ academic misconduct
X none (not applicable in this case – e.g. in case of editorial reasons)

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Expression of Concern:
☐ yes, date: yyyy-mm-dd
X no

Correction:
☐ yes, date: yyyy-mm-dd
X no

Comment:

Due to personal reasons.

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Producing Spinnable Regenerated Cellulosic Fibers from Palm Fibers for Use in the Textile Industry

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Abstract

The textile industry is considered a major industry worldwide, and some countries use available domestic raw materials for textile manufacturing, being one of many other economic resources. Meanwhile, the Kingdom of Saudi Arabia is at the forefront of States paying great attention to the cultivation of palm trees due to their great importance, which are an indispensable traditional food for a large portion of the population. However, huge quantities of palm's by-products, especially palm fibers, are constantly wasted, although they can be effectively used to produce textiles of particular end uses such as ropes. This study, therefore, sought to explore the potential of extracting cellulose from palm fibers for use in the textile industry. The study has utilized the experimental approach by applying alkaline to palm fibers so as to extract inherent cellulose. It has also applied mechanical processing to turn cellulose into fibers. Fibers' physical properties (color, diameter, length), chemical properties (ratios of cellulose, hemicellulose, and lignin), and mechanical properties (tensile strength and elongation of fibers before and after treatment) were all studied. The study has proved that the physical, chemical and mechanical properties of regenerated cellulose fibers extracted from palm fibers are similar to those of other natural fibers such as bamboo and linen, and thus can be used in the textile industry. The study also compared different types of palm trees to determine the one that contains the largest concentration of cellulose. However, it was found that sugar palm fibers contain the highest cellulose concentration of 44% and therefore, it was selected for the application of the study's theory. The study recommends making use of palm fiber in manufacturing textiles for particular end uses such as ropes, fillings and filters, as well as applying the theory of the study to other plants that have not yet been manipulated.

Keywords

Palm Fiber, Cellulose Fiber, Sugar Palm, Textile Industries

1. Introduction

The date palm is one of the important food sources in the Middle East, especially in oases and desert areas, where palm trees are distinguished by their ability to grow in dry and semi-arid areas and between latitudes (10 - 30)˚ north of the equator.

This blessed tree has been known to man and has been planted for at least 6000 years, and it is so ancient that it is not known where it originated specifically and how man knew the techniques of its propagation and pollination, but the man knew how to benefit from every vegetative part of it in his daily life, in addition to its fruits that are of various types that made it the greatest food-producing tree in the desert areas. Without it, man would not have been able to live in those areas such as Southeast Asia, North Africa and some Asian countries. This region includes all Arab countries from Mauritania in the west to Iraq and the Arabian Gulf in the east, and therefore the palm can be considered an authentic Arab tree, where the mass production of dates reached more than three million tons, and this is equivalent to two-thirds of the global production of dates according to the 1996 census of the International Agriculture and Food Organization [1].

The palm represents real wealth for the date-producing countries. The UAE, Saudi Arabia and Egypt are among the largest countries that care for palm cultivation, and we find that the number of palm trees in the Emirates is about thirty-three million palm trees [2], followed by the Kingdom of Saudi Arabia with 31 million distributed over the Kingdom's regions [3]. Egypt is followed by 15 million palm trees [4]. In these countries, about 400 varieties of dates are produced. The Kingdom of Saudi Arabia is considered the original home of the date palm.

The date palm is a strong economic tributary in terms of heritage and tourism (to preserve the cultural heritage of palm trees), as it has been closely linked to the lives of the Saudis since ancient times. This is achieved by providing many job opportunities for the residents of these areas, such as handicrafts for the manufacture of palm by-products, baskets made of fronds, ropes from palm fibers and other handicrafts, and the work of archaeological museums for the handicrafts that have been passed down through generations [5]. Palm has multiple uses. Trunks are used in the production of wood. And wicker (leaflets) in the manufacture of baskets. And the bases of papers (karnav) and fibers in the production of fuels and packing materials. Date seeds are also used in the production of animal feed [6].

The secondary palm waste (palm fiber) resulting from its annual pruning amounts to more than (5.4) million tons, which is considered a burden on farmers, a source of environmental pollution, and a neglected economic resource that must be utilized [7]. It can also be recycled for use in many products, providing job opportunities, which develops the economic aspect. Palm fronds and residues are used in the plastic, construction and manufacturing industries [8]. It is also possible to use palm fibers to reduce the problem of plastic waste [9], as attempts were made in the past to chop the palm fiber and turn it into granules that are used as a filler in the manufacture of plastic products and as a substitute for it, but the addition of these granules negatively affected the mechanical properties of the plastic (tensile and bending strength), so the largest percentage that could be added to these products was only 5% [10], and it was possible to use palm fiber in the manufacture of natural plastic by extracting cellulose and mixing it with polymer and turning it into biodegradable plastic granules within 30 days [11]. Palm fibers can also be used in new industrial fields as an alternative to wood panels and in the furniture industry [12].

The use of natural fibers and the development of textiles gave many benefits, for example: reducing pollutants harmful to the environment, reducing the import of textile materials, and encouraging economic growth and income for the community as in Blackburn's study [13]. It also gave positive results in reducing water and energy consumption and polluting emissions to the environment [14]. This energy is one of the main motives for conducting scientific research that deals with various aspects of natural resources. Since the optimal use of available resources promotes better standards of living, weaving processes must be developed using local environment-friendly materials, characterized by their renewability, in addition to the fact that these natural fibers are characterized by their low toxicity and biodegradability [15].

Thus, plant waste is transformed into real wealth characterized by high efficiency [16]. We can also benefit from them effectively without harming the environment, thus achieving the sustainable development of the palm sector in the Kingdom of Saudi Arabia. It also enabled the conversion of global secondary fibers to [1.3] million tons/year of natural textile fibers, ranking third after cotton and jute. Thus, it is considered as a good alternative for its use in the textile sector, and saves the costs paid for importing textile fibers such as cotton and jute, and covers industrial and consumer needs. Experimental products were produced from secondary palm waste (stem - fronds) in the form of (compost, pressurized filters, string) without the use of chemicals, and their manufacturing methods were based on scraping and pressing machines. It can also be improved if combined with other plants (flax, cotton, jute, sisal, etc.) [17]. Accordingly, it is clear that the fiber extracted from the palm is a material base for a wide range of different industries.

This study is distinguished than other similar studies in that it tries to produce spinnable regenerated cellulosic fibers from Palm fibers for use in the textile industry.

