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Study of Extraction, Treatment and Characterization of Pineapple Leaves Fibers as Potential Utility in Textile Industry

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ABSTRACT

Extraction, treatment and characterization of pineapple leaves fibres was achieved. The study revealed that water retting is the best way to extract fibers as it is easily controlable which reduces the chance of reducing the strength of fibres. Also,it was observed that dried pineapple leaves fibres take longer time to ret compare to fresh leaves.The fibers were treated using NaOH for scouring while bleaching was carried out using H_2O_2. The treatment of fibers was conducted to get rid of fat, wax and other impurities as well as undesired colors bonded to fibers that could not be removed through water retting. The best scouring concentration of NaOH was found to be 1.25 % while the best bleaching concentration of H_2O_2 was found to be 10 %. More so, FTIR was carried out for both treated and untreated fibers and it was shown that wax, fat and other impurities can be removed by fibres' scouring and bleaching. This was further confirmed by the use of Soxhlet to extract ethanol-benzene extract from both treated and untreated fibres, where untreated fibres showed a considerable weight loss while the treated fibers did not show any weight loss. Thereafter, mercerization was carried out and it was found out that the best mercerization concentration for pineapple leaves fibres is NaOH is 10%. Furthermore, the quantitative analysis of pineapple leaves fibers revealed that the fibers have, ethanol-benzene extractives of 2.6 %, pectin content of 1.53%, Lignin content of 12%, cellulose content of 79% and ash content of 2.15 %. The fibers showed a water, oil and vapor absorption of 82%,32 % and 29% respectively. Also, the thermal analysis showed that the degradation temperature is 400 ^{0}C while the fibers started to display thermal instability at 350 ^{0}C. Moreover, SEM and XRD analysis showed that the treatment of fibres participated in removal of wax and oil as well as other gummy materials, which also is in line with FTIR results obtained.

Keywords: Extraction, Pineapple Leaves Fibers, Scouring, Bleaching, Mercerization, Characterization, Textile

INTRODUCTION

Fiber waste from various agricultural activities has become a common environmental problem due to challenges with proper disposal among other environmental problems such as effect on health and environment as well as bioremediation potential of living organisms. Due to growing environmental concerns, the utility of both natural fibers is rising nowadays on a global scale. It has been discovered that producing synthetic fibers from petroleum-based materials is dangerous, non-biodegradable, and requires more energy [1]. Moreover, natural fibres have so gained popularity due to their low price and improved qualities. Natural fibres are the fibres that are obtained from plants, animals or mineral sources. Some of the natural fibres include cotton, silk and wool. According to their origin natural fibres are classified into three categories namely cellulose based fibres which are derived from plants like cotton, flax or linen, sisal, hemp and jute. Protein based fibres which come from animals like wool, mohair and silk as well as mineral based fibres which come from geological processes like asbestos, glass and metal graphite fibres [2]. The presence of biodegradable natural fibres has triggered researchers to study its feasibility in its usage in textile industries in which it will replace synthetic fibres that is globally used in textile industries due to its negatives effect on the environment [3]. Natural fiber performance varies depending on a number of parameters, including the procedure used to remove the fiber from the plant, the age of the plant, and other considerations. Natural fibres are extracted from their sources via a process called retting. Retting is basically of two types mainly dry retting and water retting. Water retting

technique is being used in Asian countries [2]. This research is aimed in extraction, treatment and characterization of pineapple leaves fibres and study of its potentiality to be used in textile industry.

MATERIALS AND METHOD

Extraction of Pineapple Leaves Fibres

Pineapple leaves fibres were extracted using water reting process. The sorted and cleaned pineapple leaves were put into a large basin, which was subsequently filled with fresh water until the leaves were completely submerged, following this the basin was covered with a metal sheet in order to exclude direct sunlight and rain. The basin was opened frequently, each 5 days, to measure possibility of fiber extraction manual as well as to check the cleanness of the water where water was changed where necessary [4]. However, to be sure that the renting process had come to the end. The extracted fibers which were still having gum-like substance glued to them. Thereafter, the fiber with gum-like were dried and its weight was recorded. Afterward, the dried fibers were replaced in the container and tap clean water was added until the fibres submerged by water for further renting. The re-soaked fibres for further renting were being removed from the water each 5 days washed with running tap water dried and its weight was recorded. The process was repeated until the fibers showed insignificance weight loss percentage which marked the end of renting process.






After the pineapple leaves fibers extraction, the fibers were kept in a closed nylon amid next step of fibres' treatment (Scouring).

Purification of Pineapple Leaves Fibre

After renting, the obtained pineapple leaves fibres appear with oils, fats, waxes, impurities and unpleasant colors which need to be removed to create fibres of good quality with a good dye affinity. This was achieved through two processes namely scouring and bleaching.

Scouring

Dried ten pineapple leaves fibres bundles of 5 gm were measured, this was followed by the preparation of 0.25 %, 0.5 %, 0.75 %, 1 %, 1.25 %, 1.5 %, 1.75 % , 2 %, 2.25 % and 2.5 % NaOH solution in 200 ml beakers. Afterward, fibre bunch was put in each beaker of NaOH solution heated at 100^{0}C for30-40 minutes. While heating the fibres, a stirring rod was used to turn the fibres for uniform reaction. Then, the fibre bundles were removed from the beaker, washed with running water and sun dried for 48 hours where its weights were recorded after drying [5]. The following formula was used to figure out the percentage of weight loss of the fibres bundle due to scouring process.

Weight Loss Percentage of the Sample= {(Wi-Wf)/ Wi} x 100%

Where Wi and Wf is initial weight before scouring and weight after scouring respectively.

Bleaching

A bunch of 30 gm of Pineapple leaves fibres was measured. The bunch of fibres was scoured using 1.25 % NaOH at 100 ^{0}C for 30-40 minutes to remove no cellulosic materials. Thereafter, the fibres were rinsed with running water and sundried for 48 hours. After, drying the bunch of fibres was divided into various small seven bunches of fibres weighing 3 gm. Then, the weight of the bundles after scouring were recorded and various concentration of Hydrogen Peroxide (H_2O_2) were prepared in 200 ml beakers. 5 %, 10 %, 15 %, 20 %, 25 %, 30 % and 35 % solutions of H_2O_2 were prepared. Afterward, the scoured bundles of fibers were put in the beakers, heat at 100 ^{0}C for 25-30 minutes. Then, the fibre bundles were removed from the beakers, washed with running water and dried where its weights were recorded after drying [6]. The following formula was used to figure out the percentage of weight loss of the fibres bundle due to Bleaching process.

Weight Loss Percentage of the Sample= {(Wi-Wf)/ Wi} x 100%

Where Wi and Wf is initial weight before bleaching and weight after bleaching respectively.

Bundle Fiber Tension Force Test After Bleaching

The tension force was measured in the mechanical engineering laboratory, Moddibo Adama University, Yola. The treated fibres were formed into a fibres bundles of 15 cm weighing 5 gm [7]. The fibres bundle was held by a grip and loads of known weigh were applied till failure occurred. The tension force was calculated using the following formulae:

$F=m*g$

Where m is mass of the load applied until failure occurred and g is the standard gravity constant of 9.8 m/s^2. This was done so as to find the effect of increases of H_2O_2, a bleaching agent, concentration on the strength of the fibres.

