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Research Article

Characterization of Chemically Treated Sisal Fiber/ Polyester Composites

Adane Adugna Ayalew [1] **and Awoke Fenta Wodag** [2]

[1] *Faculty of Chemical and Food Engineering, Bahir Dar Institute of Technology, Bahir Dar University, Bahir Dar, Ethiopia*
[2] *Ethiopian Institute of Textile and Fashion Technology, Bahir Dar University, Bahir Dar, Ethiopia*

Correspondence should be addressed to Adane Adugna Ayalew; adaneadugna6@gmail.com

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Natural fibers have the potential to replace synthetic fibers for making polymer composites due to their remarkable properties. Polyester is one of the core materiel used for textile and leather due to hydrophobic property. Sisal fibers have high strength among various naturals and can be used as the supporting material for polymers. A detailed experimental study was conducted for the extraction of sisal fiber and composite development. The fibers were treated by using 2%, 6%, and 10% NaOH concentrations within 24, 48, and 72 h soaking time. Composite was made from different sisal to polyester ratios of 20 : 80, 30 : 70, and 40 : 60 (w/w). Mechanical properties such as tensile strength and flexural strength of treated, untreated, and reinforced fibers were determined. Functional groups of both the treated and untreated sisal fibers were characterized using Fourier transform infrared spectroscopy (FTIR). The thermal stability of sisal fiber was analyzed by thermogravimetric analysis (TGA). The optimum tensile strength and bending strength of the composite were found at 44.0 MPa and 50.8 MPa for fiber with polyester ratio of 30 : 70, 6% NaOH concentration, and 48 h soaking time. It is confirmed that treated sisal fiber-reinforced polyester composites have better tensile and bending properties and lower water absorption than untreated fibers.

1. Introduction

The utilization of natural cellulose fibers as support composite materials has been increased over the last few periods. The good-looking aspects of natural fibers have been lightweight, high specific modulus matrix, low cost and high specific modulus matrix, and no health hazards compared to synthetic fibers [1–3]. These benefits place the natural fiber composite materials along with the high-performance composites having environmental and economic advantages [4–6]. Numerous fibers including banana, palm, jute, bamboo bagasse, and alfa fibers have been studied as filler and reinforcement in polymer composites [7, 8]. Those investigations were carried out to improve the mechanical properties including bending strength, tensile strength, and impact strength test [9, 10]. Natural fiber has appeared as a renewable and inexpensive substitute for synthetic fiber. Several investigations have reported that natural fiber-reinforced plastic composites have outstanding mechanical properties [11–13]. Natural fiber-reinforced polymer materials can show different environmental aging resistance and mechanical properties, depending on the interphase across the fiber-matrix [14, 15]. Since the interfacial bonds between the resin matrix and reinforcing fibers are a vital part of determining the mechanical properties of the composites material, the inadequate edge quality between the polymer matrix and fibers is the initial and the most critical problem in natural fiber-reinforced composites. Hence, surface modification of natural fibers by using chemical treatment is one of the biggest areas of recent research. Numerous researchers [16, 17] have paid attention to studies on the treatment of natural fibers to advance the bonding to the resin interface matrix. Amendment of the fibers by any means could either increase or decrease the power of the natural fiber, hence to understand

the structure of the thread, and their effluence on the mechanical properties of composite [18].

This research describes the preparation of polyester composites reinforced with sisal fibers. The effects of NaOH concentration (2, 6, and 10%) and duration to submerge the fibers (24, 48, and 72 h) and sisal to polyester ratios of 20 : 80, 30 : 70, and 40 : 60 (w/w) were studied. The effects of alkaline treatment on the fiber composition and composite's water absorption, tensile strength, and bending strength were analyzed and discussed.

2. Materials and Methods

2.1. Materials. Raw sisal plant was gathered from the region of Northwest of Gojam, specifically in Debanke Mountain, Bahir Dar, Ethiopia. The raw sisal fibers were manually separated from the leaves and were washed using distilled water and then dried in an oven at 70°C for 24 h. The dried fibers were then labeled as untreated fibers. Reagent-grade chemical such as sodium hydroxide (NaOH) was used for fiber surface modification. Unsaturated polyester was used as the polymer matrix.

2.2. Fiber Surface Treatment. The first step is the pretreatment process for all sisal fiber surface treatments. This brings a significant morphology change in the crystal structure of cellulose. The main component of natural fibers is crystal cellulose. In addition, it also encloses lignin, hemicellulosis, and waxy substances. Nevertheless, hemicellulosis and lignin can be degraded for a long time. Thus, alkali fiber treatments were used to boost the long-term strength of natural fiber reinforcement and to develop an interfacial connection [19]. Hemicelluloses are considered to contain hexosan, polyuronides, and xylan which are highly sensitive to the exploit of NaOH. However, it applies a slender effluence on α-cellulose. Therefore, alkali treatment by using NaOH can advance the adhesion uniqueness of natural fibers by eliminating pectin, lignin, and hemicellulosis and hence offering the fiber surface to have a rough surface. This rough and fresh fiber surface can aid in mechanical intertwining and enhances the soaking capacity of the design matrix [20]. The core change or modification of the fiber by using alkaline treatment is for removing hydrogen bonds during the formation of the networking structure.

