A Review on Mechanical Behavior of Polymers (Sisal Fiber) Reinforced Composites Material

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Abstract -*The primary goal of this review paper is to investigate the mechanical properties of various sisal fiber-reinforced composites made of polypropylene (PP), epoxy, polystyrene (PS), polyethylene (PE), urea-formaldehyde (UF), and polyester as matrix materials. Depending on the matrix employed, sisal fibers are exposed to various fiber treatments in these composites. These treated composites' mechanical properties are compared to untreated sisal fiber-reinforced composites. Compared to untreated sisal fiber-reinforced composites, these treated ones have improved mechanical qualities such as impact strength, flexural strength, density, and various other parameters. Finally, the current study's results are drawn.*

INTRODUCTION

A composite comprises at least two different materials with different properties, one of which serves as a clasp and the other as a fiber. The composites are strong, lightweight, disintegration-resistant, wear-resistant, and visually appealing. Several composites have been constructed with various types of built strands to improve mechanical qualities. Composites with constructed fibers, such as glass strands, are not earth-friendly, resulting in waste glass fiber that cannot be destroyed by nature. Composites with natural fibers have a variety of advantages over composites with manufactured strands, including less effort, less weight, openness to plants or garbage, non-lethality, and no skin irritation. The convenience of these composites comes from the ease with which the fixes can be obtained from ordinary or provincial wastes, making the composites relatively simple to make. It is possible to manufacture trademark fibers to make them widely available. On the other hand, regular strands have some flaws, including sporadic estimates, solidification, sensitivity to heat, ease of ingestion of water, and the ability to age swiftly. In an ideal world, composite materials would be used as a structural component where quality and weight are considered. The following types of fibers are Plant fibers, Animal fibers and mineral fibers.

PLANT FIBERS

Cotton, flax, jute, ramie, sisal, and hemp are just a few examples of plant fibers that contain cellulose. Cellulose filaments are enacted due to the cardboard and material's accomplishment. After demographics, a fraction of these strands are as follows: Berry filaments are strands of kapok and cotton accessed from the berries casing and berry. Leaf filaments are threads obtained from the leaves of plants such as agave and sisal. Derma filaments are threads obtained from the derma, including the plant's pivot. This fiber tolerates school activity better than filaments that have been altered.

Similarly, these strands are used to distribute strong yarn, texture, packing, and paper.

ANIMAL FIBERS

Mohair, wool, silk, and alpaca are animal fibers containing proteins in significant amounts. Horsehair, Sheep's downy, goat hair, alpaca hair, and other creatures' hairs are examples of creature hairs for the season of the address of spreads, and silk filaments are the entire strands from the seared release of terrible crawlies.

MINERAL FIBERS

Mineral fibers are naturally occurring fibers or scarcely adjusted threads that can be accessed from minerals. It has modified configurations that they are following: Much of the time, asbestos is the capital of mischance mineral fiber. Anthophyllite, amphiboles, and serpentine are examples of mineral strand variations. Ceramic filaments are aluminum oxide, glass strands, boron carbide, and silicon carbide. Classification of natural fibers is as shown in the bellow figure.