Pineapple Fibres' Mercerization to Enhance Dye Absorption

The pineapple leaves fibres that underwent treatment (Scouring with 1.25 % NaOH for pineapple leaves fibres, and bleaching with 10 % of H_2O_2 for pineapple leaves fibres). The treated fibres were mercerized with 10 %, 15 % and 25% NaOH aqueous at 15°C for 10 min. The experiment was carried out in a water bath and the condition of 15°C was created with the help of ice block to maintain the temperature at 15°C. The samples were being turned with a glass rod to ensure an even treatment. The samples were rinsed in tap water. The water absorption of samples was recorded before and after mercerization to find out which Concentration of sodium hydroxide that increase fibres' water absorption [8].

Pineapple Leaves Fibres

Fourier Transform Infrared Spectroscopy for Treated and Untreated Pineapple Leaves Fibres' FTIR was carried out to figure out the functional group of fibres from pineapple leaves. The FTIR analysis was conducted for both treated and untreated fibres. The analysis was conducted at American University of Nigeria, Chemistry Laboratory.

Quantitative Analysis of Fibres' Constituents

Ethanol-Benzene Extractives Content (E_B)

A soxhlet extraction of 1.9 g of pineapple leaves fibres, was conducted using benzene and ethanol (1:2 v/V). The cartridges of fibres were removed from Soxhlet after the extraction was completed, dried in woven at 105^0 C [9]. The level of ethanol-benzene extractives (Resins, Oil fats and Waxes) was determined using the equation below.

$E_B = \frac{m_0 - m_1}{m_0} \times 100\%$

where, m_1, the mass of the dry residue I extracted after evaporation of Ethanol-Benzene solvent and m_0 the mass of the sample before extraction.

Pectin Contents (E_P)

A mass of 1.3 g of residue I was introduced into a flask of 250 ml and 50 ml of 2% HCl solution was added. The mixture was heated under the reflux by stirring in a water bath at 80°C for 2 hours. Residue II was retained by filtration, and it was washed with distilled water and dried in the oven at 105°C until dried and its weight was recorded after cooling.

The Pectin content was determined using the following formulae [10].

$E_P = \frac{m_1 - m_2}{m_1} \times 100\ \%$

Where m_2 is the dry mass of Residue II while m_1 is the dry mass of residue I.

Lignin Contents (EL)

A mass of 0.2 gram of residue II was treated with 5 ml of 72 % concentration Sulfuric Acid for one hour in water bath at 30°C to hydrolyze the polysaccharides. The mixture was then diluted to the acid concentration of 3 % by addition of 120 ml of distilled water, and brought at 120° C in an oil bath for 2 hours. Afterward, the sample was cooled in a cool water bath and filtered using a Buchner system.

The residue that was made up by insoluble lignin was dried at 105°C and its weight was recorded [10].

The lignin contents (E_L) were calculated by the following equation:

$E_L = m_L / m_3 \times 100\%$

where m_L is the mass of extracted Lignin, m_3 the mass of Residue II.

Cellulose Content (E_C)

A mass of 1 g of Residue II was introduced into a beaker containing 50 ml of 5 % NaOH for two hours. The flask was heated in water bath for one hour at 50°C. The residue was washed with running water to get rid of lignin and hemicellulose removed by NaOH. The residue obtained was dried at 105 °C for 5 hours cooled and weighed [11].

The Cellulose content was determined using the following equation:

$E_C = (m_c/m_2) \times 100\ \%$

where m_c and m_2 are mass of cellulose and mass of Residue II.

Fibres' Ash Content (AC)

2g of fibres were placed in a porcelain crucible and then calcined at 1000°C in furnace for 2 hours. The ash content was measured via mass balance where the crucibles were weighed with the material before and after calcination [12]. The ash content was measured according to [10] using the following formulae.

$A.C = (m_a / m_f) \times 100\%$

Where m_a is the mass of ash obtained while m_f is the mass of fibres.

Fibres' Water , Moisture and Oil Absorption Test

Water absorption test was carried out according to [7] fibres specimens were placed in oven at 150 °C for 1 hours to drain all captured moisture. Thereafter 1 g of each fiber was measured and immersed in water at room temperature for 2 hours. After, the sample fibres were removed and patted dry with a lint free cloth, and weighed using an electronic weighing balance.

The percentage water absorption was determined using the following formulae

$\%\ W.A = \{(W_f - D_f)/ D_f\} \times 100\%$

Where W_f and D_f stand for wet and dried fibres respectively.

Oil and moisture absorptions test were carried out like water absorption test by changing absorption medium with Soya beans Oil and water vapor respectively. The water vapor was created by heating water bath at 85°C and the fibers were hanged on 13 Cm above the level of water in the water bath for 2 hours [13].

Thermal Analysis

Thermal analysis which involves the techniques that study the properties of materials as they change with temperature. Thermal analysis was conducted at Tafawa Balewa University, and both Thermogravimetric Analysis (TGA) and Differential Thermal Analysis (DTA) of the fibres were carried out. TGA measures change in weight in relation to change in temperature while DTA involves the measurement of temperature difference between a substance and a reference materials [14].

Morphology Analysis

Morphology of banana pseudo-stem fibres was studied with using scanning electron microscopy (SEM).

Crystallinity Analysis

Crystallinity analysis of banana pseudo-stem fibres was studied with X-Ray Diffraction (XRD

RESULTS AND DISCUSSION

Extraction of Pineapple leaves Fibres

The extraction of pineapple leaves fibres was carried out using water retting. During the course of retting pineapple leaves fibres, it was observed that the pineaples leaves do not get retted at the same time, some were able to be retted in 21 days while others become retted after 30 days. This is because the retting process depend on many factors including the place where the plant was grown, maturity of the plant, room temperature during retting etc, [15]. Also, it was noticed that the dried pineapple leaves take much time to ret compare to fresh pineapple leaves, this is because dried pineapple leaves need to absorb water in its cells to swell up before the retting process begins, unlike fresh pineapple leaves that has water in its cells. Also, dried pineapple leaves resulted in brownish fibres compare to fresh pineapple leaves that resulted in yellowish-green fibres which request extra effort to bleach.