2. Research Problem

Huge amounts of palm fiber are wasted every year in Saudi Arabia despite its great importance as a natural resource for cellulosic fibers that can be processed and used in the manufacture of some end-use textile products. Also, the failure to exploit this natural resource prevents the realization of economic benefits for the Kingdom, creating job opportunities and contributing to the addition of a new industry within the existing textile industries in the Kingdom. The research problem is summarized in the following questions:

- What is the possibility of extracting spin able cellulose fibers from palm fibres for use in the textile industry?
- What are the physical and chemical properties of cellulosic fibers produced from palm fibres, and what are the potential uses for these fibers according to their properties?
- Are there any statistically significant differences between the types of palm fiber in terms of the different physical and chemical properties of the cellulose fibers in them?

3. Research Objectives

- Examining the possibility of producing high quality cellulosic fibers from palm fibers for use in the textile industry.
- Identifying the potential uses through the physical and chemical properties of cellulose fibers and the thread produced from those fibers.
- Find out whether there are statistically significant differences between the types of palm fiber in terms of the percentage of difference in the physical and chemical properties of the cellulose fibers, so as to determine the type that contains the highest percentage of cellulose.

4. Research Significance

- To benefit from palm fiber as a natural resource for cellulosic fibers that can be used in the manufacture of textile products, which is currently a wasted and abundant by-product.
- To maintain the diversification and development of sources of economy and income in line with the Kingdom's vision (2030), which is based on the strengths owned by our country, especially the agricultural resources, which include palm fiber.
- Achieving economic benefits by utilizing palm fiber as a secondary source of agricultural wealth in the Kingdom, and persevering it from being wasted.
- Expanding the experiment to other agricultural products such as oil palm, to maximize the value of these untapped resources and creates new economic value.

5. Research Hypotheses

- It is possible to produce high quality cellulosic fibers from palm fibers for use in the textile industry.

- There are statistically significant differences between the physical and chemical properties of cellulose fibers and the thread produced from those fibers.
- There are statistically significant differences between the types of palm fiber in terms of the different physical and chemical properties of the cellulose fibers in favor of the sugar palm fiber, which makes its fiber the most suitable for extracting cellulose from it compared to other types of palms.

6. Research Methodology

The research followed the experimental method, which uses experience in examining and testing a specific hypothesis, and determines the relationship between two variables or factors, through the study of the corresponding situations that controlled all the variables except for the variable whose impact the researcher is interested in studying [18], in order to achieve the study's objectives, as the study was based on experimenting with different techniques on palm fiber material to extract cellulose and convert it into yarns for use in the textile industry.

7. The Research Sample

The research sample consisted of 7 samples of different palm fibers. Sugar palm was chosen because it has the highest concentration of cellulose. The samples were divided into two groups, the first as a control (before treatment) and the other as an experimental group (after treatment).

8. Research Tools

- Tests (physical-chemical-mechanical):
- Pruning the palm to obtain the fiber, where the raw material (palm fiber) was taken in its dry natural form, dried, cleaned and then cut into small parts, in preparation for conducting physical, chemical and mechanical tests on it.
- Testing the physical properties of the yarns, including: length, smoothness, appearance, and moisture.
- Testing the chemical properties: percentages of cellulose, hemicellulose, and lignin.
- Testing the mechanical properties: tensile strength, elongation, thread denier.

The examination procedures also included the following:

- Imaging the fibers by electron microscopy (SAM/E-DAX) before and after subjecting them to chemical treatments.
- Chemical treatment of the fibers to extract cellulose, after preparing the fibers, where the fibers were dried, cleaned and cut into small pieces and then chemically treated.
- Genetic fingerprinting of the fibers using a (PCR) machine by taking random samples from the fiber before treatment (crude fiber B) and comparing it with the fiber after treatment (the extracted fiber BN).
- Pulling cellulosic fibers and making a thread.

- Application of physical, chemical and mechanical tests of the thread.
- Analyze data statistically.
- Conclusion

9. Research Limits

- Spatial: The theoretical part was carried out in the Kingdom of Saudi Arabia and the applied part was conducted in the Arab Republic of Egypt; Where the cellulosic material was extracted from palm fiber and then transformed into a textile thread. Necessary tests were carried out in the laboratories of the Textile Industry Support Fund, the laboratories of the National Research Center, and the Delta Factory for Spinning and Weaving.
- Temporal: the study was conducted along four semesters to achieve the objectives of the study.
- Objectivity: Examining the possibility of extracting cellulosic material from palm fiber and turning it into spin able fibres.

10. Research Procedures and Devices

Sensitive Balance:

An electronic scale with very high quality and accuracy. It contains retractable doors to isolate the sample from the outside environment. It displays the results of its readings through a visible screen. It was used to measure the weights of samples during chemical processes (Figure 1).

Ultrasound device

It is a device that allows the disintegration of biological cells and tissues, as well as accelerates the interactions between materials, by converting electrical energy into intense ultrasound waves of 20 Hz to facilitate the method of dissolution and homogenization.

It was used to facilitate the dissolution of substances in solvents during chemical processes (Figure 2).

Source: From Nirco's website.

Figure 1. Picture of the sensitive scale.

Electrospinning System for R & D

A device that converts a polymer solution into fibers by controlling the external environment via adjusting the degree of pressure, temperature and humidity. The solution is contained in a tank (usually in a syringe), connected to a sharp needle (for needle electrophoresis), a pump, a high-voltage power source, and a (nanoponic) collector (Figure 3).

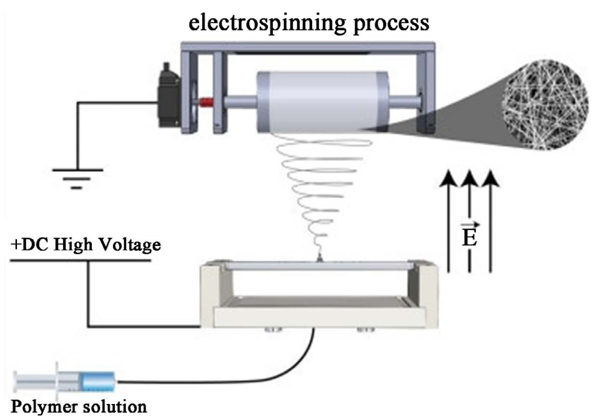
It was used to manufacture cellulosic nanofibers by making an external electric field directed on a polymer solution [19].

Fourier-Transform InfraRed Spectroscopy (FTIR):

Most biomolecules contain one or more saturated groups or aromatic rings and polar reactive groups that have the ability to absorb infrared radiation. The absorption of macromolecules is due to one or more radiation-absorbing residues such as amino acids, fatty acids and nitrogenous bases. Infrared spectroscopy is nowadays one of the most important analytical techniques; many methods have been published describing hydrogen bonds in cellulose by using different techniques, and FTIR has proven to be one of the most useful [20]. FTIR can be used to identify the chemical, and clarify the structures of natural and

Source: From the comcta. website.