Fibers were soaked using different NaOH concentrations (2, 6, and 10%). The treatment was performed at ambient temperature for about 24, 48, and 72 h soaking time to activate the hydroxide (OH) groups of lignin and cellulose in the fibers. The chemically treated fibers were then continuously washed by using distilled water and allowed to dry in sunlight for 24 h. During alkaline treatment, a reaction occurs on the fibers' surface as shown in the following equation:

$$\text{Fiber} - \text{OH} + \text{NaOH} = \text{Fiber} - \text{O} - \text{Na}^{+} + \text{H}_2\text{O}. \quad (1)$$

2.3. Fabrication of Composite Specimens. Fabrication of the composite material was done using a mold that is made from polywood (Figure 1(c)). Moulding was carried out by the hand layup process, which is the simplest way of fabrication composite. The prepared specimen had a dimension of 300 mm × 300 mm × 3 mm. The mould was placed in atmosphere conditions for preparation to make a composite material. The bottom and the top surface of the walls and mold were coated with wax and tolerated to dry up. The wax was used on the mold for easy removal and to offer good surface finishing of the plates. Slim plastic sheets were used at the bottom and top surface of the cast laminate to obtain a fine and uniform surface finished product. The polyester resins were taken besides 5% of the catalyst of methyl ethyl ketone peroxide and also using a cobalt naphthenate accelerator. Primarily, the catalyst was added with the polyester resin and followed by the accelerator. The first layer of the mold was packed with the polyester resin mixture and the next sisal fibers were arbitrarily extended with the resin mixture and then rolled with a hand roller to evade and remove the air foams. Over again, the resin mixture was dispensed on the sisal fibers and afterward hard-pressed for 3 h before exclusion. Subsequently, the composite specimen was exposed to some hours of sunlight to eradicate the moisture content.

2.4. Fiber Characterization Techniques

2.4.1. Fourier Transform Infrared Spectroscopy (FTIR). The chemical structures of treated and raw fibers were studied by using FTIR to recognize the alteration of the fiber's functional groups tempted by the treatments. The FTIR spectra were performed at room temperature by a JASCO model 4100 equipped with a potassium bromide (DTGS, KBr) glass detector. The FTIR transmittance spectra were recorded with a range of 400–4000 cm^{-1}. The treated and untreated fiber were milled and then each sample was mixed with KBR. The disk holds the prepared sample by using a hydraulic press.

2.4.2. Thermogravimetric Analysis of Sisal Fiber. Thermographic analysis (TGA) has been used to study the effect of temperature and to forecast the influence of thermal stability and degradation of alkali-treated sisal fibers. Thermal properties and mass loss of sisal fibers were analyzed using TGA 6200 model thermogravimetry analysis system. The sample was prepared in a powder form of about 5 mg. The sample was deposited in an aluminum pan in a temperature range from 25°C to 500°C and under the inert atmosphere of liquid nitrogen at a flow rate of 50 ml/min with a heating rate of 10°C per minute.

2.4.3. Mechanical Characterization

(1) Tensile Test. Tensile strength was performed based on the ASTM-C1557 method using a universal tensile test machine (Model TH2730, Germany) with a load cell of 5 kN with a regular speed rate of 2 mm/min to estimate the tensile value of the sisal fiber. The test specimens composites were sliced into a rectangular form (250 mm × 25 mm × 3 mm), and the gauge length was 150 mm. A 50 mm gauge length

Figure 1: Fabrication of specimen composite material. (a) Sisal plant leaves, (b) extracted sisal fiber, (c) handloom machine and fabricated mat, and (d) laminated via polyester and prepared specimens.

extensometer was attached to the samples during the tensile test to record the tensile strength data; five samples of each category were evaluated. Tensile tests were conducted using a computerized universal testing machine. The speed of the crosshead was 2 mm/min. The tensile strength was reported in MPa.

(2) Flexural Test. Flexural strength was performed at ambient temperature via a three-point bending test using a computerized universal testing machine. The specimen composite was prepared according to ASTM D790 with a dimension of 125 mm × 15 mm × 3 mm. The rate of the crosshead was 3 mm/min. The composite specimen was freely supported by using a beam and the point load was exerted in the center of the composite specimen. The flexural strength was reported in MPa.

2.4.4. Water Absorption Determination of Composites. The water absorption test of the composite was carried out using the standard method of ASTM570 [18]. To measure the uptake capacity of the specimen composite, the sample was prepared and distilled water was used as a medium. The percentage of water absorbance was calculated from the difference of final and initial weights before and after immersion in the water bath for 24 h. In each specimen composite test, three samples were tested and average values were reported. The testing was performed until the percentage of water absorptive reached equilibrium. The calculation was based on the following equation [21]:

$$\text{Water absorpation}\,(\%) = \frac{Wt - Wo}{Wt} * 100\%, \qquad (2)$$

where Wt and Wo are the weight before and after immersion, respectively.