Treatment/Purification of Pineapple leaves fibres' purification

Scouring

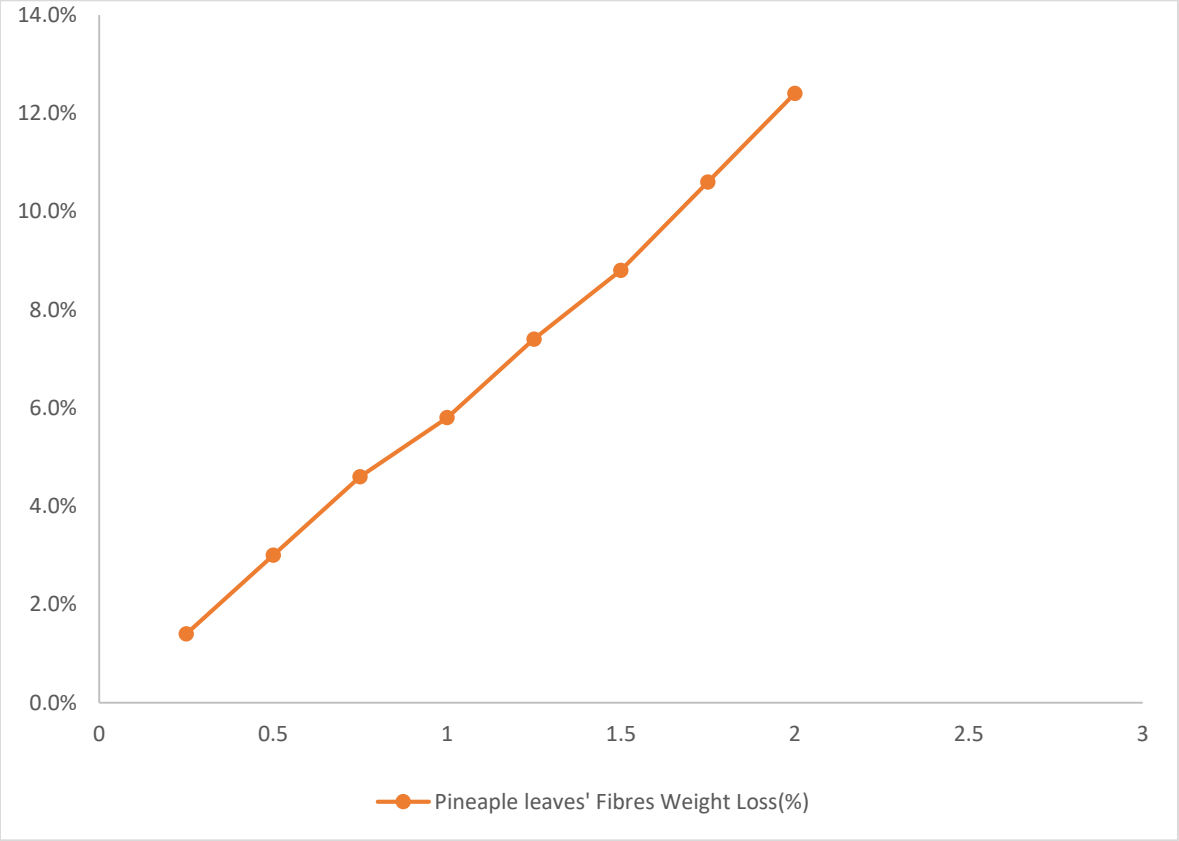


Figure 1: Effect of NaOH of Various Concentration on Weight Loss of Pineapple Leaves fibres (NaOH concentrations on X-axis and Weight loss on Y-axis)

Figure 1, present the various concentration of Sodium Hydroxide used in the scouring of pineapple leaves fibres and various weight loss of the samples at various concentration were recorded. The concentration ranges from 0.25% to 2 % with the interval of 0.25 % which resulted in the obtainment of 8 samples. The highest weight loss of 12.4 % was recorded at the concentration of 2 % while the lowest weight loss of 1.4 % was recorded at the concentration of 0.25 %. The exercises revealed that the sample scoured with 1.25 % concentration of NaOH have7.4 % weight loss which fall within the range of the standard weight loss of scoured fibres of 7-8% [16]. Therefore, the best NaOH concentration for scouring pineapple leaves fibres is 1.25 % which gives the weight loss of 7.4 %.

From the weight loss comparative graphs, it can be noticed that the increase of NaOH concentration is

directly proportional to the increase of fibres weight loss. That is to say, the weight loss of fibres increases with the increases of concentration of NaOH and vice versa. This is attributed to the fact that unscoured fibres contain various kinds of impurities that can't be removed during renting such as waxes, fats, and mineral salts that when unremoved they cause the fibres to be non-absorbent to the dye. Scouring process remove all fat/oil and waxes materials and hydrophobic character of fibres are removed from the fibers with the aid of alkali such as sodium hydroxide. During scouring, saponifiable oils and free fatty acids convert into soaps, pectose and pectin change into soluble salts of pectic acid, proteins hydrolyze into soluble degradation products, and the unsaponifiable oils and waxes are emulsified by the soaps formed from saponification. Saponification is the reaction in which insoluble and water-immiscible materials convert into water-soluble products, and its reaction is as oil + caustic soda + water = soap +glycerin. The removal of the non-cellulosic materials lead to the weight loss of the fibres [17]. Moreover, the chemicals used during scouring attack fibers at higher concentration, leading to reduction in strength and loss weight as well. This is because sodium hydroxide works on swelling methods and attack the secondary cell wall of the fiber which is mainly pure cellulose [18].

Bleaching

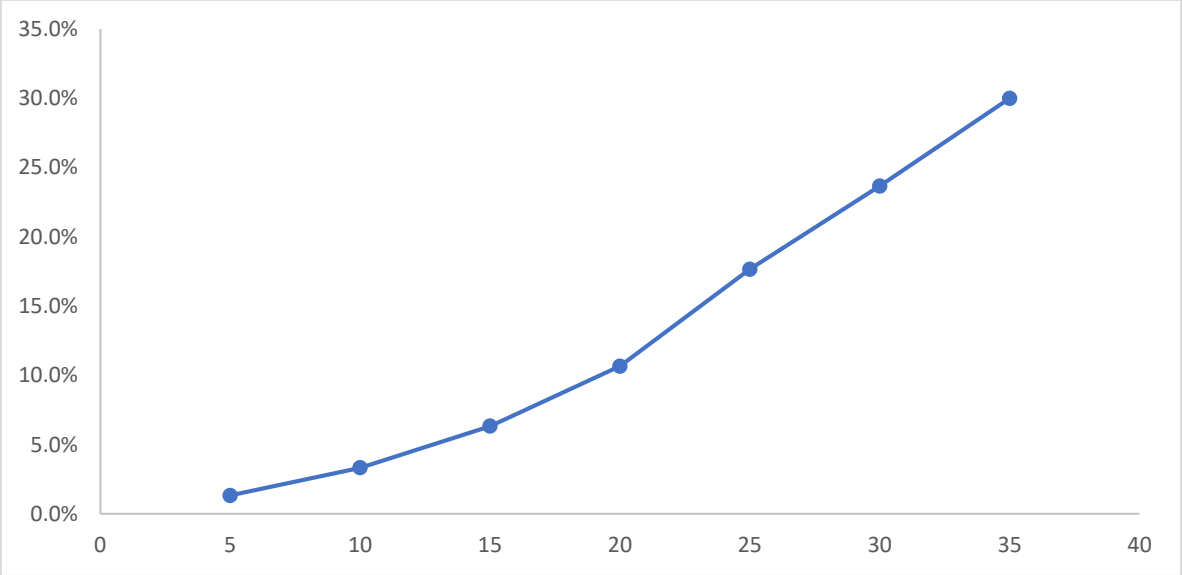


Figure 2: Effect of H_2O_2 of Various Concentration on Weight Loss of pineapple leaves Fibres During Bleaching Process. (H_2O_2 concentrations on X-axis and Weight loss on Y-axis)