Figure 2. Ultrasound image



Source: from the inovenso website.

Figure 3. Electron spinning device

modified natural fibers.

According to [21] and [22], each region on the electromagnetic spectrum has a specific energy that depends on the wavelength, and infrared radiation is divided into two main parts:

High frequency absorption area: It is the region where the absorption of the effective aggregates occurs and the wavenumber range in this region extends from 1300 - 3600 m^{-1}.

Low frequency absorption area: It is the region in which strong absorption of aromatic groups occurs, and the wavenumber range in this region extends from -1-650-909 m.

It can be divided into four distinct areas as follows:

- **Frequency region cm3600 - 2700 $^{-1}$:**

It is the region in which the absorption of the expansion of bonds occurs between a hydrogen atom and another atom of large atomic weight such as oxygen, nitrogen or carbon, and therefore this region is concerned with the expansion of the bonds H-C, H-N, H-O.

- **Frequency area cm2700 - 1850 $^{-1}$:**

It is the region where the absorption of the expansion of the triple bonds C = N, C = C occurs.

- **Frequency area cm1850 - 1555 $^{-1}$:**

It is the region where the absorption of the expansion of double or double bonds occurs C = C, O = C, N = C.

- **Frequency area 1500 - 700 $^{-1}$ cm:**

It is the fingerprint region that contains the adsorption of the single bond between carbon atoms and atoms other than hydrogen atoms such as O-C, C-C, Cl-C and others. The absorption of the bonds that make up the basic structure of the molecule occurs in it, and the extension of other bonds and bending of the bonds, so any small change in the structure of the molecule leads to a clear change in the number and positions of absorbers; Therefore, this area is called the footprint area.

Scanning Electron Microscope (SEM):

It was invented by Manfred von Arden in 1937 AD, and it is one of the types of electron micwroscopes in which the image appears as a result of the interactions of electrons with atoms on the surface of the sample, and produces various signals that contain information about the topography and composition of the surface (**Figure 4**).

The sample does not need to be cut into strips to see it, but it is sufficient to spray it with thin metallic paint. A beam of electrons is sent to fall on the surface of the sample, which causes the metal coating to fire a shower of electrons towards a fluorescent screen or photographic plate, giving an enlarged image of the object's surface, a stereoscopic and clear. Scanning electron microscopes can magnify objects up to 100,000 times.

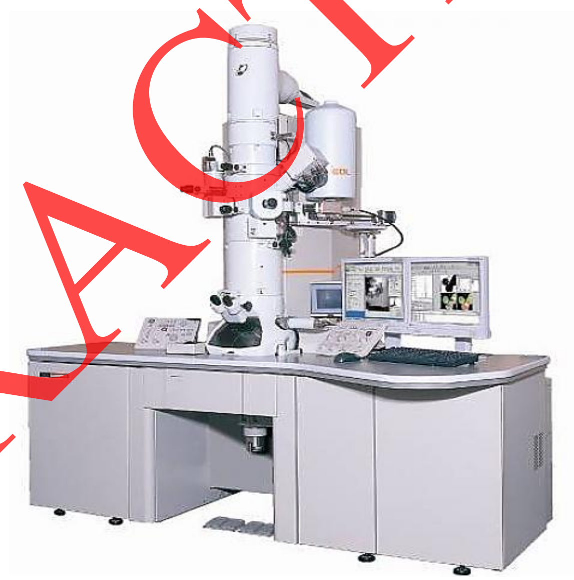
One of the device's attachments is Energy Dispersive X-Ray Analysis (EDX), referred to as EDS or EDAX (see **Figure 5**), which is an X-ray technique used to determine the elemental composition of materials [23].

Pressley Strength Tester:

Fiber strength measurement device (Figure 6). This method is used to determine the tensile strength or cutting strength of flat fibers, using a fiber length of

Source: from jascoinc.com.

Figure 4. Infrared device image.



Source: from the yupeace.org website.

Figure 5. Scanning electron microscope image.

Source: from the testextextile website.

Figure 6. Picture of a Persley test device.

known or equal to zero.

This method is characterized by its speed and ease, and the study of the relationship between properties, methods of operation and the quality of the final product.

Geneamp Polymerase Chain Reaction (pcr) Test Device (Figure 7):

It is a test device for DNA in polymeric chains. This method is used to determine the percentages of matches in acids between two different samples, using specific reagents [24].

Chemicals used in the study (Table 1)

Based on the studies reviewed by the researcher, the chemicals needed to carry out the experiment were identified as follows:

Sodium Hydroxide: To get rid of unwanted impurities.

- Sodium hypochlorite: to get rid of lignin (brown waxy substance) and bleach the color of the fibers.
- Acetic acid: to obtain acetylation.
- Ethanol: to get rid of impurities resulting from acetylation.
- Acetone: an intermediate for dissolving fibers.

Source: from the thermofisher company website.

Figure 7. Picture of the DNA test device.

Table 1. Materials used in the experiment.

Substance	Formula	Molar mass g/mol	Melting point	Boiling point	Density point
SODUIM hydroxide	NaOH	39.9971 g/mol	318˚C	1388˚C	2.13 g/cm^3
Sodium hypochlorite	NaClO	74.442	16˚C	101˚C	1.11 g/cm^3
Acetic acid	$C_2H_4O_2$	g/mol	289˚C	391˚C	1.049
Sulfuric acid	H_2SO_4	60.05	10.38˚C	279.6˚C	g/cm^3
ethanol	C_2H_5-OH	g/mol	−114.3˚C	78.4˚C	1.84
acetone	C_3H_6O	98.08	178˚C	329˚C	g/cm^3

Preparation of raw material

The raw material (palm fiber) was taken in its dry natural form, it was dried, and after cleaning, it was cut into small pieces. The material is later subjected to the following chemical treatment to get the best results (Figure 8).

Chemical treatment

The raw material was treated with chemical methods and materials as per the following stages:

The first stage (preliminary preparation):

10 g of raw material (fiber) (in the form of small portions) was put in a circular flask with a capacity of (1000 ml), (350 ml) of sodium hydroxide solution was added at a concentration of 10%, and then the mixture was heated at (100˚C) using evaporation for a period of (2 hours), then the solid was separated by filtration and a process of washing with distilled water was repeated several times to get rid of the alkaline substance. Finally, the material was dried with an electric dryer at (70˚C) for an hour and a half (see Figure 9).