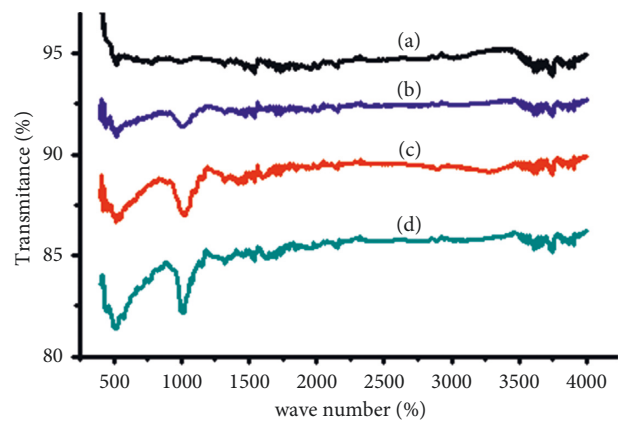

Figure 2: FTIR spectra analysis of (a) raw fiber and (b) (2%), (c) 6%, and (d) 10% NaOH-treated sisal fiber.

3. Results and Discussion

3.1. FTIR Analysis of Raw and Treated Fibers. The changed chemical composition of the fiber can be observed in the FTIR spectra of the treated and untreated sisal fibers in Figure 2. The untreated fiber attributed a strong transmittance band peak in the range of 3400–3800 cm^{-1} assigned to O-H stretching vibration of the OH group in cellulose molecules. The sharp peak at 2156.5 cm^{-1} and 2014.5 cm^{-1} is assigned to C-H and CH_2 stretching vibrations in the methyl and methylene groups [22]. The carbonyl peak at 1545 cm^{-1} is assigned to C=C unconjugated stretching of the carboxylic acid or ester of the hemicellulosis [23]. Transmittance at 1317.7 cm^{-1} in the spectra of the fiber is assigned to C-O stretching in acetylated hemicelluloses. The transmittance peak at 1001.6 cm^{-1} indicates the presence of C-O, C=C, and C-C-O stretching vibration of the acetyl group present in the lignin [24]. Evaluation of the FT-IR spectra indicates a

chemical modification of the sisal fiber surface that was subjected to treatment.

The spectra of the treated fibers were found to be different from those of untreated fibers. These differences vary according to the different types of concentration applied to fiber. In the case of applied difference between concentrations of NaOH treatment, the decreasing intensity of characteristics of bands is assigned to change and shifted after treatment. The examination of the spectra has shown the appearance of 1001 cm^{-1} peak, indicating the lignin component is intact in the alkali-treated fibers. The band near 1545 cm^{-1} is due to C=O stretching frequently in the acetyl and carboxyl ester group.

After alkali treatment, there was an observed gradual decline of peaks as the concentration of the alkali solution raised from the *b* to *d* curve. These peaks are attributed to the stretching of C=O bonds and to the plane C-H bending vibration of the hemicellulosis. The decline is due to the elimination of hemicellulosis from the fiber surface, which is caused by alkaline treatment with caustic soda solution [7]. The intensity of alkaline-treated fiber was reduced and, finally, the disappearance of characterization starching vibration indicated significant removal of the hemicellulose alkali treatment. Furthermore, the reduction of the peak in 1317–1340 cm^{-1} of hemicelluloses appeared as the alkali concentration increased, which confirmed the removal of hemicelluloses. This involves the observation that the hemicelluloses components are simply detached through the alkalization process relative to the lignin component.

3.2. Thermogravimetric Analysis of Sisal Fiber. Cellulose materials are very sensitive to temperature. When cellulose is heated, it undergoes physical and chemical changes at elevated temperatures around 300°C. As shown in Figure 3, TGA (thermogravimetric analysis) was carried out to determine the thermal properties of the sisal fibers. Thermogravimetric analysis is important to know the temperatures resistance of the materials mass loss, and other composite functional groups. The intensive mass loss is observed for sisal fiber at 59°C and 378°C which corresponds to the removal of surface moisture. The TGA arc of the sisal fiber sample displays an intense endothermic peak at 59°C. These reactions were due to the removal of physically bound water and other degradation components. Thus, the observed endothermic peaks from TGA are due to the formation of low bond attachment between the water molecules and the fiber. This results in mass loss at temperature below 59°C. The peak observed at 378°C could be due to water molecules adsorbed in the interlayer. This phenomenon can be attributed to the dehydration of exterior fiber surface and the interlayer matrix of the sisal fiber. At this temperature, the sample displays a weight loss as shown from endothermic peaks, which is probably due to the dehydrogenation of hydroxyl groups. The result confirmed that the surface treated sisal fibers were more resistant for 260°C temperature and below. It can also be observed that the unstable treated sisal fiber formed at 250°C. Thus, the alkaline-treated fibers showed a slight change in decomposition temperature, showing considerably upgraded thermal stability of the treated sisal fibers.

