Chapter 2

*Literature Survey*
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2 LITERATURE SURVEY

Before starting the research work, the author surveyed the literature in the field of modification of reinforcement/matrix and its effect on the properties of polymer composites. For this, he surveyed the literature online at Sri Krishnadevaraya University Ananthapuramu, Indian Institute of Chemical Technology Hyderabad, National Chemical Laboratory (NCL) Pune, Central Leather Research Institute (CLRI) Chennai, CFTRI, Mysore, and Banaras Hindu University, Varanasi. As the number of references is very large, the author presents only the latest literature (i.e. in the last few years). The surveyed literature is presented in chronological order below.

F. Sarasini et al.[23] Investigated the effects Drop-weight impact behavior of woven hybrid basalt–carbon/epoxy composites. Interply hybrid specimens with two different stacking sequences (sandwich-like and intercalated) and interlaminar shear tests are used for the mechanical characterization along with two non-destructive methods, namely acoustic emission and ultrasonic phased array, in order to get further information on both the extent of damage and failure mechanisms.

Ferhat Sen et al. [24] Studied to improve hybrid dual-curable cyanate ester/boron phosphate composites via sequential thiol-ene photo polymerization and thermal polymerization for high performance applications such as aerospace and electronic devices.
The obtained results prove that the composites have good thermal and mechanical properties and with the help of easier preparation techniques. Hazizan Md Akil et al.[25] analyzed the pultruded jute and jute/glass hybrid reinforced polyester composites of environmental degradation effect on mechanical properties of with high fiber volume fraction (0.70) has been investigated with special focus on the effects of water ageing and moderate temperature (up to 80 °C).

Khalil Ahmed et al. [26] studied Reinforcement of natural rubber hybrid composites based on marble sludge/Silica and marble sludge/rice husk derived silica. It is observed the development is to scrutinize the cure characteristics, mechanical and swelling properties of such hybrid composite. The study suggests that the use of recently developed silica and marble sludge as industrial and agricultural waste is accomplished to provide a probable cost effective, industrially prospective, and attractive replacement to the in general purpose used fillers like china clay, calcium carbonate, and talc.

I.D.G. Ary Subagia et al. [27] observed the effect of stacking sequence on the flexural properties of hybrid composites reinforced with carbon and basalt fibers. The hybrid composites were fabricated using a vacuum-assisted resin transfer molding process. Three-point bending test was performed and the fracture surfaces were examined by scanning electron microscopy. The present results showed that the flexural strength and modulus of hybrid composite laminates were strongly dependent on the sequence of fiber reinforcement.
Yongli Zhang et al. [28] studied the mechanical behaviors of unidirectional flax and glass fiber reinforced hybrid composites. It is observed on the hybrid effects of the composites made by natural and synthetic fibers. The tensile properties of the hybrid composites were better with the growing of glass fiber content. A modified model for calculating the tensile strength was given based on the hybrid effect of tensile failure strain.

Emanuel M. Fernandes et al. [29] investigated Hybrid cork–polymer composites containing sisal fiber: It is observed that the effect of treatment on the mechanical properties and tensile properties. With variation of the fiber content and orientation get affect on properties. M.R. Mansor et al. [30] investigated using analytical hierarchy process manufacture hybrid composites with natural and glass fibers reinforced polymer for automotive brake lever design. D. Shanmugam et al. [31] studied Palmyra Palm Leaf Stalk Fiber/jute fiber reinforced hybrid polyester composites Khalil Ahmed [32] observed In this assessment, hybrid composites were prepared from the combination of industrial waste, as marble waste powder (MWP) with conventional fillers, carbon black (CB) as well as silica as reinforcing material, incorporated with natural rubber (NR). The properties studied were curing, mechanical and swelling behavior.

Alaattin Aktas et al. [33] studied the impact behavior of woven/knit fabric glass/epoxy hybrid composites. It is observed that impact behavior has to be enhanced. M.M.B. Hasan et al. [34] studied
steel fibers and glass filament yarn reinforced with polypropylene using spinning technique. By varying steel fibers content, properties of the materials also increased.

E. Sarlin et al. [35] discussed on vibration damping properties of steel/rubber composites structures. By using hybrid composites, attractive and advantageous combinations of material properties can be achieved. It is observed that the mechanical properties of materials enhanced by suitable material selection. The interfacial properties will get effect on structures of properties.

N. Venkateshwaran et al. [36] observed that Tensile strength and modulus of short and randomly oriented hybrid natural fiber composite was observed by using Rule of Hybrid Mixture (RoHM). E. Barjasteh et al. [37] analyzed the moisture absorption of unidirectional hybrid composite rods were conditioned in humid air. It is observed that moisture effect on properties of the hybrid composite. Property retention and reversibility of property deprivation were also measured.