Types of composites-

Metal Matrix Composites (MMCs)- Metal matrix composites have a metal system, as the name implies. In such composites, lattices link aluminum, magnesium, and titanium. Carbon and silicon carbide are joined together in a traditional fiber. Metals are essentially braced to fit the plan's requirements. The adaptability and nature of metals, for example, can be extended while extensive co- compelling of warm advancement and warm and electrical conductivities of metals can be lowered by extending strands, such as silicon carbide.
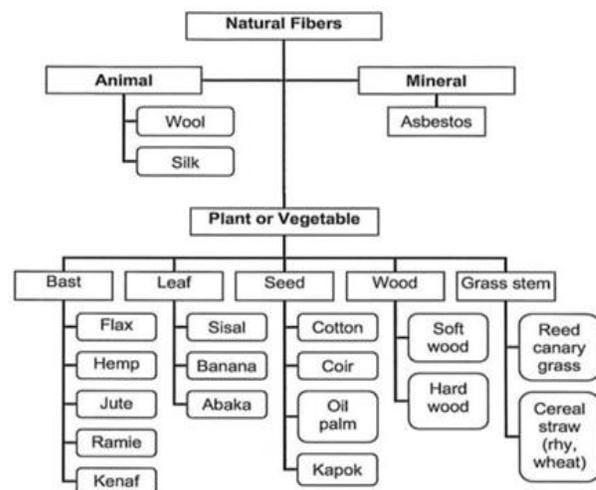
Ceramic Matrix Composites (CMCs)-Clay grids, such as alumina, calcium, and aluminum silicate strengthened by silicon carbide, are used in earthenware framework composites. CMC's advantages are high quality, hardness, high administration temperature limitations for pottery, concoction inactivity, and low thickness. Earthenware materials, which are generally resistant to high temperatures, are prone to becoming delicate and breaking. Silicon carbide strands are used to reinforce composites created with burned networks. These composites have a high thermal resistance equivalent to super combinations but without thickness. Composite manufacturing is complex due to the delicate concept of earthenware production. The majority of CMC generation procedures use starting ingredients in a powder frame.

Polymer Matrix Composites (PMCs)-Polymer grid composites are the most generally recognized propelled composites. These composites are made up of a thermoplastic or thermosetting polymer reinforced with fibers (regular carbon or boron). These materials can be shaped and sized into various forms and sizes. They give fantastic quality and solidness alongside imperviousness to consumption. Their minimal effort, high quality, and specific assembly standards are essential. The polymer composites regularly demonstrate remarkable properties because of the constituents' low thickness.

Importance of polymer matrix composites-Polymer framework composites is short or uninterrupted filaments connected by a natural polymer framework, with a solid fortifying scattering stage that provides excellent quality and firmness. They were designed to bolster the mechanical loads that the structure is subjected to benefit the structure. The framework can connect the strands and exchange stacks. Polymer Matrix Composites are well-known for their simplicity and straightforward manufacturing methods. The use of non-fortified polymers as structure materials is limited due to their low mechanical capabilities, notwithstanding their intermediate quality; polymer materials have low effect resistance. Mechanical implementation is vastly streamlined through experimentation until the outline's utilitarian requirements are met. There are two types of polymers. They are 1. Thermoplastic polymers 2. Thermosetting polymers. Natural fibers have a low density, are inexpensive, and are biodegradable. However, one of the most significant disadvantages of natural fiber composites is the low capacity between reinforcement and matrix. As a result, chemical alterations are taken into account when adjusting the surface properties of fiber composites.