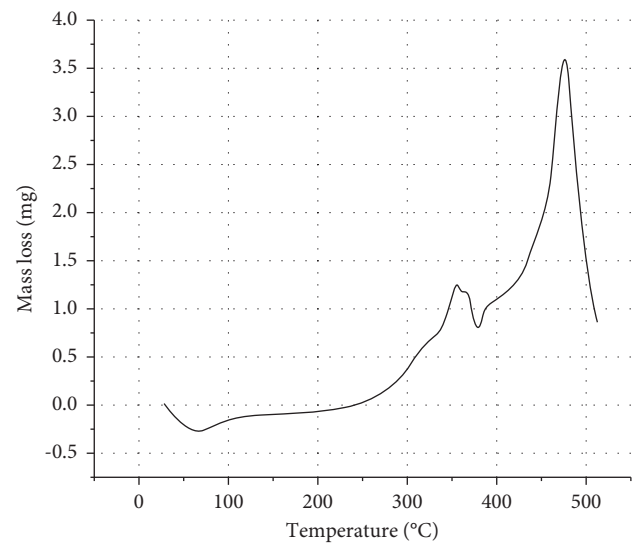

Figure 3: Thermogravimetry analysis of sisal fiber.

3.3. Mechanical Properties of Composites

3.3.1. Tensile Strength. The influence of sisal fiber treatment by alkaline on the tensile strength of sisal-reinforced polyester composite can be observed in Figure 4. Different values of tensile strength were recorded for the given fiber to polyester ratio with different values of soaking time and alkaline concentration. When the soaking time increased initially from 24 to 48 h, the tensile strength was increased with increasing fiber to polyester ratio and alkaline concentration as shown in Figure 4(a). However, when the soaking time increased from 48 to 72 h, the tensile strength decreased for all alkaline concentrations. This may be due to the formation of a strong adhesive bond between the matrix and the fiber. However, when the time peaks beyond the optimum value, the tensile strength was gradually decreased. This is attributed to the degradation of cellulose at such a high concentration of alkali and a long soaking time. Best tensile strength was recorded at 44.00 MPa as shown in Figure 4(b) at 6% NaOH solution and 48 h soaking time. The present value tensile strength is well confirmed compared to the previous study's result at 35 : 65 treated sisal fiber to polyester ratio and was found to be 44.78 MPa.

Figure 4(c) has shown that the tensile strength was obtained at the highest value at a low fiber to polyester ratio (20 : 80) and at 72 h soaking time. However, after 48 h soaking time, the tensile value has shown a sharp decrement with increasing fiber to polyester ratio and soaking time from 48 to 72 h at 10% NaOH concentration. As the polyester to fiber ratio is increased in composites, the tensile strength elongation increases. After achieving the optimum mechanical property, its tensile strength decreases with high fiber loading. The decrease in tensile strength at higher fiber loading may be due to the limitation of filler at higher loading.

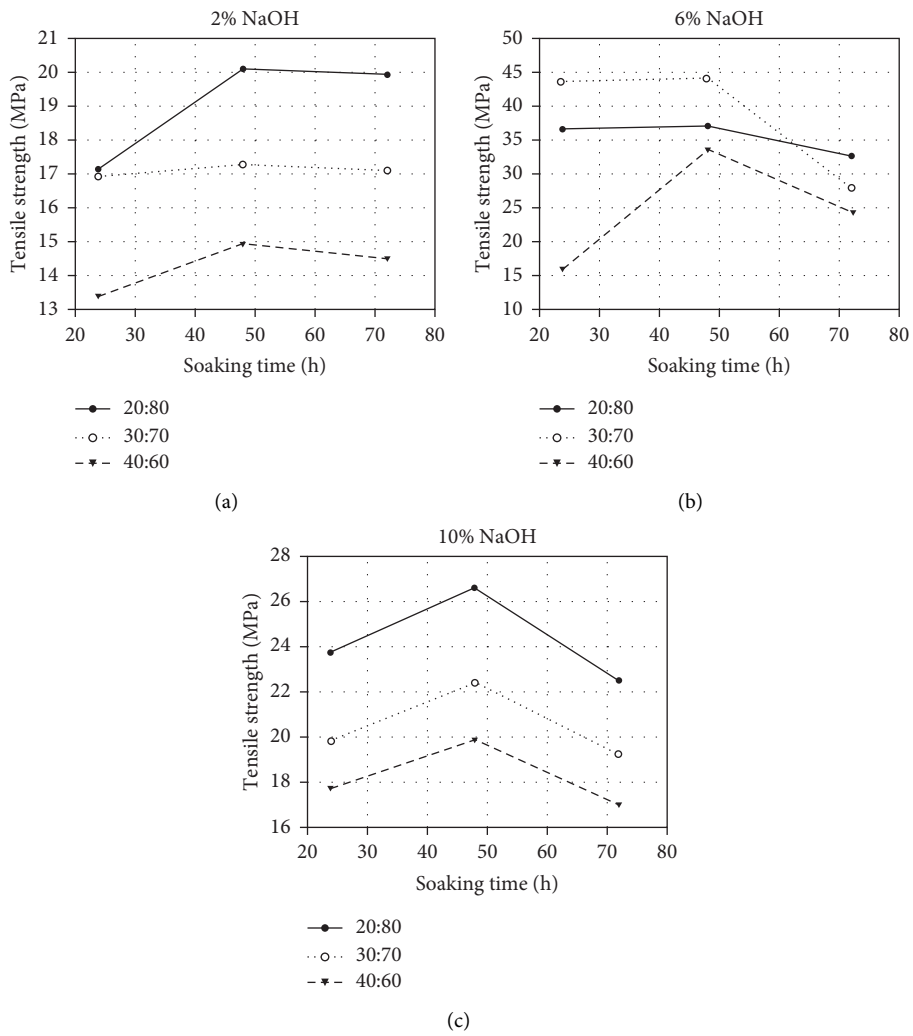

Figure 4: Effect of fiber to polyester ratio on tensile strength of composites: (a) 2%, (b) 6%, and (c) 10% NaOH.