M. Jawaid et al. [38] studied on Cellulosic/synthetic fiber reinforced polymer hybrid composites. It deals the growth of cellulosic/synthetic fibers and cellulosic/cellulosic based reinforced hybrid composites. Marco Valente et al. [39] studied by using the two step process in compression machine manufactured the thermoplastic composites with wood flour and recycled glass fibers.
Brian Burks et al. [40] investigated on a unidirectional carbon/glass/epoxy hybrid composite fatigue properties for generation high voltage transmission lines. M. Jawaid et al. [41] observed, tensile and flexural performance of tri layer (EFB)/woven jute (Jw) fiber reinforced epoxy hybrid composites subjected to layering pattern has been experimentally investigated.

M. Jawaid et al. [42] discussed on Mechanical performance of Oil palm empty fruit bunches (EFB)/jute fiber reinforced epoxy hybrid composites with different sequence. Maria Grazia Raucci et al. [43] studied the development and analysis of hydroxyapatite (HA)/polycaprolactone (PCL) hybrid composite materials synthesized by sol–gel method.

Alireza Ashori et al. [44] discussed the moisture absorption and thickness swelling behavior of the hybrid composites manufactured with recycled materials. In this study effect weight fractions of fibers and coupling agent concentration on the physical properties of composites analyzed. Ercan Sevkat et al. [45] observed the response of plain – woven hybrid composites with repeated impacts.

K.V. Arun et al. [46] discussed on the glass/textile fabric reinforced hybrid composites under normal condition and sea water environments. With interlaminar and intralaminar directions the shear strength and impact toughness is evaluated. With the scanning electron microscopy it was identified the fractureness as a reinforcement volume.
Kenny Kong et al. [47] studied the deformation micromechanics of model was investigated. In this model composite was deformed until the fiber fragmented. Tomohiko Sugie et al. [48] discussed the effect on carbon and glass fiber multi-axial warp knitted fabric is a useful reinforcement for composite.

Sanjay K et al. [49] discussed, the effect of polypropylene-bamboo/glass fiber reinforced hybrid composites (BGRP) using an intermeshing counter rotating twin screw extruder followed by injection molding. Florence Sanchez et al. [50] studied the effect of micro structural, physical, and mechanical properties on carbon nano fiber loading up to 2 wt% and adding silica fume cement. The spectacular effect seen in the composite the properties had to be increased with increasing the volume fraction of fiber.

Mubarak A et al. [51] studied, The effect of injection molding on jute and cellulose fibers reinforced with polypropylene. It is observed that properties improved with adding different compositions of jute fiber wt%.

A. Athijayamani et al. [52] investigated on the effect on mechanical properties of Roselle and sisal fibers hybrid polyester composite at dry and wet conditions were studied. X. Wang et al.[53] discussed, the effect of fiber arrangement in 3D woven hybrid composites on their low velocity impact properties, aramid (Kevlar® 129), basalt fibers, and epoxy resin were used to manufacture with different type yarn were placed in different layers.
Mahmoodul et al. [54] studied Hybrid bio-based composites with using bio-based polymer with unsaturated polyester reinforced with natural fibers. It is observed that the synergy between natural fibers (industrial hemp) in a nano-reinforced bio-based polymer can lead to improved properties. Seung-Hwan Lee et al. [55] studied the hybrid composite materials with non-woven tissue are synthesized to improve the mechanical properties of conventional fiber reinforced plastic composite materials. Richard K et al. [56] developed the composite sheets reinforced with chopped lyocell by using random wetlay process.

Amr S et al. [57] studied the effect of surface treatments on the tensile bond strength of repaired water-aged anterior restorative micro-fine hybrid resin composite. Yi, et al. [58] studied the thermal stability and mechanical properties of sisal in cycle process.

Aquino et al. [59] studied the effect of glass and jute fibers reinforced with polyester by moisture absorption on mechanical properties. John et al. [60] studied the effect of chemical resistance on sisal/glass reinforced unsaturated polyester composites. They observed the results that the developed hybrid composite are resistant to the entire tested chemical except carbon tetrachloride.

Noorunnisa Khanam et al. [61] studied the tensile, flexural and compressive properties of sisal/silk hybrid composites. They found that 2cm fiber length composites have higher tensile, flexural and compressive strength than 1 cm and 3 cm fiber length composites.
Suhara Panthpulakkal et al. [62] studied the mechanical, water absorption and thermal properties of injection-molded short hemp fiber/glass fiber reinforced poly propylene hybrid composites.

Navin Chand et al. [63] studied the influence of fiber orientation on high stress wear behavior of sisal fiber-reinforced epoxy composites. Sreekumar et al. [64] observed the effect composite to get change of their mechanical properties by fabricating compression molding techniques of sisal fiber reinforced polyester composite. It is observed that properties were enhanced in this technique.

Abdul khalil et al. [65] studied the mechanical and physical properties of oil palm empty fruit bunch/glass hybrid reinforced polyester composites. By using RoHM principle with increasing fiber content in the different ratios the properties get varied.