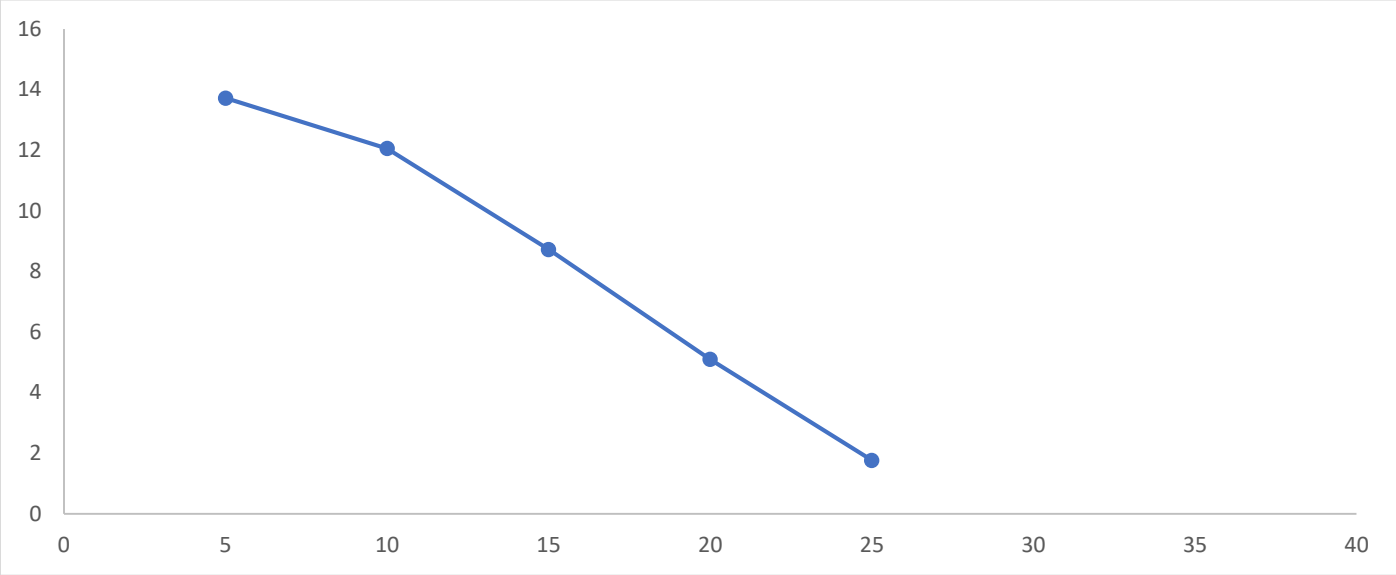


Figure 3: Effect of H_2O_2 of Various Concentration on tension force of pineapple leaves Fibres During Bleaching Process. (H_2O_2 concentrations on X-axis and Weight loss on Y-axis)

Figures 2 and 3 present various concentration of H_2O_2 used in bleaching of pineapple leaves fibres. Also, the same appendix presents the wight loss of Pineaple Leaves' fibres at each concentration. The concentration used range from 5-35 % with interval of 5 %, and the highest weight loss of 30% was obtained at concentration of 35 % while the lowest weight of 1.33 % was obtained at concentration of 5 %. According to [19] the weight loss of cellulosic fibres due to bleaching has to fall within the range of 2-3 %. Therefore, the best concentration of H_2O_2 to bleach pineapple leaves fibres is 10 % as it gave a weight loss of 3.33%. Moreover, It was noticed that as the concentration of bleaching agent, H_2O_2 , increases , the weight loss increases and vice versa, This is because during bleaching the cellulosic fibres lose a trace of any impurities that was not removed during scouring and helps in removing any color on the fibres to produce white fibres which has more affinity to the dye [20]. The bleaching with H_2O_2 occurs as a result of perhydroxyl ion ($HO2^-$) that is obtained when H_2O_2, a weak acid, is ionized in water [21]. Figure 3 presents the data of pineapple leaves fibres' tension forces obtained at various concentration of H_2O_2. It was observed that the tension forces of fibres decrease as the concentration of H_2O_2 increases and vice versa. This is because as the bleaching take place, some amorphous part of the fibres reduces, thus the increase of H_2O_2 damages cellulose chain in fibres which will decrease the mechanical strength of the fiber, thus reduced tension force [22].

MERCERIZATION

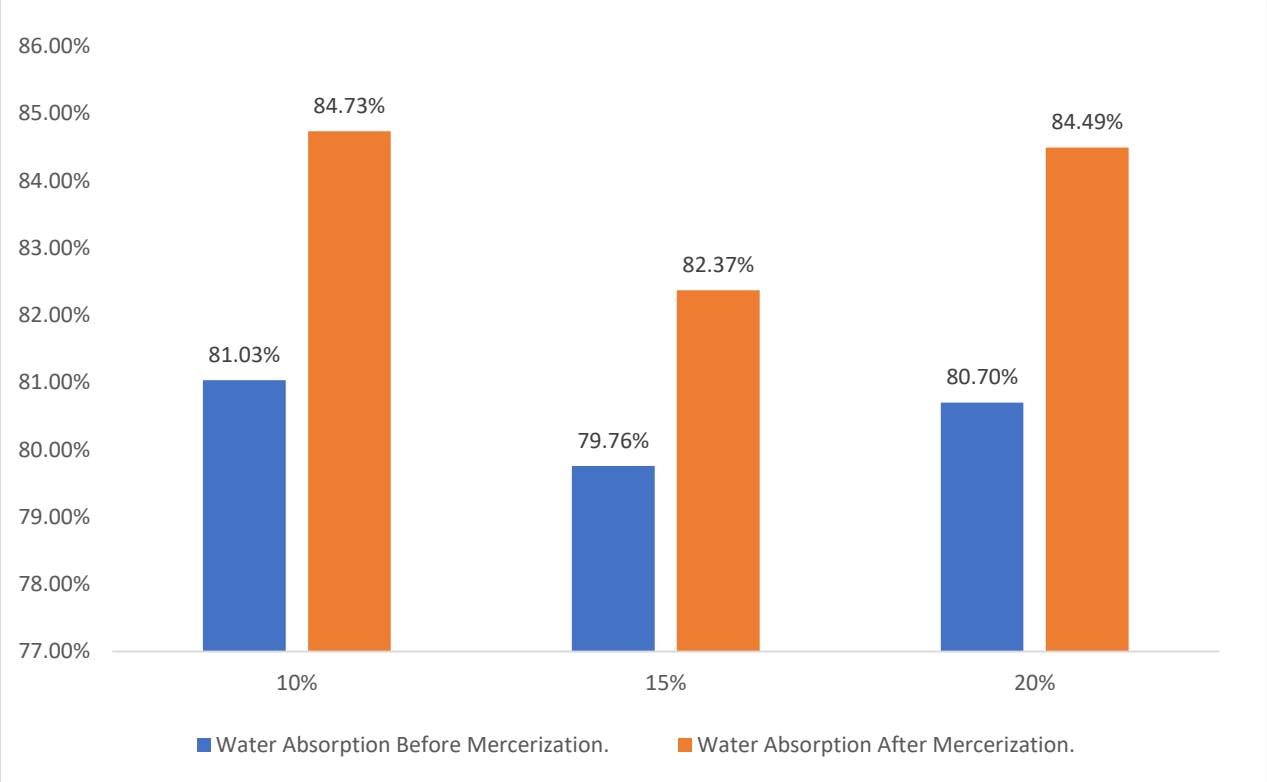


Figure 4: Effect of Mercerization with NaOH at high concentration on water absorption of Pineapple leaves fibres

The data on figure 4 shows the data captured during mercerization of pineapple leaves fibres. The data shows the water absorption percentage before and after mercerization of fibres at NaOH concentration of 10%, 15 % and 20 %. The statistical comparative data presentation in figure 9 above shows that the water absorption before mercerization is lesser than water absorption after mercerization. This is because when cellulose is immersed in a solution of caustic soda of mercerizing strength, water and alkali diffuses in and the material swells. The fibre hair quickly commences to untwist from its twisted ribbon like form and tends to become more cylindrical due to deconvolution. Also, the higher the water absorption of cellulosic fibres the higher the dye absorption on those fibres [23]. Therefore, best NaOH concentration for pineapple leave fibres mercerization is 10 % which shown the water absorption of 84.73 % after mercerization took place.