In general, when compared across chemical treatments, the composites containing alkaline-treated sisal fibers had comparable or higher tensile strength than composites containing untreated fibers.

The deviation in textile strength value can be explained on the basis of the changes in chemical interactions at the fiber-matrix interface with various treatments. The value of tensile strength in sisal fiber-reinforced composites is determined by both the tensile strength of the fiber and the presence of weak lateral fiber bonds. The change of tensile strength value for the composite at different modification manners is due to the effluence of alkaline treatment and the change of structural configuration of the sisal fibers. The alkaline treatment improved the fiber surface to become smooth and made the fibers overlap with each other. Moreover, it also enlarged the amount of cellulose on the shell of the sisal fibers.

3.3.2. Bending Strength Test. The bending strengths of the sisal fiber-reinforcement composite are presented in Figure 5, which displays the influence of the alkaline treatment, fiber to polyester ratio, and soaking time. The reported values are based on the average and standard deviations calculated from the replicates tested for each sample type. It can be seen that the trends of the flexural strength values are similar to those of tensile strength. The composite was formed between sisal fiber and matrix with different ratios being used to compare and select the preferred strength among others. As shown in Figure 5(a), the highest bending strength was obtained at 50.81 MPa at 48 h soaking time with 6% NaOH-treated sisal fiber and at 30 : 70 fiber to polyester ratio. This may be due to the proper interlocking of fibers to the matrix and more superior adhesion between fiber and polyester present, which avoids solvent entry, and little swelling occurs. From Figure 5(b), better flexural strength result was recorded at 30 : 70 fiber to matrix ratio than 20 : 80 and 40 : 60 fiber to matrix ratio. When the soaking time increased from 24 to 48 h, the bending strength was increased from 14.33 to 26.96 MPa at 20 : 80 ratio in 2% NaOH, 42.01 to 50.81 MPa at 30 : 70 ratio in 6% NaOH, and 23.70 to 26.64 MPa at 20 : 80 ration with 10% NaOH concentration as shown in Figures 5(a)–5(c), respectively. Unidirectional sisal fiber laminated with polyester at a ratio of 20 : 80 was studied

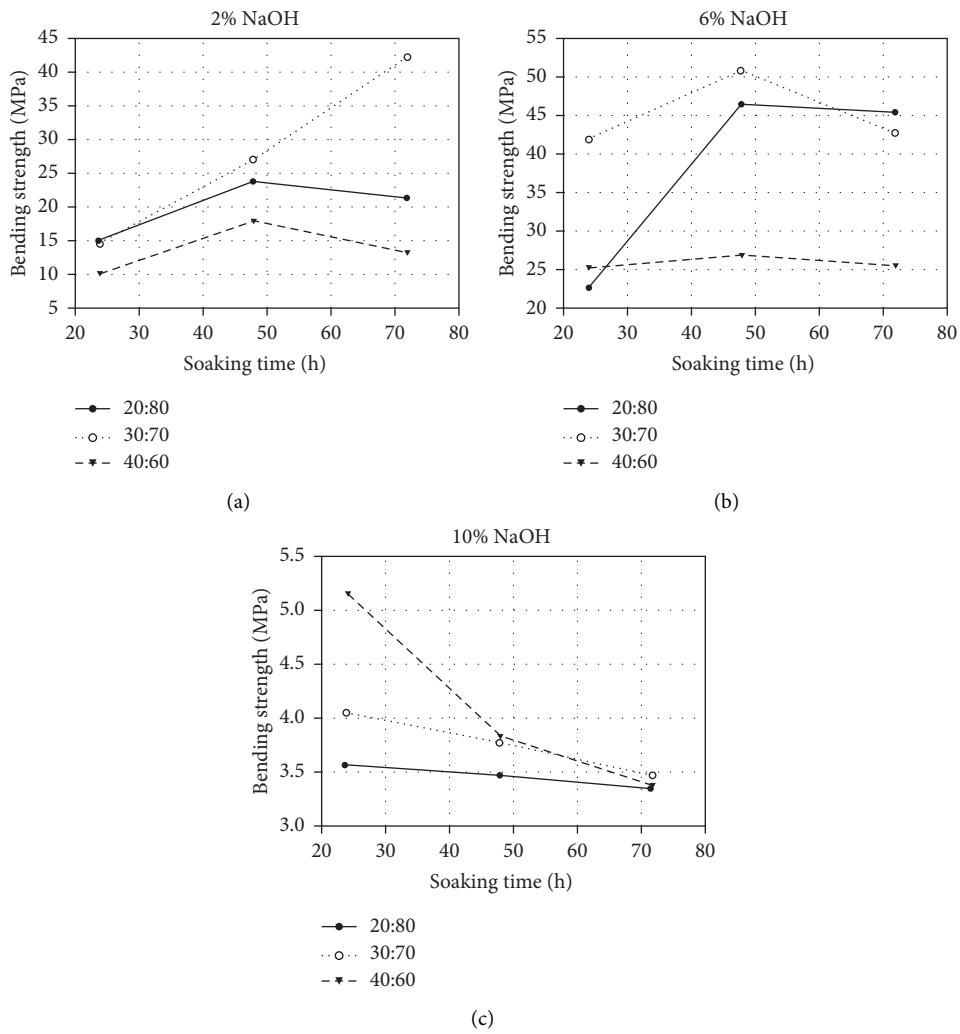

Figure 5: Effect of fiber to polyester ratio on bending strength of composites: (a) 2%, (b) 6%, and (c) 10% NaOH.

by Ramasamy et al. [25] and got 26 MPa for bending strength which was lower than that in this study.