The second stage (cellulose extraction):

10 g of the material obtained from the previous stage was placed in a circular flask with a capacity of (1000 ml) (see Figure 10). 50 ml of sodium hypochlorite solution was added at a concentration of 5%, and 200 ml of water was added. The mixture was shaken and heated at (50˚C) for a period of (two hours), then the solid material was separated by filtration and the washing process (removal of plankton and impurities) with distilled water was repeated several times to get rid of the alkaline substance. The process was repeated several times until the resulting material was completely bleached. Finally, the material was dried with

Figure 8. Picture of a palm leaf before and after cutting.

Figure 9. Pictures of palm leaf during treatment and after filtration.

an electric dryer at (70˚C) for 6 hours.

Third stage (cellulose acetate):

1gm of the chemically treated substance was added to the acetylation reaction medium, which consisted of (40 ml) of anhydrous acetic acid with (15 ml) of glacial acetic acid and (3 ml) of concentrated sulfuric acid as a catalyst (see Figure 11). The mixture was continuously shaken at a constant reaction temperature of (7˚C) using an ice bath for a period of (6) hours. Then the resulting material was filtered, washed with ethanol and then with warm distilled water (50˚C) for several times. Finally, the material was dried at (70˚C) for two hours.

Fourth stage (cellulose acetate fibres):

2 milliliters of cellulose acetate and 5 milliliters of acetone were placed in the ultrasonic device until complete dissolution (see Figure 12). A filtration was

Figure 10. Pictures of cellulose extracted after drying.

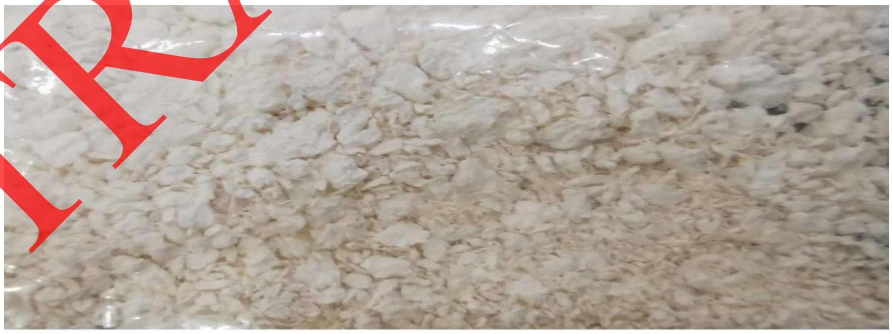


Figure 11. Pictures of cellulose extracted after drying.

Figure 12. Pictures of cellulose fibres.

done to ensure that there were no impurities, and then the material was placed in the electronic spinning device. Finally, the fibers are manually wrapped on the spool of the machine.

<u>**Physical Analysis**</u>

It is noticeable that the color of the fibers changed after treatment with chemicals, and this means a decrease in the percentage of (lignin and hemicellulose) present in the fibers as shown in (Figure 13) and the comparison was made via observation.

11. Results of Experiments

Physical and mechanical properties of fibers:

It is necessary to know and determine the physical and mechanical properties of textile fibers, and to determine the standard specifications and properties of raw and processed fibers and their relationship to each other in order to improve product quality and competition in global markets.

Analyzes of the components that make up parts of the palm, such as date fruit, kernels and pollen (pollen) have been conducted in two studies by [25] and [26].

Microscopic examination

Electron microscopy (SAM) was used. The raw fiber (B) and the post-treatment fiber (BN) were photographed at high magnifications, to observe the difference between the surfaces of the outer capillaries and the amount of improvement in them.

Comparisons were made with microscopic imaging of the fibers using the (SEM) device. It was proven that chemical treatments improved the resulting fibers after treatment in terms of appearance and smoothness. This is supported by many studies such as [27] [28] that were conducted on flax and hemp, and the study of [29] [30], which were conducted on different parts of dates.

Infrared analysis of fibers (Table 2)

It is clear from the infrared spectrum of the cellulosic fibers extracted in (Figure 14) that there are two main absorption regions which are the high absorption region (3500 - 2800 cm^{-1}) for NO_2^- and the lower absorption region (800 - 1700 cm^{-1}) for COH-, and a strong and wide absorption was noted in a

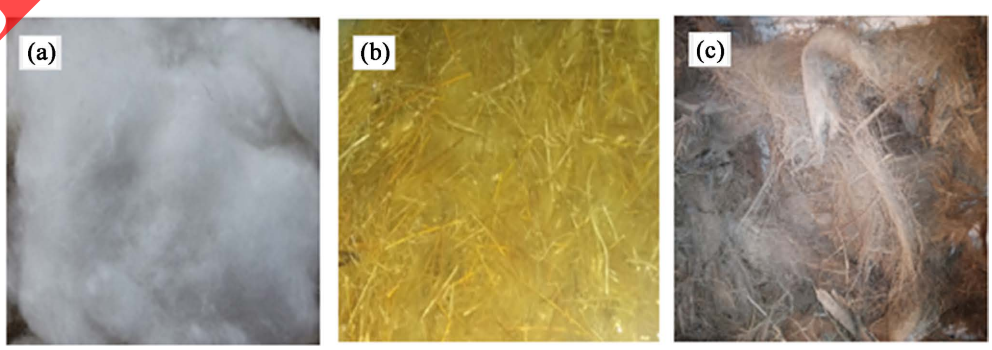
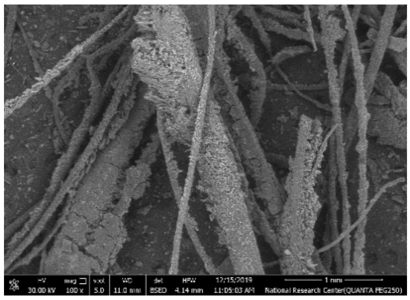
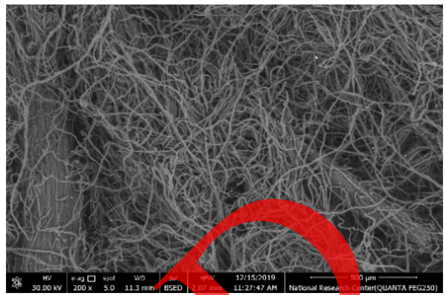
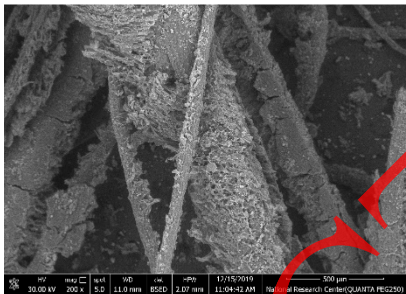
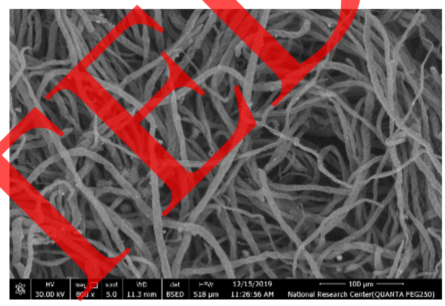
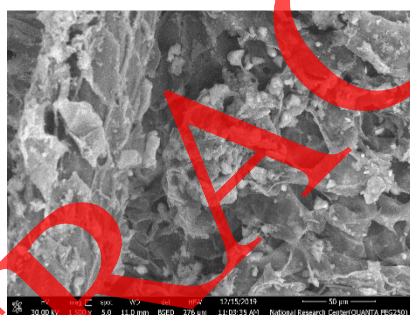
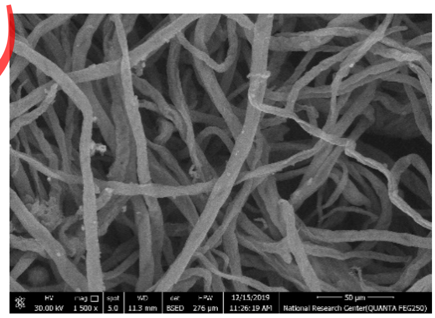
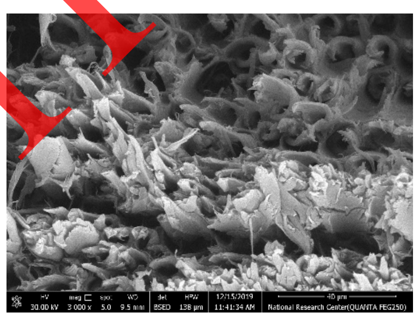
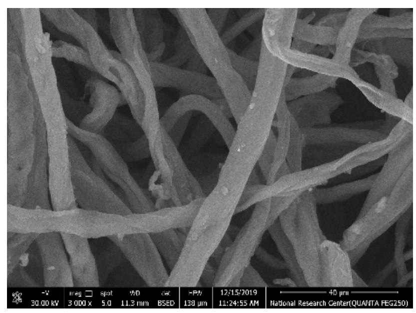