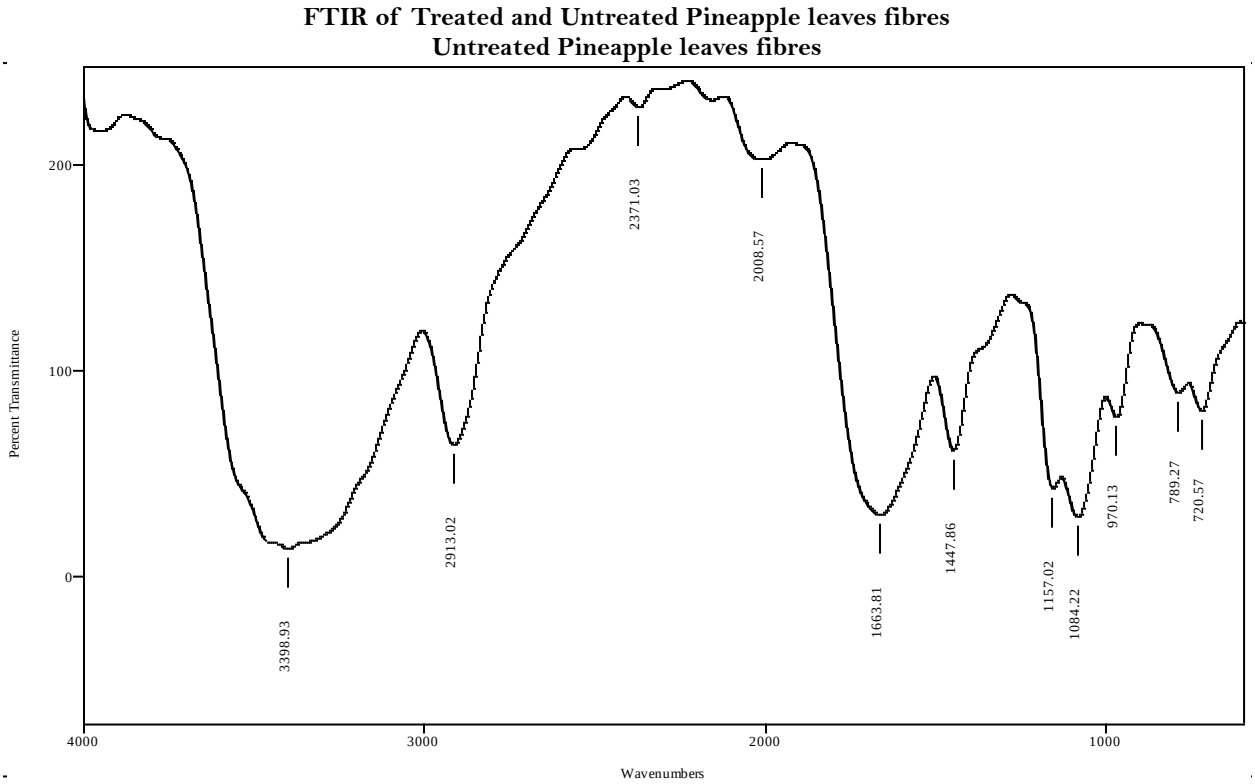


Figure 5: FTIR of untreated Pineapple leaves fibres

FTIR of Pineapple leaves fibres was carried out to figure out the type of functional groups present in the fibres. The FTIR spectra of the tested sample was registered in the spectral range of 4000–1000 cm^{-1} as shown in figure 12 above. The spectrums of pineapple leaves fibre have different absorption bands characteristics of functional groups.

The band that appears at 3398.93 cm^{-1} represents elongation of -OH from cellulose Lignin, and Hemicellulose while the band at 2913.02 cm^{-1} represents C-H present in cellulose and hemicellulose. The peaks at 2371.03 and 2008.57 cm^{-1} are associated with the presence of alkyne group in 17-octadecynoic acid [24], stearolic acid and tariric acid [25]. They occur in plant as a triglyceride, a composition of three fatty acids esterified to a glycerol molecule that are available in plant fat [26]. The peak at 1663.81 cm^{-1} is attributed to symmetrical aromatic elongation, C=C, present in lignin [27].

The peak that appeared at 1447.86 cm^{-1} represents the bending of CH_2 in cellulose and a symmetric deformation of CH_2 in cellulose [28]. The peak at 1157.02 cm^{-1} is associated with C-O stretching vibration triacylglycerides [29]. The peak at 1084.22 cm^{-1} is attributed to C=C stretching of the symmetrical elongation present in Lignin [30]. The peak that appears at 970.13 cm^{-1} arose due to elongation of -OH and C=O bonds of cellulose, and ester group present in pectin and hemicellulose [29]. The peak at 789.27 cm^{-1} is assigned to symmetrical stretching of C-H and O-H bonds of cellulose [28]. while the peak at 720.57 cm^{-1} correspond to C–OH out-of-plane deformation in cellulose [31].

These results show that pineapple leaves fibres are composed of Cellulose, Hemicellulose, Pectin, Lignin, fat and waxes. They are therefore similar to known plant fibers such as Sisal, Coconut, and Jute.