Generally, from the results in Figures 4 and 5, the tensile and bending strength values of treated fiber indicated better mechanical properties than the untreated fibers. Raw sisal fiber pretreatment could clean the fiber surface, chemically modify the surface, and increase surface roughness. As the raw sisal fibers bear hydroxyl groups from cellulose and lignin, therefore, they are amenable to modification. The hydroxyl groups may be involved in the hydrogen bonding within the cellulose molecules, thereby reducing the activity of the matrix. Chemical modifications may activate these groups or can introduce a new moiety that can effectively interlock with the matrix. However, as the concentration and soaking time rise to 6% and 72 h, respectively, the strengths drop because the treatment creates a trench groove on the surface of raw sisal fibers.

3.4. Water Absorption of Composite Materials. As shown in Figure 6, the water absorption of sisal fiber-reinforced composite decreased with increasing alkaline treatment concentration and soaking time. This may be due to the increase in the removal of the hydrophilic nature of the chemical components like lignin, cellulose, and hemicellulosis from the fibers. The presence of lignin, cellulose, and hemicellulosis in the plant fiber increases the water absorption rate, which in turn degrades the properties of the composites. As shown from the result, within the same alkaline concentration treatment, the rate of water absorption of the composite material was significantly increased as the fiber amount increased. This is because of the formation of higher interlocking of polyester with sisal fibers leading to the occurrence of microvoids in the matrix so water molecules start diffusing into microvoids till reaching the saturation state.

The water absorption of the composite was lower at 72 h with 6% NaOH concentration and 20 : 80 fibers to polyester ratio which was 3.194%. This is because of the presence of excess polyester which has great hydrophobic nature and the removal of hydrophilic components of fibers. Arrakhiz et al. [26] studied the performance of water absorption by sisal fiber-reinforced epoxy and stated that the water absorption increases from 3.32 to 3.76% as the fiber content increases

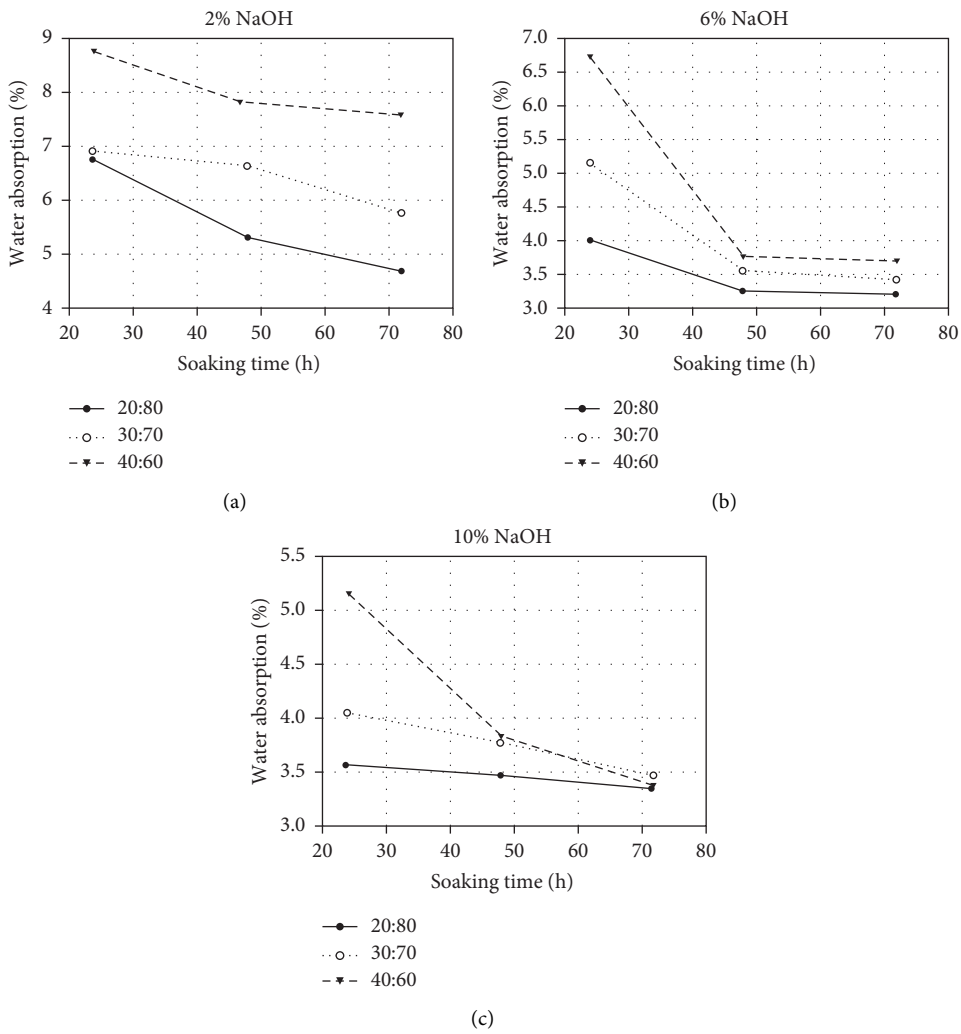

Figure 6: Effect of fiber on polyester ratio for water absorption of composites: (a) 2%, (b) 6%, and (c) 10% NaOH.