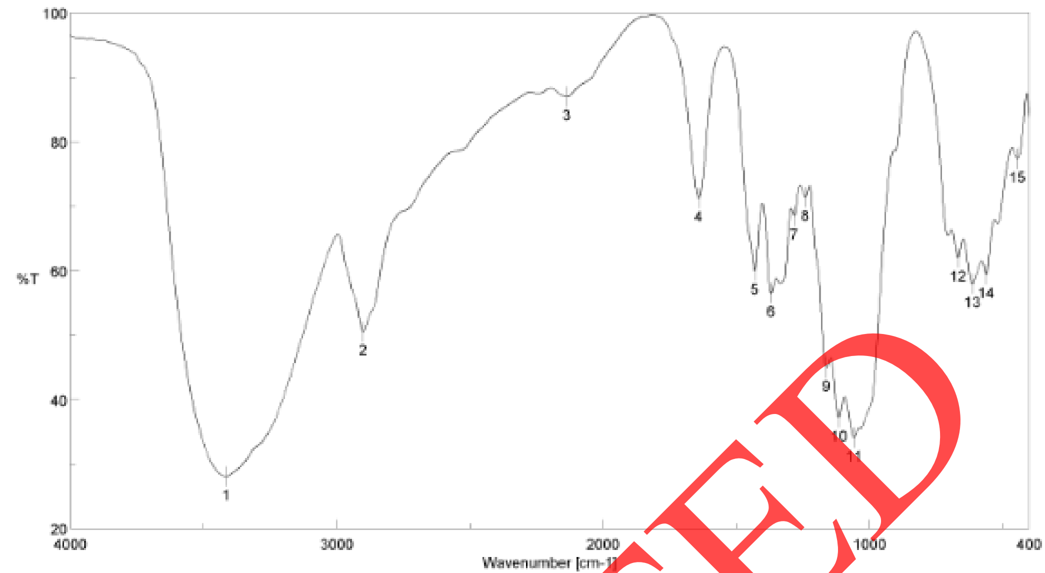
Figure 13. Pictures (a) The fiber before treatment, (b) The fiber after treatment, (c) Cellulose extracted.

Table 2. The shape of the fibers before and after treatment.

Level of magnification	B	BN
200		
800		
1500		
3000		

wave of 3500 cm^{-1}, due to the presence of hydrogen bonds on cellulose and that the absorption of radiation by fibers in the most important points appeared as follows:

- (1400 - 1450 cm^{-1}) where the alkane bonds derived from lignin appear.
- (1300 - 1350 cm^{-1}) single bonds with atoms taken from aromatic circular polysaccharides appear.
- (1100 cm^{-1}) where hemicellulose and lignin were removed
- (1050 cm^{-1}) where bonds appeared to confirm an increase in the value of crystalline cellulose.



[Result of Peak Picking]

No.	Position	Intensity	No.	Position	Intensity	No.	Position	Intensity	No.	Position	Intensity
1	3414.35	28.07409	2	2900.41	50.52893	3	2136.74	86.98183	4	1641.13	71.25904
5	1429.96	59.94429	6	1369.21	56.50003	7	1282.43	68.48580	8	1240.97	71.37182
9	1160.94	44.94178	10	1114.65	37.19683	11	1057.76	34.10664	12	667.25	61.98840
13	613.252	57.93852	14	561.184	59.39122	15	444.512	77.38091			

Figure 14. Infrared spectrum of extracted cellulose fibres.

These results differ from the results of infrared spectroscopy for cotton fibers in the studies of [31] [32] and [33].

It also differs from the results of infrared spectroscopy for flax fibers in Bismarck's study [34], as well as the results of infrared spectroscopy for jute fibers in Duan's study [35] and Abbasi (2019) and differs from the results of the infrared spectrum of hemp fibers as in Stevulova's study [36].

X-ray spectroscopy (E-DAX) analysis

The ratio of the basic components of different parts of the palm was measured according to the following studies: [37] [38] [39] and [40].

Based on the above, the electron microscope attachments (E-DAX) were used to analyze the extracted cellulose to find out its constituent elements as listed in (Table 3). It was found that the highest substance is oxygen, followed by calcium, and the lowest substance is potassium (Figure 15).

Calcium is one of the most important elements that form cell walls in particular, and it is of great importance in the formation of cell membranes, and it is important for the normal functioning of the cell wall and plasma membranes [41].