Treated Pineapple leaves fibres

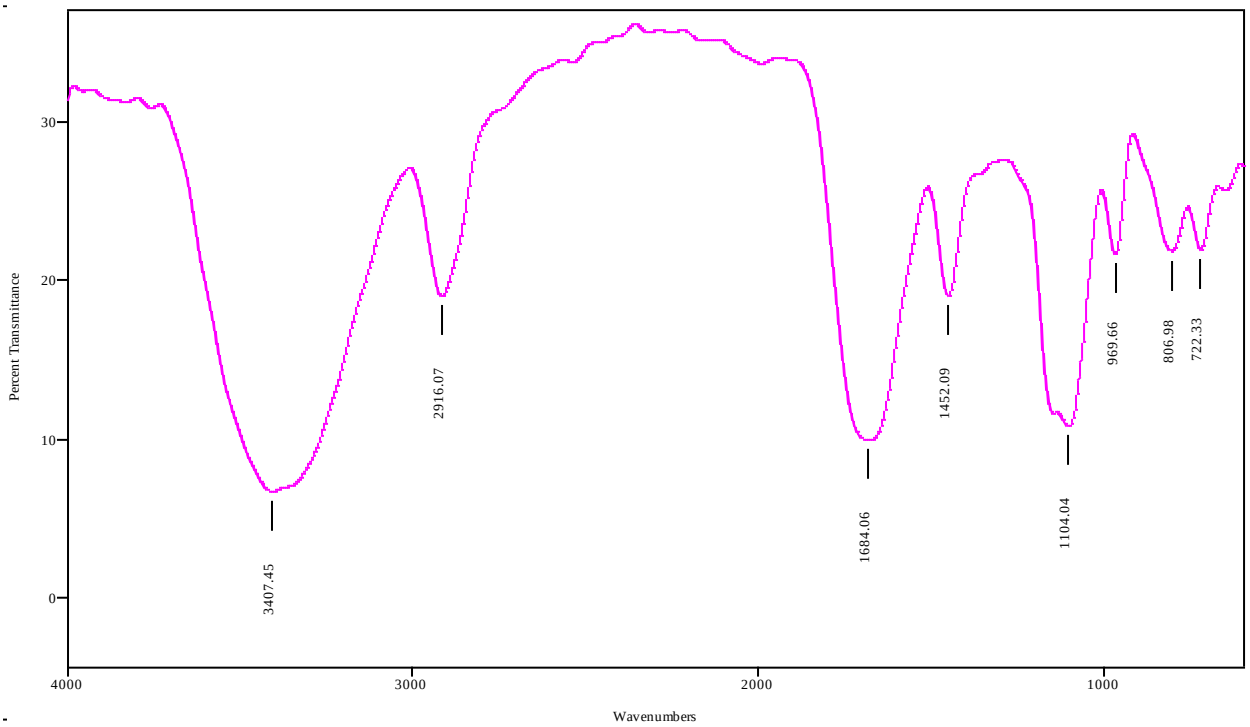


Figure 6: FTIR of treated Pineapple leaves fibres

The FTIR results of treated pineapple leaves fibres shows that the peak at 2371.03 cm^{-1}, 2008.57 $cm^{-1}$and 1157.02 cm^{-1} have disappeared after treatment of fibres with NaOH and H_2O_2 to remove wax and fat substances and unwanted colors through scouring and bleaching so as to enable a good dyes absorption. This was also confirmed by the Soxhlet extraction of fibres using ethanol- benzene (1:2 V/V) solvent where both treated and untreated fibers extracted. The untreated fibers showed presence of oil, wax and gum material while treated fibres showed no sign of oil and wax materials.

Quantitative analysis of fibres' constituents

Ethanol-Benzene Extractives Content (E_B)

After Soxhlet extraction of 1.9 g of pineapple leaves fibres, the fibres turned out to weight 1.85g which resulted in EB of 2.6% for pineapple leaf fibres. After extraction the fibres lost Resins, oil fats, Waxes and other impurities which made the fibres to lose weight. However, the result obtained while extracting treated fibres showed no trace of oil, as the fibres did not lose any weight. This results from fibres treatment using NaOH for scouring and H_2O_2 for bleaching, where all oil, wax, fat and other impurities and undesired colours were removed, resulting in no sticking but whitish fibres.

i. Lignin Contents (E_L)

The lignin contents (E_L) were calculated by the following equation:

$E_L = (m_L / m_3) \times 100\%$

where m_L is the mass of extracted Lignin, m_3 the mass of Residue II.

Also, a mass of 0.2 g of fibres was used. After the fibres treatment methodology section, the lignin obtained was weighed, and 0.024 g was recorded to be lignin obtained from pineapple leaves fibres respectively.

When the above formulae for E_L was applied the result showed that the E_L for pineapple leaves fibres is 12%.

ii. Pectin Contents (E_P)

The study revealed that the fibres have pectin content of 1.53 %

iii. Cellulose *Content (E_C)*

The study revealed that the fibres have cellulose content of 0.79 g which account for ***E****c*of 79%.

iv. Ash Content (AC) of Treated Fibres

The study revealed that pineapple leaves fibres have 0.043 g of ash. When the formulae to calculate AC was applied, it was shown that pineapple leaves fibres have AC of 2.15 %.

Water, Oil and Moisture Absorption Test

The following formulae was used to calculate water absorption in both fibres.

% W. A= $\{(W_f-D_f)/ D_{f\}} \times 100\%$

Where W_f and D_f stand for wet and dried fibres respectively.

1 gm of treated fibres was used and the fibres were emerged in water for 2 hours. After, two hours the fibres were removed cleaned and its weight was measure to be 1.82 g, and when the above formula was applied, the results showed that pineapple leaves fibres have a water absorption of 82 %.

Cellulosic fibres do absorb water due to its hydrophilic nature which is as result of the presence of H-bonds from -OH groups between macromolecules of cell wall in fibres. When the fibres come into contact with water/moisture, H-bond breaks and -OH groups create new H-Bonds with molecules of water, thus the higher the cellulose content the high-water absorption [32]. Oil absorption was carried out like water absorption test by changing absorption medium to Soya beans Oil. 1 g of fibres was used, and the weight of fibres after 2 hours of soaking fibers in oil were weighed to be 1.32 g for pineapple leaves fibres. When the same formulae used in water absorption calculation was applied, the oil absorption percentage was shown to be 32 %. It is noticed that the oil absorption percentage is lower than the water oil absorption this is attributed to the fact that oil is less dancer than water making it to float on the surface of the fibres [33]. 1 gm of treated fibres was used and the weight of pineapple leaves fibres after being exposed to water vapor created using water bath for 2 hours was recorded to be 1.29 g respectively, and when the formula for water absorption test was applied, the results showed pineapple leaves fibres have water absorption of 29 %.

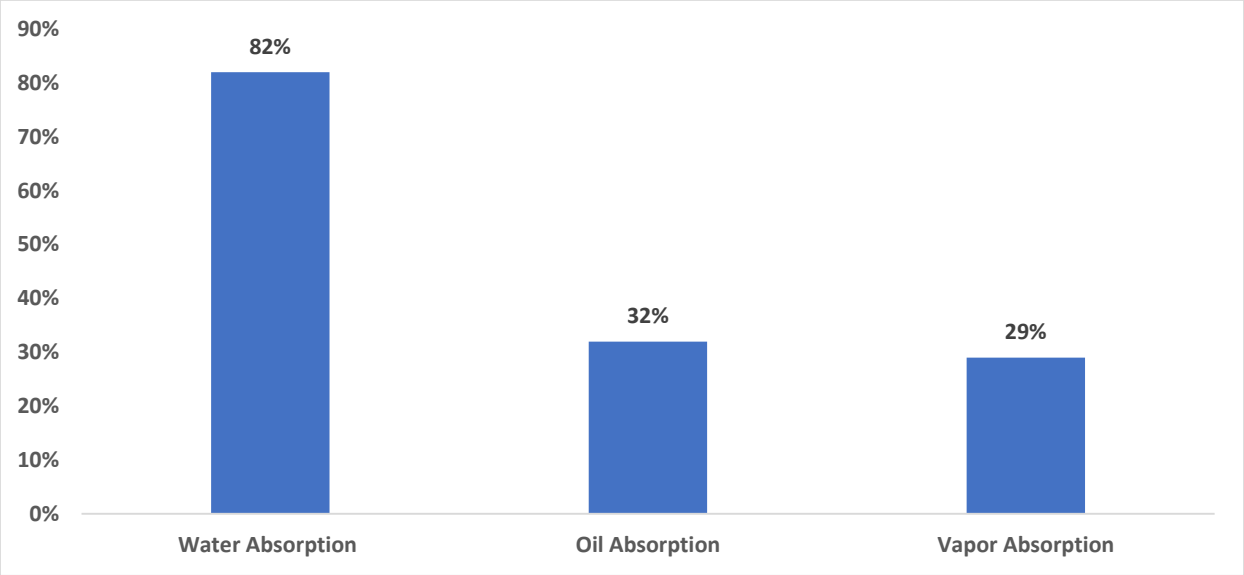


Figure 6: Statistical Comparison of water, oil and moisture absorption of pineapple leaves fibres

Thermal Analysis of the pineapple leaves fibres (TGA and DTA)

Pineapple Leaves Fibres

The TGA curve below shows that the fibres understudy broke down into six phasis marked with blue ink. According to [8] this thermal behavior is for plant fibres. The first change occurred at 110^{0}C and end at 200^{0}C. This is due to the evaporation of moisture. Another noticeable change occurred at 390 ^{0}C to 420 ^{0}C. Change is due to the loss of CO gaz. Another noticeable change occurred at 500 ^{0}C to 550 ^{0}C while another negligible change occurred at 690 ^{0}C. This is due to the formation of CO_2 gaz. In the last phase after change that occurred at 690 ^{0}C the fibres weight loss become slow leading to a formation of a stable residue. More so, the graph of DTA shows that the degradation temperature of pineapple leaves fibres occurred at 400 ^{0}C.