from 15% to 30%. The results are almost similar to the current work of this study. Alkali treatment changes the orientation of the cellulosic structure and forms a vague region. This provides more access to penetration by chemicals. In the vague region, water molecules fill in the space between the cellulosic molecules. Alkali groups (OH) are broken down and react with water molecules to move out from the fiber structure. Therefore, the remaining molecules form fiber-cell-O-Na groups providing more resistance to moisture absorption.

As the mass of fiber ratio relative to polyester increases, the preliminary rate of water absorption increases. This is because they are cellulose fibers. However, with the low mass of fiber ratio and higher concentration of alkaline treatment, the moisture content of fiber dramatically declined as shown in Figure 4(c). This showed that alkali treatment of sisal fiber polyester composite has removed the hemicellulosis content of the fibers, causing the moisture content of the fiber to be diminished. Under alkali treatment, the interstices between the groups of microfibers of the fiber can be blocked by alkali which can reduce water accessibility [27].

3.5. Effect of Fiber to Polyester Ratio. The effects of untreated and treated sisal fiber to polyester ratio on tensile strength, bending strength, and water absorption were investigated and presented in Figure 7. As shown from the result, the water absorption of the untreated sisal fiber-reinforced polyester composite was increased from 6.97 to 8.86% as the ratio increased from 20 : 80 to 40 : 60. However, for treated sisal fiber, water absorption value was decreased as the ratio increased. The minimum water absorption at 20 : 80 ratio was found at 3.32 and 3.19% at alkaline concentrations of 10% and 6%, respectively. This is because untreated sisal fibers are highly hydrophilic due to the existence of lignin, cellulose, and hemicellulosis in the fiber. On the other hand, the water absorption of treated sisal fiber composites is decreased due to the higher surface contact area of fiber with the matrix, which has less permeability of water than untreated fibers. The increase in water uptake is owing to the hydrophilic nature of the sisal fibers and the greater interfacial area between the sisal fibers and matrix. Sisal fiber shows a hydrophilic nature due to the presence of cellulose. With increasing sisal fiber mass, the weight portion of the fiber is also increased which

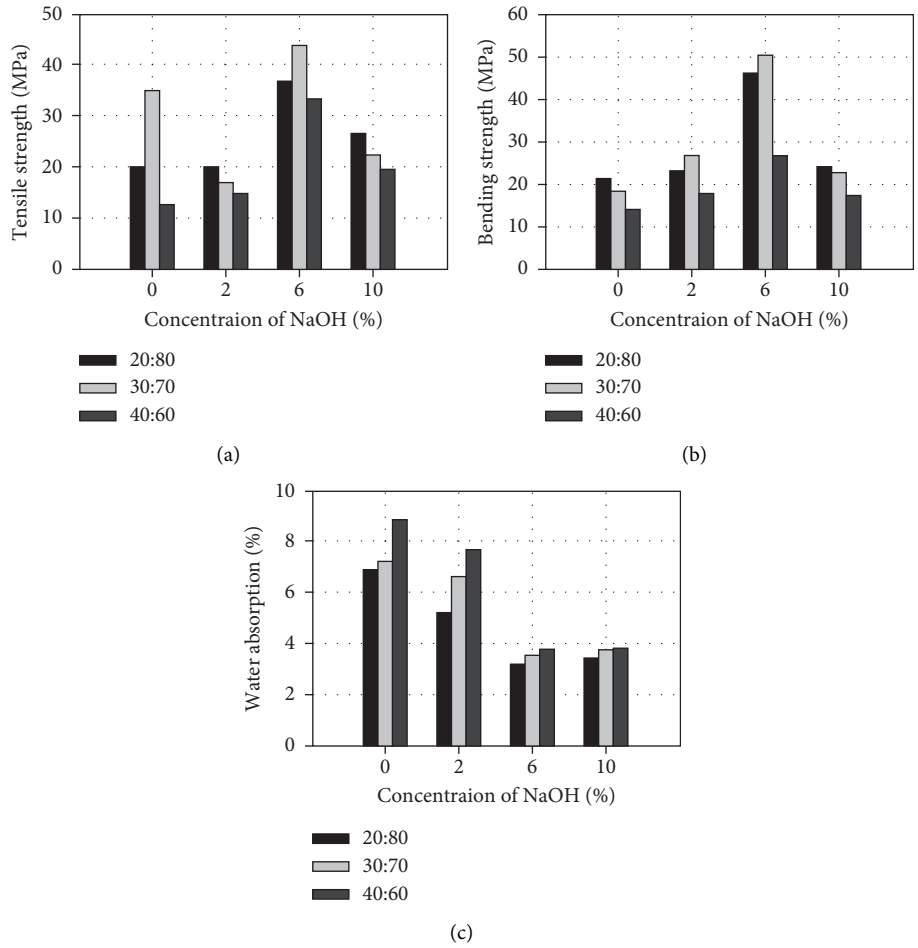

Figure 7: Effect of untreated (raw) fiber to polyester ratio on (a) tensile, (b) bending strength, and (c) water absorption.