METHODOLOGY

An internal mixer was used to mix PP and untreated or treated sisal fibers for sisal fiber reinforced polypropylene composites (Hakke Rheomix 3000p). The fiber content was 10, 20, and 30%, respectively. The mixing temperature was 170°C, and the rotor speed was 50 rpm. The total time spent mixing was 13 minutes. MAPP was introduced at a content of 3 phr to MAPP modified PP composites an injection molding machine was used to create test specimens. The tensile characteristics of PP and PP composites were examined using a universal testing machine following ASTM D638 (Instron, 5565). A load cell of 5 KN, a cross-head speed of 10 mm/min, and a gauge length of 50 mm were used to test the specimen. The impact strength of PP and PP composites was measured using an impact testing machine following ASTM D256. Unidirectional composite laminates with various fiber volume fractions were developed for sisal fiber reinforced epoxy composites. Before use, both treated and untreated fibers were dried to make prepregs, a resin mixture with the necessary amount of hardener was utilized. Hot pressing 10–14 pieces of prepregs (depending on the sisal content) at 60°C for 30 minutes and then curing at 80°C for 6 hours yielded composite laminates with a volume of 1315.53cm3. The pressure on the mold was maintained until the resin solidified into a solid mass to maintain a constant sample thickness, composite sheets with various fiber compositions were manufactured under various pressures. At room temperature, the tensile properties of untreated and treated sisal fibers were evaluated using an LWK-5 electronic tensile tester with a cross-head speed of 2 mm/min. The LWK-5 tester was used to determine composite laminates' tensile and flexural properties at a cross-head speed of 10 mm/min. Unidirectionally oriented fiber composite sheets were created for sisal fiber reinforced polystyrene composites using a solution mixing process followed by injection molding and compression molding, as reported in the previous study. Fibers of 6 mm length were used to make composites containing 20% by weight of untreated, benzoylated, triethoxyoctyl silane treated, methyl triethoxy silane treated, TDI treated, and PSMA coated sisal fiber on a Good Brand-Jeffreys Testomeric Micro 500 testing equipment, the tensile characteristics of the composite were measured at a cross-head speed of 5 mm per minute and a gauge length of 50mm. A conventional UTM tensile test programme evaluated the mechanical parameters (ultimate tensile strength, young's modulus, elongation at break, and yield point) using a conventional UTM tensile test programme. Plaspet Polymer Recycling Industry – Maringa – PR – Brazil provided the recycled high-density polyethylene for the sisal fiber reinforced high-density polyethylene composites. The polymer was separated from other polymers by hand, rinsed with water, and cut into 1.5 mm diameter pellets on-site. The polyethylene pellets were rinsed again and dried at 60°C for 8 hours before being surface modified in the lab. The conditions for surface alteration had already been established. The pellets were immersed in 0.25 moll–1 KMnO4 (Nuclear, Brazil) and 0.50 moll–1 HCl (Nuclear, Brazil) acidic medium at 25°C for 8 hours. As a result, the oxidized polyethylene will be referred to as PEox, whereas the untreated polymer will be referred to as PE. The ASTM D-638 test technique determined the composite tensile strength and modulus. Tensile testing was performed on the samples in a Brazil-based EMIC DL 2000 machine at a 50 mm/min constant cross-speed. The tensile characteristics of eight samples of each mixture were determined. The three-point bending test followed by the ASTM D-790-00 A test method assessed the

composite flexural strength and modulus in an EMIC DL 2000 machine (Brazil).In a 5 KN load cell, a 63 mm span was used. The load was balanced in the middle of the supports. The applied cross-head speed was 20 mm/min. The flexural characteristics of eight samples of each mixture were determined. The notched Izod impact strength tests were performed at room temperature in an EMIC-Al testing machine (Brazil) with a 5.4-J hammer, according to ASTM D 256-00 A. A solution mixing approach was used to make the LDPE-sisal composites, then extruded. The fiber was added to a viscous slurry of PE in toluene made by adding toluene to a melt of the polymer in the solution mixing method. For 10 minutes, the mixing was done manually in a stainless steel beaker with a stainless steel stirrer. The mixing temperature was kept constant at l 0°C to remove the solvent. The mixture was placed in a flat tray as lumps and kept in a vacuum oven at 70°C for 2 hours. Fibers with lengths ranging from 2 to 10mm were used to make composites containing 10, 20, and 30% fiber. Tensile testing was performed on rectangular specimens of 120mm x 12.5mm x 3mm on an Instron Universal testing machine model 1190 with a cross-head speed of 200 mm min-1 and a gauge length of 50mm. A mixture of SF, UFR, and inorganic filler $CaCO_3$, as well as a curing agent (NH_4Cl, 3 wt percent of resin) and a mold release agent (zinc stearate, 1 wt percent of the total mixture mass), were prepared for sisal fiber-reinforced urea-formaldehyde composites, which were then baked for 2 hours at 90°C as such, the blends were taken for composite construction. The specimens were made by compression molding at 140–145°C for 4 minutes at an 8 MPa pressure. The composites were then post-cured for 2 hours at 120°C.UFR 50, 40, 30, 20, and 10 wt percent were found in the composites containing 30, 40, 50, 60, and 70 wt percent SF, respectively. Nonwoven sisal mats 30 X 30 cm2 from untreated and surface-treated sisal fibers were made in the laboratory using poly(viny1 acetate) emulsion as a reinforcing binding agent for sisal fiber reinforced polyester composites. In unsaturated polyester resin, they were impregnated with 1.5 wt percent methyl ethyl ketone peroxide and 1.5 wt percent cobalt naphthenate. The four impregnated plies were layered and pressed between two resin-coated metal plates with a sisal content of 50.1%.and compacted for 2 hours at a pressure of -1.5 MPa in a hydraulic press; the mold releasing agent was poly(viny1 alcohol). The laminates were cured for 24 hours at ambient temperature before being post-cured for 4 hours at 80°C at a pressure of -1 MPa.