Analysis of the basic components of fibers (ASTM D5867)

Through the implementation of the (ASTM D5867) test to identify the natural properties of the fibers and the percentages of changes between the basic components in the sugar palm fiber, a comparison was made between the raw fiber (B) and the fiber after treatment (BN), and the analyzes have demonstrated as shown in (Figure 16) that raw fiber made up the bulk of the ingredients, while moisture constituted the least proportion of the components. Carbohydrates

Table 3. Percentages of the contents of the extracted cellulose.

Substance	O	Zn	Mg	Al	Si	S	K	Ca	Fe
Percentages	44.69	4.38	4.86	4.11	8.6	2.14	1.82	25.84	3.75

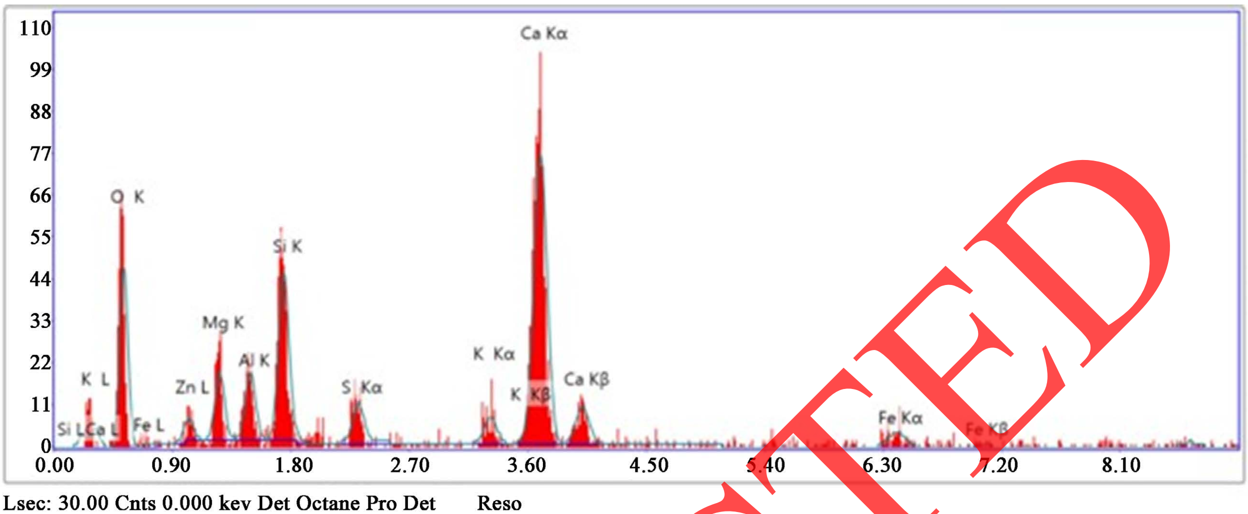


Figure 15. Components of the extracted cellulose.

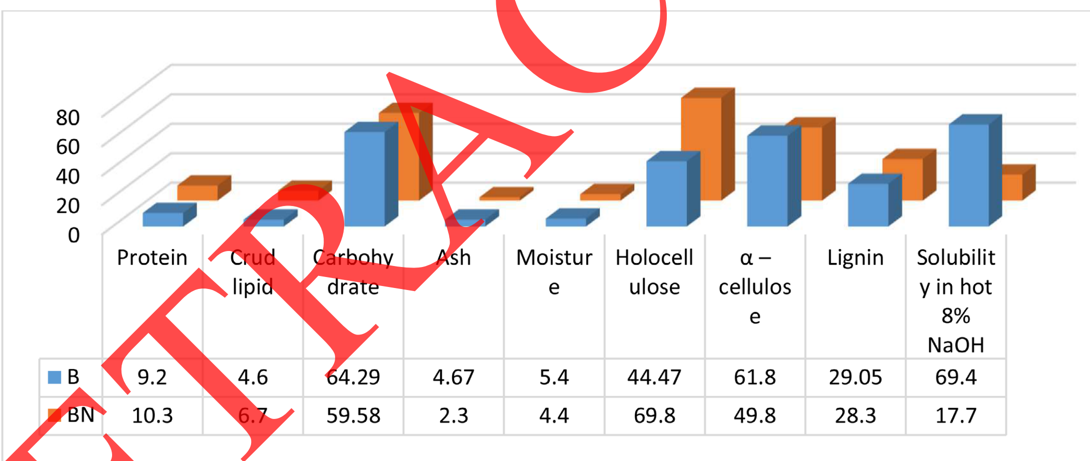


Figure 16. The main components of the fiber before and after treatment.

accounted for the highest percentage of fiber after treatment, while ash formed the lowest percentage of the components.

PCR. polymerase chain reaction test

In view of the foregoing tests on the fibers of natural plants (genetic fingerprint analysis) such as the cotton plant as in the study of [42] and [43], which proved that the extracted fibers are part of the same natural plant (cotton). In their papers, they made genetic fingerprints for different types and parts of palm, and the fronds and stems parts were among the parts that were analyzed [44] and [45].

Based on the above, the fingerprint analysis of palm fibers was conducted using a (PCR) machine by taking random marks from the fiber before treatment (crude fiber B) and comparing it with the fiber after treatment (extracted fiber BN), as shown in (Figure 17).

Through the analysis, matches of each marker with the fibers were compared, and the genetic similarity between BN and B was recorded at 91.5, 80, 85, 100 and 100% for the five random markers, respectively, as shown in Table 4 and Figure 18.

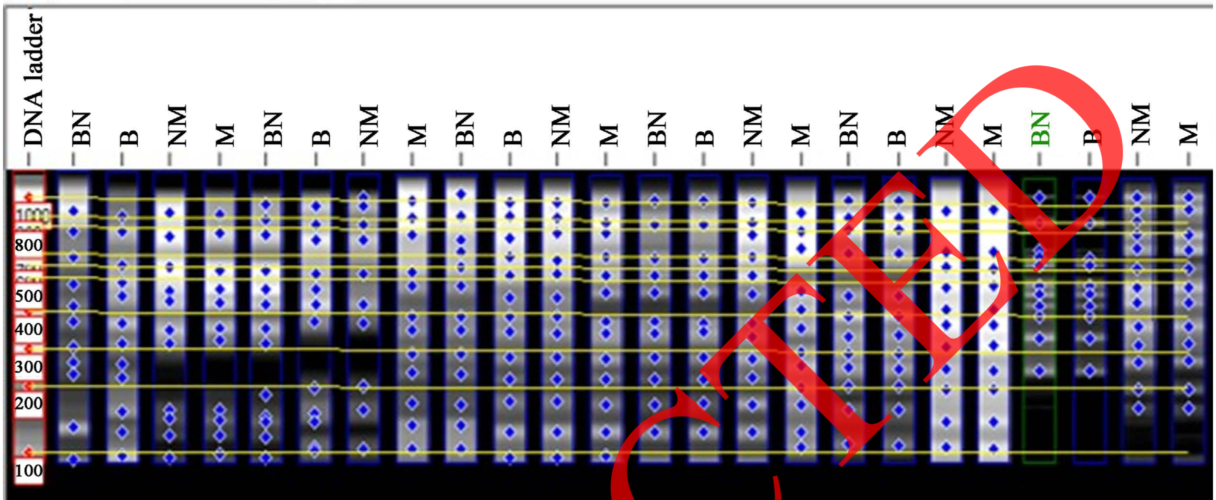


Figure 17. Matching random test scores.