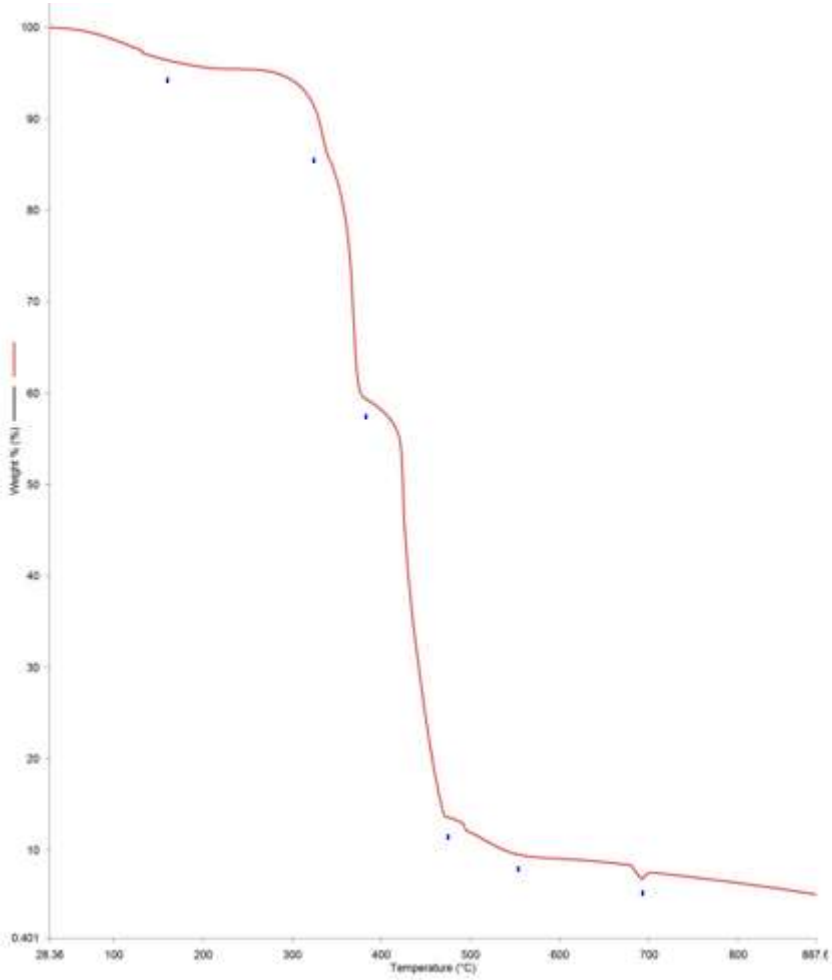


Figure 7 : TGA of Pineapple leaves fibres

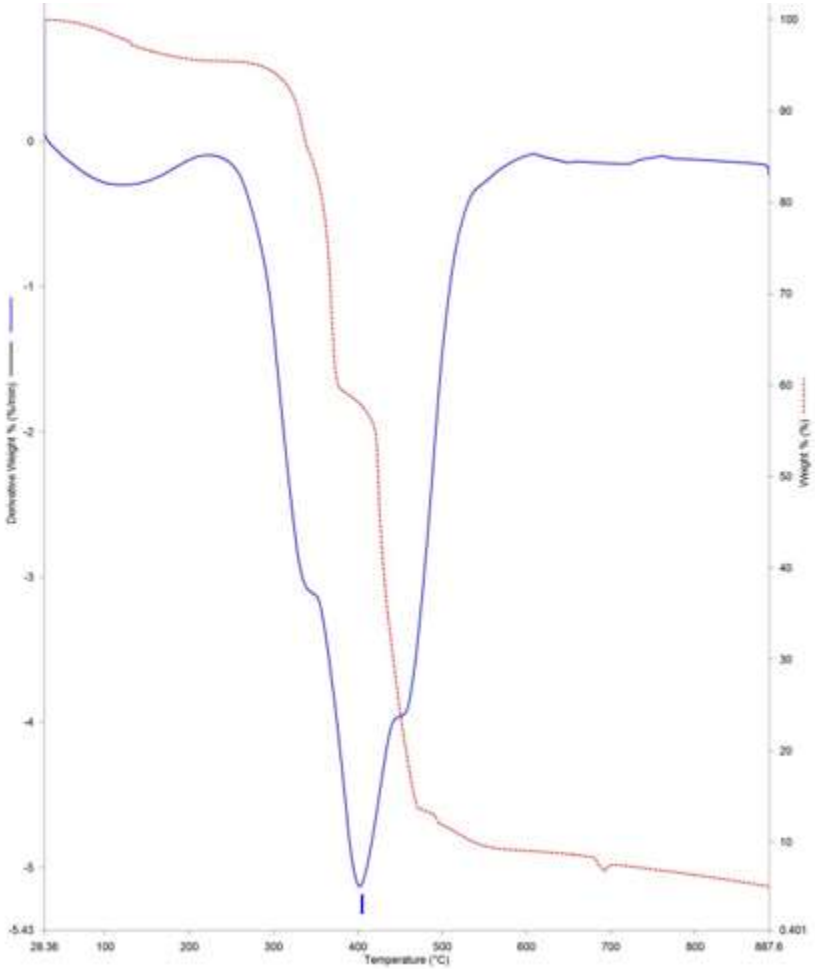


Figure 8: DTA of Pineapple leaves Fibres

Morphology Analysis

Scanning electron microscopy was carried out with the aim of studying change in morphology of banana pseudo stem fibres as a result of scouring and bleaching. Figure 10 below clearly shows significant change in the physical appearance of the fibres surface. Right SEM image revealed that the untreated fibres presented a low level of fibrillation due to the presence of wax, fat and other gummy materials. However, the left SEM image revealed that after treatment of the fibres with sodium hydroxide and hydrogen peroxide, all wax, fat and gummy materials disappeared leading to well sorted fibres. This is in line with the results presented by FTIR where peaks that represent wax, fat on the fibres disappeared.