RESULTS AND DISCUSSIONS-
1. Mechanical properties of sisal fiber-reinforced thermoplastic composites

a) Sisal fiber reinforced polypropylene composites:- Sisal fiber serves as reinforcement in this composite, while polypropylene is the polymer matrix. The mechanical characteristics of sisal fiber (SF)/polypropylene (PP) composite with a fiber content of 10, 20, and 30 wt. per cent were investigated. The following are untreated and interfacial modified composites' tensile characteristics and impact strength.

S.No	Type of composite	Fiber content (Wt%)	Young's Modulus (GPa)	Elongation at break (%)	Tensile Strength (MPa)	Impact Strength (KJ/m²)
1.	PP+UTSF	10	0.7	12.5	23	17
		20	0.88	10.5	24	15
		30	0.92	7.0	25	14
2.	PP+ATSF	10	0.68	14.5	24	19
		20	0.86	12.5	25	16
		30	0.98	9.5	26	15
3.	PP+HTSF	10	0.74	16	25	21
		20	0.94	12	26	19
		30	1.06	8.5	27	17
4.	PP+UTSF+ MAPP	10	0.74	16.5	27	22
		20	0.92	12.5	28	19
		30	1.1	10	29	17

UTSF: Untreated sisal fiber, ATSF: Alkali treated sisal fiber, HTSF: Heat treated sisal fiber, MAPP: Maleic anhydride grafted polypropylene

Alkalization and heat treatment improved the PP composites' tensile strength, young's modulus, elongation at break, and impact strength. According to the findings, the mechanical properties of alkali-treated and heat-treated sisal fiber/PP composites at the same fiber content were driven by increased interfacial adhesion between the fiber and the PP matrix by fiber qualities. Compared to fiber treatment, including MAPP into sisal fiber/PP composites resulted in a superior increase in mechanical characteristics. MAPP improved interfacial adhesion between non-polar PP and polar sisal fibers by interacting with the fibers' hydroxyl groups and MAPP's carboxyl groups. MAPP PP chains spread into the PP matrix, causing physical entanglement of PP molecules. Tensile strength and young's modulus of PP composites with and without interfacial modification increased when fiber content was increased. It was owing to the fibers' strengthening effect.

However, the PP composites' elongation at break and impact strength dropped.

b) Sisal fiber reinforced epoxy composites:- Sisal fiber is used as reinforcement in this composite, and epoxy is used as the polymer matrix. The influence of fiber treatment on the mechanical properties of unidirectional sisal-reinforced epoxy composites has been investigated to change the fiber surface and internal structure, treatments such as alkalization, acetylation, cyanoethylation, the application of a silane coupling agent, and heating were used.

S.NO	Type of composite	Fiber Volume Fraction Vf (%)	Flexural Strength (MPa)	Flexural Modulus (GPa)	Tensile Strength (MPa)	Young's Modulus (GPa)
1.	UTSF/Epoxy	50	200	300	275	460
2.	HTSF/Epoxy	50	250	400	300	460
3.	ATSF/Epoxy	50	225	360	340	275
4.	ACSF/Epoxy	50	325	375	260	200
5.	ANSF/Epoxy	50	220	400	250	225

UTSF: Untreated sisal fiber, ACSF: Acetylated Sisal fiber, ANSF: Cyanoethylated Sisal fiber, SCSF: Organ silane coupling agent treated Sisal fiber, HTSF: Heat treated Sisal fiber, Mixed treatments (AT+SC)SF, (AT+HT)SF