Table 1: Comparison of flexural strength between various existing single and hybrid fiber composites.

Fiber/matrix (W/W)	Fabrication method	Chemical treatment	Flexural strength (MPa)	References
Sisa/kenaf fiber/polyester	Compression molding	Alkali treatment	150	[28]
Sisal/kenaf/epoxy	Hand layup	—	1	[29]
Banana/kenaf/polyester	Hand layup	SLS treatment	150	[30]
Roselle/sisal/polyester	Hand layup	—	80	[31]
Kenaf fiber/polyester	Compression molding	Alkali treatment	123	[32]
PALF/glass/polyester	Hand layup and compression molding	—	100	[33]
Bamboo/epoxy	—	—	107–140	[34]
Jute roving/polyester	Hand layup	Alkali treatment	115	[35]
Henquen/polyethylene	Compression molding	Silane treatment	130	[36]
Banana/sisal/polyester	Hand layup	—	65	[37]
Sisal/polyester composite	Hand layup	Alkali treatment	50.81	Present work

enlarges the content of microvoids, cellulose, and edge surface area. Exposure of raw sisal fiber-reinforced composites to moisture results in a significant drop in mechanical properties due to degradation of the fiber-matrix interface.

Chemical treatment of fibers is used to reduce water absorption, thus enhancing the mechanical properties. The tensile strength of untreated sisal fiber-reinforced fiber composite increased from 20.15 to 35.00 MPa as the fiber to polyester ratio increased from 20 : 80 to 30 : 70. This is due to the formation of better interlocking of fiber to polyester, but as the fiber to polyester ratio increases from 30 : 70 to 40 : 60, the tensile strength becomes reduced to 12.50 MPa. Similarly, the bending strength value decreased from 21.92 to 18.59 MPa as the fiber to polyester ratio increased from 20 : 80 to 40 : 60. This may be attributed to the poor adhesion between sisal fibers and polyester materials. In general, it could be confirmed that untreated fiber has low tensile and bending strength than treated fiber by alkaline treatment

Table 2: Comparison of flexural strength between various existing single and hybrid fiber tensile strengths.

Fiber/matrix (W/W)	Fabrication method	Chemical treatment	Tensile strength (MPa)	References
Sisal kenaf fiber/polyester	Compression molding	Alkali treatment	91.3	[28]
Sisal/kenaf/epoxy	Hand layup	—	23.7	[29]
Banana/kenaf/polyester	Hand layup	Cyanoethylation	75	[30]
PPLSF/jute/polyester	Hand layup and compression molding	Alkali treatment	83. 3	[38]
Palmyra/glass/rooflite resin	Compression molding	—	80	[39]
Glass/Phenol formaldehyde	Hand layup	—	55	[40]
Banana/sisal/epoxy	Hand layup	—	32.0	[41]
Roselle/sisal/polyester	Hand layup	—	60.0	[31]
PALF/glass/polyester	Hand layup and compression molding	—	70.0	[33]
Banana/sisal/polyester	Hand layup	—	58.0	[42]
Henequen/polyethylene	Compression molding	Silane treatment	80.0	[36]
Sisal/polyester composite	Hand layup	Alkali treatment	44.78	Present work

and untreated fiber has higher water absorption than treated fibers. Tables 1 and 2 show the comparison between tensile and flexural strength of various existing single and hybrid fiber composites.

4. Conclusion

Sisal plant fibers treated with different concentrations of NaOH showed a distinct enhancement in their mechanical properties when compared to raw sisal fibers. The FT-IR study confirmed the removal of lignin and hemicellulosis as functional groups indicated that either the hemicellulosis was absent or the peak intensity could gradually decrease as alkali concentration increased. The maximum tensile and bending strength of composite material obtained from the experiment were achieved at 48 hours with a 6% NaOH solution. Alkalization within the limits induced better interfacial bonding and yielded an improvement in the mechanical properties. Composites were formed after the extraction and treatment of fibers by a combination of different concentrations of fibers in a matrix through interlock of 20 : 80, 30 : 70, and 40 : 60 fiber to matrix ratios. Among those ratios, the 30 : 70 fiber to matrix ratio recorded the optimum tensile and bending strength values of 44.003 and 50.81 MPa, respectively. The treated fiber composites showed decreased water absorption due to the higher surface contact area of fiber with the matrix, which has less permeability to water than natural fibers. The water absorption was lowered at 72 h with 6% NaOH concentration and 20 : 80 fibers to polyester ratio which was 3.194%. It is clear that all mechanical properties are evaluated and the surfaces of fibers are significantly affected by the alkaline treatment of the sisal fiber.

Data Availability

All experimental data used to support the findings of this work are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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