Table 4. Shows the percentage of matches of each marker with the fibers.

	Primer1		Primer2		Primer3		Primer4		Primer5	
	BN	B	BN	B	BN	B	BN	B	BN	B
Total amplified bands	11	12	13	12	13	13	11	11	12	12
Polymorphic bands	2	2	4	3	2	2	0	0	0	0
Monomorphic bands	9	11	11	9	11	11	11	11	12	12
Similarity %	91	92	85	75	85	85	100	100	100	100
Total	91.5		80		85		100		100	

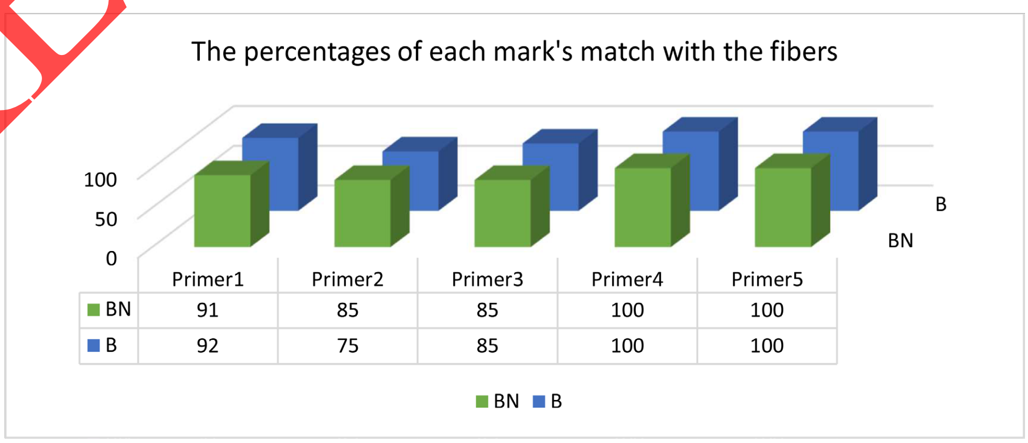


Figure 18. The proportions of each marker with the fibres.

And it was clear that there was a wide difference between the results of the samples compared with five genetic fingerprints for the Egyptian cotton types (G92, G93, G86, G87, G88).

Fiber Tests

The properties of the yarns depend on the type of fibers used, and by identifying the properties of the fibers, a high-quality product can be obtained to reach a high-performance efficiency (see **Figure 19**), according to [46].

Thus, ASTM D1440 test for length, ASTM D1445 test for durability, ASTM D2495 test for moisture, and ASTM D1448 test for the softness of fibers after treatment were carried out (the extracted fiber BN), **Table 5**.

Through a comparison between treated palm fibers and natural fibers, it became clear that the softness of palm fibers is 4.5 dinars, which is a low percentage compared to flax, which amounts to 1.7 dinars, and close to the percentage of wool, which ranges from 3 - 5 dinars, as mentioned [47] in **Table 5**, which means that it gives relatively coarse fabrics that are not preferred in summer clothes.

The length of the treated palm fibers was close to flax, as it reached 27 mm in length, and the flax fibers were 25 mm in length, which means that the cohesion strength of the fibers increases, and thus the strength of the produced thread increases.

The durability of treated palm fibers is equal to that of linen, as the durability of the fibers leads to obtaining durable threads, so the number of cuts in the

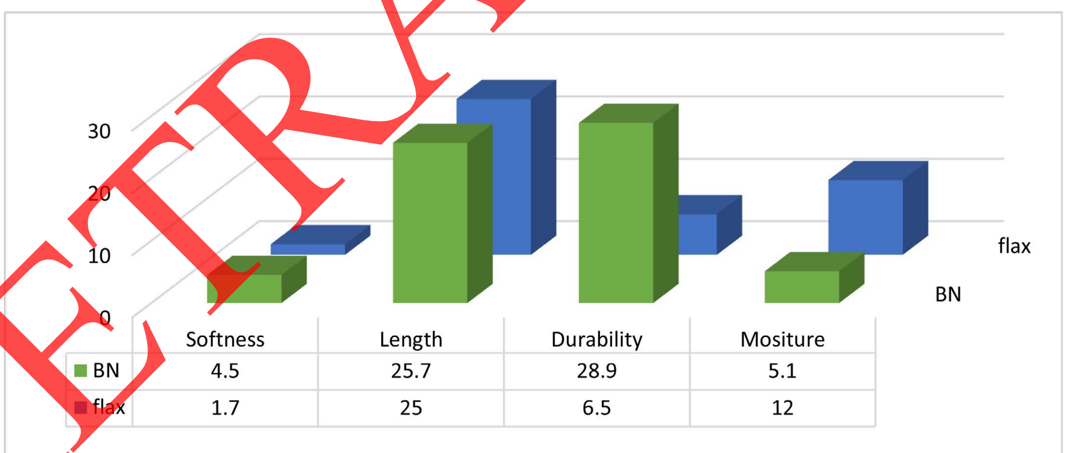


Figure 19. Comparison of filament tests.

Table 5. Fiber tests.

Test details	Test type	The result
Humidity	(ASTM D2495)	5.1%
durability	(ASTM D1445)	28.9 g/denar
height	(ASTM D1440)	25.7 mm
softness	(ASTM D1448)	4.5 dinars

threads decreases during the different stages of operation, in addition to the durability of the final fabrics in the future.

Sometimes short fibers are preferred to produce fabrics that have a smooth hairy surface and are warm to the touch because the spun yarns contain air spaces, which insulate the heat and provide softness to the touch.

As for the moisture absorption test, the treated palm fibers were less absorbent than linen. It was found that the absorption rate was 5.1%, which is equivalent to the absorption rate of nylon, and therefore it can be used in rain-protective clothing.

From all of the above, we conclude that it is possible to make threads and fabrics with the length and durability of the existing filaments, and that the percentage of softness is low, which means that the fabrics are close to the feel of wool and that the absorption of moisture is very low in a way that allows manufacturing rain and water-resistant fabrics.