Because of the enhanced crystalline of cellulose, HTSF displays a considerably more substantial increase in tensile strength in the table above. Similarly, ACSF has increased tensile strength, whereas ANSF and SCSF have decreased tensile strength, consistent with cellulose crystallinity alterations. All chemical treatments result in increased extensibility and decreased modulus. ACSF/epoxy composites have lower tensile strength than untreated sisal/epoxy composites. Compared to ATSF and UTSF composites, ACSF composites have a relatively high flexural performance. ANSF laminates exhibit the lowest tensile and flexural strengths among the composites reinforced by chemically treated fibers investigated in this research. Because of the higher crystalline, heat-treated sisal offers better tensile characteristics. The composites' tensile and flexural strengths are higher than untreated sisal composites when the fiber is added to epoxy. It should be mentioned that HTSF composites have lower flexural strength than ACSF/epoxy composites.

C) Sisal fiber reinforced polystyrene composites:- Sisal fiber serves as reinforcement in this composite, while polystyrene is the polymer matrix. The impact of interface changes on the mechanical properties of polystyrene-sisal fiber composites (tensile, impact, and flexural) was examined. Sisal fibers were treated with benzoyl chloride, polystyrene maleic anhydride (PSMA), toluene diisocyanate (TDI), methyl triethoxy silane, and triethoxy octyl silane to modify the interface. These fiber alterations improve the compatibility of hydrophilic sisal fiber with a hydrophobic polystyrene matrix and alter the composite's tensile, impact, and flexural properties to variable degrees, depending on the fiber modification.

S.NO	Type of composite	Fiber content (Wt%)	Tensile Strength (MPa)	Young's Modulus (MPa)	Elongation at break (%)
1.	USF/PS	20	43	1000	8
2.	SeSF/PS	20	44.5	1400	6
3.	BSF/PS	20	45	1010	7
4.	TSF/PS	20	46	1010	6
5.	SmSF/PS	20	47	1010	7
6.	MSF/PS	20	48	1300	7

USF: Untreated Sisal fiber, SeSF: Triethoxyoctyl silane treated Sisal fiber, BSF: Benzoylated Sisal fiber, TSF: Toluene diisocynate treated Sisal fiber, SmSF: Methyl Triethoxy silane treated Sisal fiber, MSF: Polystyrene Maleic anhydride treated Sisal fiber

Fibers of 6 mm length were used to make composites containing 20% by weight of untreated, benzoylated, triethoxyoctyl silane treated, methyl triethoxy silane treated, TDI treated, and PSMA coated sisal fiber. These composites were designated by the symbols U206, B206, Se206, Sm206, T206, and M206, respectively. U-untreated, B-benzoylated, Se-triethoxy octyl silane treated, Sm-methyl triethoxy silane treated, T-toluene diisocyanate treated, and M-polystyrene maleic anhydride treated fiber are the first letters in these notations. The first and second numerals represent the fiber's weight percentage, while the third digit represents the fiber's length. As shown in the table, the fiber alteration enhances the composites' tensile strength, and the improvement occurs in the order M206 > Sm206 > B206=T206 > Se206 > U206. Young's modulus's treated composites have improved and now follows the order.Se206 > M206 > B206 = T206 = Sm206 > U206 > Sm206 > U206 > Sm206 > U206 > Sm206 > U206 > Sm206 > UPS. .The improvement in Young's Modulus could be ascribed to better adhesion between the fiber and the matrix. The effect of fiber treatment on the PS-sisal composite's percentage of elongation at break is listed in the following order: PS > U206 > B206 = M206 = Sm206 > T206 = Se206. The composite will break at a lower elongation when the fiber-matrix adhesion is higher, indicating the better adhesion between the fiber and matrix in treated composites. Fiber modification reduces the fiber's hydrophilicity and improves the fiber's physical/chemical interactions with the polystyrene matrix. The existence of phenyl structure in treated fiber similar to that of polystyrene, which enhances the thermodynamic compatibility between the fiber and polystyrene, is attributed to the improvement in tensile qualities of benzoylated and TDI treated fiber composite.