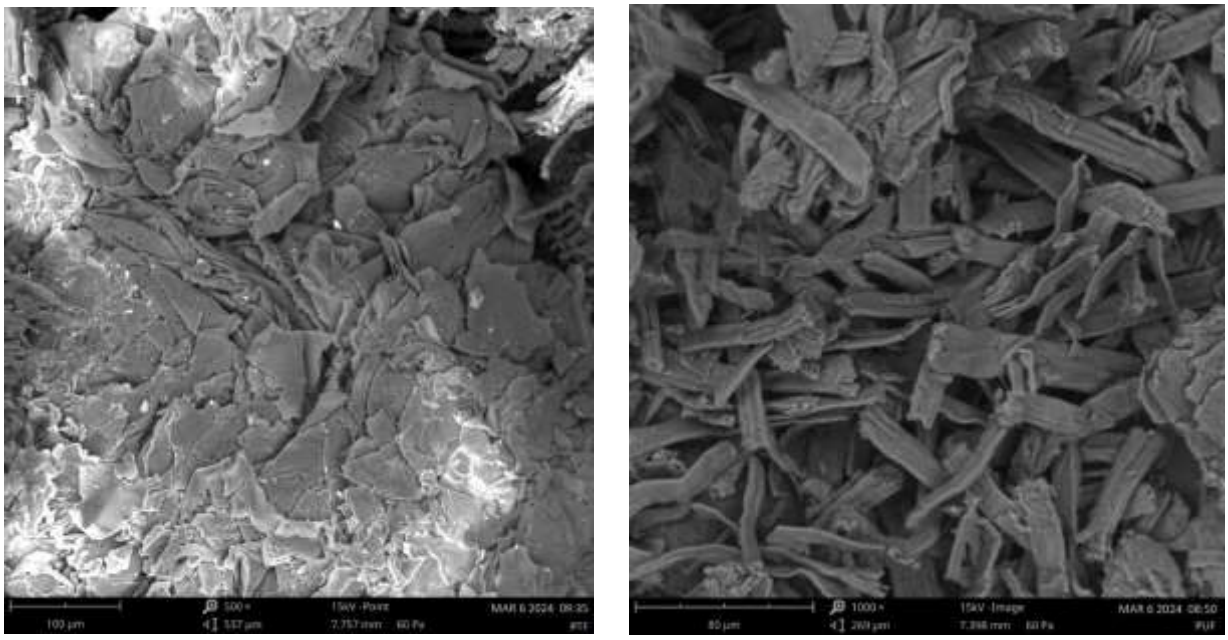
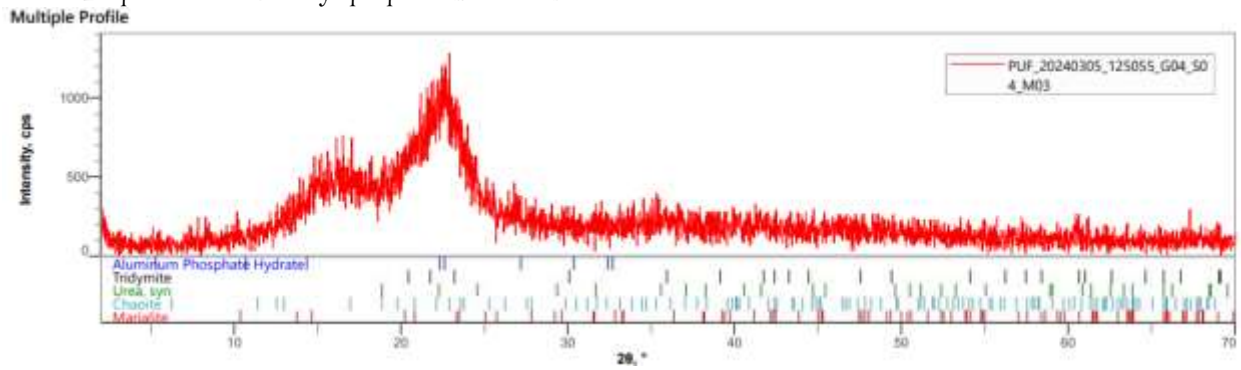


Figure 9: SEM of untreated pineapple leaves fibres (Left) and SEM for treated pineapple leaves fibres (Right)

Crystallinity Analysis with X-Ray Diffraction

The result of X-ray diffraction plots the intensity of the signal for various angles of diffraction at their respective two theta positions. The greater the intensity of the peak, the greater the amount of crystals or molecules with that distinct spacing. The width of the peaks is inversely proportional to the crystal size. A thinner peak corresponds to a bigger crystal. A broader peak means that there may be a smaller crystal, defect in the crystalline structure, or that the sample might be amorphous in nature. The peaks intensity of XRD are related to crystallinity of the sample and it is used to determine the crystallinity index (CI) of a sample. The intensities of XRD peaks are directly proportional to the crystallinity of the sample. Higher peak intensity indicates higher CI and vice versa. Generally, if you get a very broad humped peak, then the material will be amorphous with short range ordering. If you get a sharp peak in the XRD pattern, then the sample is crystalline. From the expression given above, we can conclude that pineapple leaves fibres treatment has enhanced its crystallinity as the peaks obtained after fibres treatment have high intensity compare to the peaks obtained for untreated fibres. This is because of the realignment of celluloses molecules in the crystal lattice and removal of lignin and hemicellulose which form amorphous region of the fibres [34].



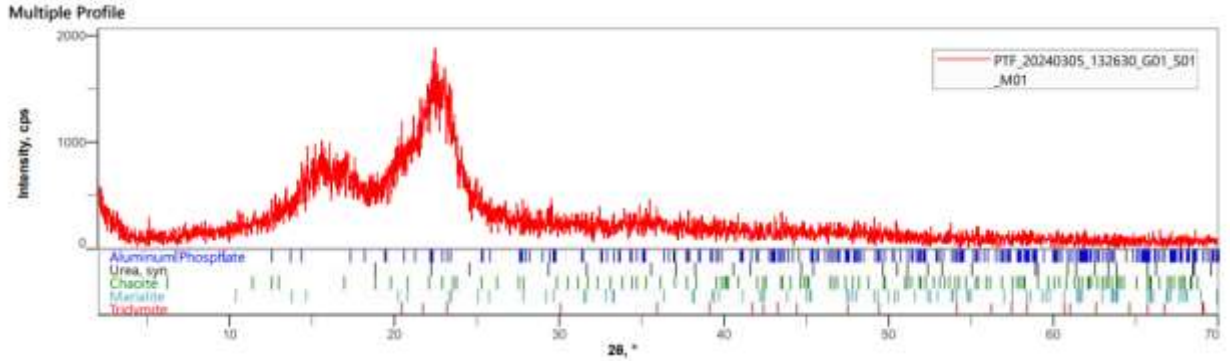


Figure 10: XRD for untreated (above) treated (below) pineapple leaves fibres.

CONCLUSION

The aim of this research which was to extract, treat and characterize fibres from pineapple leaves fibres was achieved. This study showed that, it is possible to get fibres from pineapple leaves fibres which is actually considered as a waste after the harvest of pineapple fruits is harvested. However, the leaves fibres have to undergo treatment to remove gummy, oil and other unpleasant color that might be present on the fibres. This is done in two processes namely scouring and bleaching. Also, another step to further increase the absorption of dye by fibres known as mercerization has to be performed. The extracted fibre can be used to produce a yarn which can further be used to produce some other items such as carpets, hand bags, ropes, keyholders and sacks through weaving and/or knitting depends on the product desired. Also, the produced fibres can be used in the production of non-woven fabric in which the fibres are bonded together to create a fabric. The fibres can be bonded chemically, mechanically or thermally. Nonwoven fabric is of great important ranging from medical and healthcare to civil engineering.

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