Test of spun yarn

The properties of the fabrics depending on the yarns, and by identifying the properties of the yarns, a high-quality product can be obtained to reach a high-performance efficiency. Thus, tests were carried out (ASTM D1907 for thread denier, ASTM D2256 for tensile strength, ASTM D1425 for regularity and defect ratio, and ASTM D2255 for regularity after treatment of fibers (extracted fiber BN) (Table 6).

The analyzes showed that the tensile strength of the flax was higher than that of the palm fibres, due to the chemical treatments that were carried out on the palm fibres. This was confirmed by the study of (Rizk and Al-Awwam, 46) (see Figure 20) which means that it is less resistant to cutting speed than linen. That is, it is rubber and has the ability to withstand an elongation before cutting by 7.6%, and this property is very important in clothes, especially in places subject to tension such as knees or elbows. In the production of yarns and fabrics, it is preferable that the elongation is not less than 10% (but there are fibers such as cotton and linen that have a small elongation at break, but they are successful in the clothing industry). This means that threads and fabrics from palm fibers can be made similar to cotton and linen.

The appearance of the threads was lower than that of linen, due to the fact that the threads contain thick and very thin places, as they did not go through

Table 6. Tests of natural fibers.

Test type	Fibers		
	cotton	linen	wool
Humidity	8.5%	12%	13.6% - 16%
durability	3 - 5 grams/denier	6.5 g/denar	1 - 1.7 g/denar
height	16 - 52 mm	25 mm	50 - 120 mm
softness	1.5 - 2 dinars	7.1.3 - 1 dinars	3 - 5 dinars

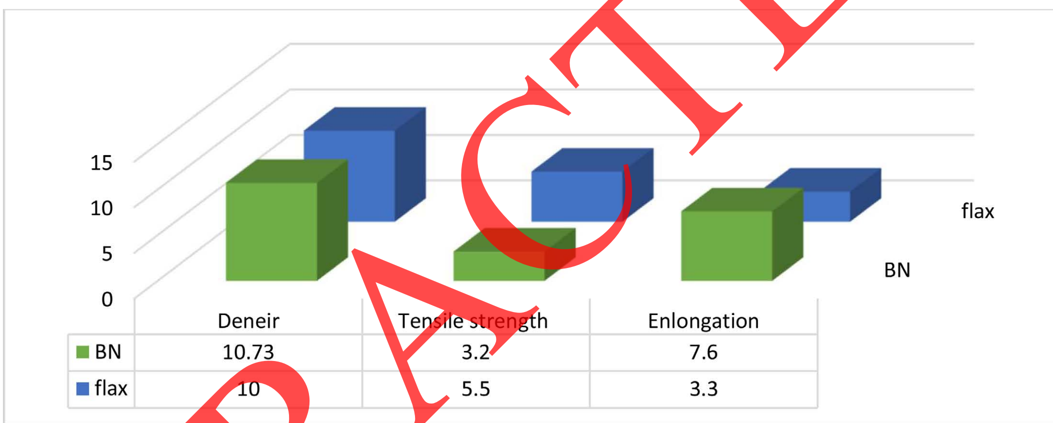
the stages of combing due to the small size of the extracted sample, and therefore the appearance can be improved if the amount of fibers is high.

Comparison of different palm fibers

Through the foregoing tests of cellulose fibers extracted from palm fiber, a sample of different types of palms was taken to compare fibers in terms of strength and length through ASTM D1445 test and ASTM D1440 test respectively, and determine the best type among them (Table 6).

As per Figure 21, and by comparing the previous results of the fibers, it was found that the best type among the palm types is the sugary one because its fibers are characterized by length. The least long fiber was Ruthana, and it was found that the high strength was in favor of Luna, followed by Al-Anbara, then Al-Safawi, and the least was Ajwa.

Thus, the third hypothesis can be proven as changing palm fibers can improve yarns and fabrics in favor of fruitful palm fibers (sugar in fiber length and Luna



	Deneir	Tensile strength	Enlongation
BN	10.73	3.2	7.6
flax	10	5.5	3.3

Figure 20. Comparison of thread tests.

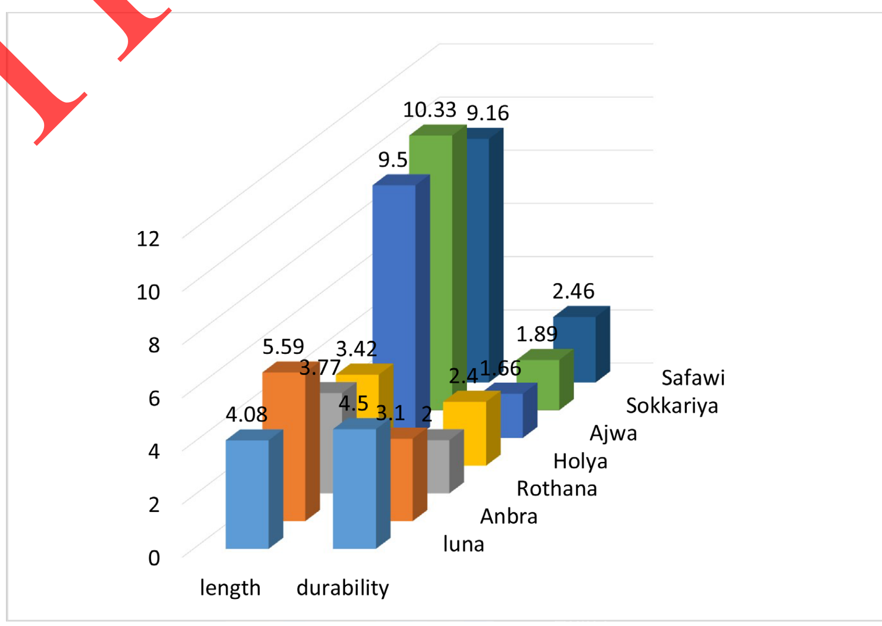


Figure 21. Comparison of various palm fibers.

in durability).

The study reached several results that can be summarized as follows:

- The fibers have been discolored after treatment and this is due to the low percentage of lignin and hemicellulose present in the fibers.
- It turns out that the percentage of cellulose in the sugar palm fiber ranges between 49.6% - 61.9%, which provides high investment opportunities.
- We find that the softness of palm fibers is low compared to linen, and this means that it gives relatively coarse fabrics similar to wool.
- It was found that the best type of palm fiber is sugary because it is characterized by its length and high durability.

11. Recommendations

- Using the results of the study to increase benefits from palm trees and increase job opportunities.
- Conducting more studies on date palms because of its great importance.

Inviting the concerned authorities to spread awareness among farmers about the importance of palm fiber and its economic value.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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