2) Mechanical properties of sisal fiber-reinforced thermosetting composites
a) Sisal fiber reinforced Polyethylene composites
1) Sisal fiber-reinforced high-density polyethylene (HDPE) composites
The reinforcement in this composite is sisal fiber, while the polymer matrix is high-density polyethylene. Natural fibers are commonly employed as reinforcing in plastic composite materials. Composites of post-consumer high-density polyethylene (HDPE) reinforced with sisal fibers were created to improve their compatibility with PE, and sisal fibers were chemically treated to increase the hydrophobic character of the sisal fiber and the hydrophilic character of HDPE. Sisal was mercerized and acetylated in a NaOH solution, and the PE was oxidized in a $KMnO_4$ solution. Fourier Transformed Infrared Spectroscopy (FTIR) and 13C Nuclear Magnetic Resonance Spectroscopy characterize the chemically changed fibers (13C NMR). Extrusion of modified and unmodified materials containing 5 or 10% fibers was used to make the composites.

S.NO	Type of composite	Fiber content (Wt%)	Tensile Strength (MPa)	Tensile Modulus (MPa)	Flexural Strength (MPa)	Flexural Modulus (MPa)	Impact Strength (MPa)
1.	PE/S PE/S	5 10	20 21	17.5 18	23 25	17 20	57 63
2.	PEOX/S PEOX/S	5 10	18.5 18	16.5 18	22 23	18 21	55 45
3.	PE/Sac PE/Sac	5 10	19 .5 19.5	17.5 18	20 23	17 20	60 65
4.	PEOX/Sac PEOX/Sac	5 10	18.5 19	16.5 17.5	20 24	16 20	44 55

PE: Polyethylene, S: Sisal, PEOX: Oxidized Polyethylene, Sac: Acetylated sisal fibers

The tensile characteristics of PE, PEox, and composites containing 5 and 10% S or Sac are investigated. PE/sisal composites showed a steady decline in tensile strength compared to the pure polymer matrix. Composites containing modified PEox and S or Sac had the lowest tensile strength.PE/S10 showed tensile strength values that were similar to pure PE. Furthermore, adding sisal to the polymer matrix improves the tensile modulus from almost 450GPa for PE to around 520GPa for PE/S10, PE/Sac10, PEox/S, and PEox/S10, a 16 percent increase. The composites with the lowest tensile modulus values were those with 5% reinforcing. PE and four different composites reinforced with either 5 or 10% sisal fiber were tested for flexural characteristics.PE/S5 and PE/S10 flexural strength were enhanced by roughly 10% and 15%, respectively. As seen in the tensile tests, the flexural strength of composites containing PEox decreased compared to composites with the same amount of reinforcement. For example, the composite PE/S10 showed values near 25 MPa, while the composite with the same number of fibers and matrix oxidized (PEox/S10) showed around 22 MPa. Following chemical modification, the lack of phase compatibility between sisal fibers and polymer surfaces could explain this result. The flexural modulus increased significantly in all composites with 10% reinforcement (c.a. 55%).

1) Sisal fiber reinforced low-density polyethylene (LDPE) composites

Sisal fiber is used as reinforcement in this composite, and low-density polyethylene is used as the polymer matrix. Chemical treatment affects the tensile characteristics of sisal fiber-reinforced LDPE (low-density polyethylene) composites to increase bonding at the fiber-polymer interface; treatments with chemicals such as sodium hydroxide, isocyanate, permanganate, and peroxide were used. The treatments significantly improved the composites' tensile characteristics, albeit to various degrees.

S.NO	Type of composite	Fiber content (Wt%)	Tensile Strength (MPa)	Modulus (MPa)	Elongation at break (%)
1.	Untreated sisal/PE	30	31.12	3086	2
2.	Alkali treated sisal/PE	30	34.27	3328	1
3.	Isocynate treated sisal/PE	30	41.5	4066	4
4.	Benzoyl peroxide treated sisal/PE	30	40.90	4018	3
5.	Dicumyl peroxide treated sisal/PE	30	41.80	4156	4
6.	KMnO4 treated sisal/PE	30	38.80	3816	3

Tensile strength and modulus increase with fiber loading, as seen in the table. On the other hand, the alkali-treated composites have better tensile characteristics than the untreated composites. It is because alkali treatment increases the adhesive properties of the fiber surface by eliminating natural and manufactured contaminants, resulting in rough surface topography—tensile characteristics of CTDIC-treated, alkali-treated, and untreated sisal-PE composites with a 30% fiber load. CTDIC-treated fiber composites outperform alkali-treated and untreated composites in tensile strength and modulus. At 30 per cent fiber loading, the effect of Dicumyl peroxide (DCP) and Benzoyl peroxide (BP) concentration on the tensile strength of the sisal-LDPE composite was observed. It's worth noting that peroxide treatment greatly enhances tensile characteristics. The tensile characteristics of BP-treated composites are also improved. The treated composites' modulus values follow a similar pattern. It's worth noting that the tensile properties of permanganate-treated composites were noticeably better than those of untreated composites.

a) Sisal fiber reinforced urea-formaldehyde composites

The reinforcement of this composite is sisal fiber, while the polymer matrix is urea-formaldehyde. In order to make composites with self-synthesized urea-formaldehyde resin as the matrix phase, alkali-treated sisal fibers were employed as a new reinforcement. After compression molding, the composites, the effects of sisal loading on mechanical parameters such as impact strength and flexural strength were examined.

S.NO	Type of composite	Fiber content (Wt%)	Flexural Strength (MPa)	Flexural Modulus (GPa)	Density (g/cm^3)	Specific Strength (MPacm^3/g)	Specific modulus (GPacm^3/g)
1.	SF/UF	30	58.58	7.63	1.53	38.29	4.99
2.	SF/UF	40	55.80	5.27	1.52	36.71	3.47
3.	SF/UF	50	53.07	4.93	1.48	35.86	3.33
4.	SF/UF	60	37.73	4.09	1.44	26.20	2.84
5.	SF/UF	70	15.28	1.59	1.22	12.52	1.31
SF: Sisal fiber, UF: urea-formaldehyde							

The composite containing 30% sisal fibers had the best flexural strength of all the composites, indicating the best bonding and adhesion. The flexural strength improves rapidly when the SF concentration is reduced from 70 to 30 wt%, i.e., from 15.28 to 58.58 MPa, roughly 283.4 per cent. The flexural modulus rises from 1.59 to 7.63 GPa in the meantime. Because better mixing will result in better sisal distribution, the bridging gaps between the fibers will be conducted more effectively.

b) Sisal fiber reinforced polyester composites

Sisal fiber serves as reinforcement in this composite, while polyester is the polymer matrix. The effects of several chemical treatments on the characteristics of sisal fibers employed as reinforcement, including organ titanate,

zirconate, silane, and N-substituted methacrylamide, were examined.

S.NO	Type of composite	Fiber content (Wt %)	Tensile Strength (MPa)	Elongation (%)	Tensile Modulus (GPa)	Flexural Strength (MPa)	Flexural Modulus (GPa)
1.	Untreated SF/Polyester	50	29.66	9.52	1.15	59.57	11.94
2.	N-Substituted methacrylamide treated SF/ Polyester	50	39.48	9.75	2.06	76.75	15.35
3.	Silane treated SF/Polyester	50	34.14	5.71	1.75	96.88	19.42
4.	Titanate Treated SF/Polyester	50	36.26	8.00	1.67	75.59	15.13
5.	Zirconate Treated SF/Polyester	50	34.69	9.51	1.39	72.15	14.46

When sisal fibers were treated with surface treatments, they improved their characteristics. Surface-treated composites (excluding silane) have higher strength retention than untreated composites. It was discovered that sisal composites treated with N-substituted methacrylamide had superior characteristics. Most of the physicomechanical properties of composites made from surface-treated fibers are superior to those made from untreated fibers. Surface modification of sisal fibers improved tensile strength by 15 to 33 per cent, tensile modulus by 45 to 79 per cent, and flexural strength and flexural modulus by 21 to 29 per cent (silane-treated samples showed an improvement of 62 per cent in flexural properties). Silane-treated composites have a lower elongation at break than the others.

CONCLUSION

The interfacial changes in sisal fiber reinforced polypropylene composites improved the mechanical characteristics of the PP composites. The mechanical characteristics of the alkalized and heat-treated PP composites were similar. It implied that the fiber treatment processes were equivalent. Adding MAPP to the PP composites resulted in the most effective improvement in mechanical characteristics. Tensile strength and young's modulus of the PP composites increased as fiber content increased, while elongation at break and impact strength decreased. The influence of fiber treatment on the mechanical properties of unidirectional sisal-reinforced epoxy composites was investigated in sisal fiber reinforced epoxy composites. To change the fiber surface and internal structure, treatments such as alkalization, acetylation, cyanoethylation, the application of a silane coupling agent, and heating were used. Chemical and physical treatments can be used to modify sisal fibers efficiently. Composites reinforced with processed sisal are one option for structural materials. Treatment of sisal fibers that improves fiber strength and matrix adhesion. While without adding any new bonding to the intercellular area to prevent cell pull-out would favor an overall improvement of sisal laminates' mechanical properties (particularly tensile qualities). In order to improve its efficacy, various chemical treatments (benzoyl chloride, toluene diisocyanate (TDI), methyl triethoxy silane, and triethoxy octyl silane) on sisal fiber were tested as reinforcement in polystyrene-sisal fiber composites in the instance of sisal fiber-reinforced polystyrene composites. All fiber alterations increase the composite's tensile characteristics, although to varying degrees. Except for benzoylation, the flexural strength of treated composites improves. Both benzoylated and toluene diisocyanate treated fiber composites exhibit a drop in flexural modulus, while silane treated fiber composites show an improvement. Unmodified and oxidized recycled HDPE composites reinforced with unmodified and acetylated sisal fiber were created by extrusion and injection molding in the case of sisal fiber-reinforced high-density polyethylene composites. The tensile and flexural modulus of the composite produced with 10% acetylated sisal fiber and unmodified polyethylene matrix increased significantly after sisal fibers were incorporated into the PE matrix. Compared to the impact strength of pure HDPE, this composite showed a 40% improvement in impact strength. The effects of different fiber treatments such as alkali, isocyanate, permanganate, and peroxide on the tensile properties of sisal-LDPE composites were investigated as a function of fiber loading, fiber length, and orientation in the case of sisal fiber-reinforced low-density polyethylene composites. Due to their rough surface topography and higher aspect ratio, alkali-treated fiber composites have more excellent tensile characteristics than untreated composites. CTDIC-treated composites have been shown to have superior mechanical characteristics. This could be because the CTDIC-linked cellulosic fibers have a long chain structure that makes them hydrophobic, compatible, and dispersible in the PE matrix. Because of the peroxide-induced grafting, the tensile characteristics of peroxide-treated composites improved. Permanganate-treated composites followed a similar pattern due to grafting caused by the permanganate. CTDIC and DCP treatments had the best properties out of all the treatments tested. In the sisal fiber-reinforced urea-formaldehyde

composites, the composite with 30% sisal fibers had the best flexural strength of all the composites, indicating the best bonding and adhesion. It has been shown that as the SF content decreases, the flexural strength and modulus increase dramatically. The effects of several chemical treatments, such as organ titanate, zirconate, silane, and N-substituted methacrylamide, on the characteristics of sisal fibers employed as reinforcement in polyester composites were investigated. When sisal fibers were treated with surface treatments, they improved their characteristics. Surface-treated composites (excluding silane) have higher strength retention than untreated composites. It was discovered that sisal composites treated with N-substituted methacrylamide had superior characteristics. Most of the physicomechanical properties of composites made from surface-treated fibers are superior to those made from untreated fibers.

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