Varadarajulu et al. [66] studied the tensile properties of ridge ground /glass fiber reinforced phenolic composites. They observed that tensile properties are increased with increasing glass fiber in the hybrid composites. Venkata Reddy et al. [67] studied chemical resistance studies of kapok/glass kapok/sisal fabrics reinforced unsaturated polyester hybrid composites. Alvarez et al. [68] developed the sisal fiber and starch based composites and observed the effect of microstructure on the tensile properties and fracture properties of composite.

Padma priya et al. [69] developed mechanical properties of the natural fiber and glass fiber reinforced with epoxy hybrid composites
and analyzed that with adding of the glass fiber the properties of the composite were increased. Because synthetic fiber is stronger than the natural fiber. Sabeel Ahmed et.al. [70] Studied the effect of hybridization on mechanical properties of untreated (as received) woven jute and glass fabric-reinforced isothalic polyester composites have been evaluated experimentally.

Akil et al. [71] developed the bio based polymer composites and studied their mechanical properties. Rajashekhar et al. [72] evaluated the compression and hardness properties of E- glass/polyurethane composites. Sreenivasulu et al. [73] studied the chemical resistance and tensile. Properties of epoxy/polycarbonate blend matrix bamboo composites, which were occurring naturally. They observed that blend matrix bamboo composites have high tensile strength and showed better chemical resistance.

Varadarajulu et al. [74] studied the thermo gravimetric analysis of ridge gourd natural fabric reinforcement. Namasivayam and suresh Kumar [75] studied the anionic adsorption characteristics of surfactant modified coir pith, which is a waste lingo-cellulosic polymer. They attributed these characteristics to ion exchange and chemisorptions process. Yang et al. [76] studied the water absorption behavior and mechanical properties of lingo-cellulosic filler polyolefin bio-composites. They observed that mechanical properties decreased while the water absorption slightly increased as the filler load increased, but the composites had an acceptable strength level.
Huang and Yu [77] studied the structure and properties of thermoplastic corn starch/montmorillonite biodegradable composites. These composites were characterized by wide-angle X-ray diffraction, SEM and TEM techniques. They observed that the thermal properties and water resistance of these composites improved considerably by the nano filler. Uysal [78] studied the influence of pretreatment on the bonding strength of various wood species. They studied the effect of treatment on the bonding strength of wood materials. They reported improved in shear strength by the pretreatment.

Shanks et al. [79] developed the composites of poly (lactic acid) with flax fibers modified by interstitial polymerization. They studied the morphology and mechanical properties using microscopic and dynamic mechanical analysis (DMA) techniques respectively. They observed that these composites were resistant to mold fungi growth.

Shih et al. [80] developed water bamboo-husk reinforced poly (butylenes succinate) biodegradable composites and studied their performance. They observe that the mechanical and thermal properties of these composites were increased with the addition of coupling agent treated fiber. Shibata et al.[81] studied the flexural properties of natural fiber/polypropylene composites by injection moulding. They used kenaf and bagasse fiber as reinforcements. They identified with increasing volume fraction of fibers that lexural modulus of the composites increased.
Antich et al. [82] studied the mechanical behavior of high impact polystyrene reinforced with short sisal fibers. They observed that young’s modulus increases with fiber content where as tensile strength and deformation at break decreased. Mehata et al. [83] developed the jute biomass hybrid composites and studied the characteristics of electrical and mechanical properties of composites. These properties would be seen higher in these composites other than any composite. Seong Ok Han et al. [84] analyzed the thermal and mechanical properties of waste silk reinforced poly (butylenes succinate) bio composites. It was observed that with increasing temperature on composite thermal conductivity increased and with increasing load on the composite the tensile modulus and tensile strength increased.

Maries Indicula et al. [85] studied the mechanical properties of randomly oriented shot banana and sisal hybrid fiber reinforced polyester composite and they observed that a positive hybrid effect in mechanical properties. Varadarajulu et al. [86] studied the mechanical properties of short natural fiber Hildegurdia populifolia/pp composites. Wanjun Liu et al. [87] developed the composite with soya and PLF reinforced with polyester and discussed the thermal and mechanical properties of biodegradable composites. By using the SEM the surface morphology has to be studied.

Laly Pothan et al. [88] studied the mechanical properties of glass fiber and banana fiber reinforced with polyester composites.
Ramakrishna et al. [89] studied the tensile and flexural properties of epoxy toughened with PMMA/granite powder and epoxy/PMMA fly ash composites. Padma priya et al. [90] observed the chemical resistance and mechanical properties of waste silk fabric-reinforced epoxy composites. With these composites it is well capable to store chemicals in storage tanks. Varadarajulu et al. [91] developed *Hildegurdia populaifolia* reinforced styrenated polyester composites. By using UTM machine it was observed that the mechanical properties and tensile properties of the composite and by using the SEM technique the fractured surfaces of the specimen are to be analyzed.

Kishore et al. [92] developed composite with adding the fly ash particles in epoxy matrix. The compression strength of the composite would be better in saline treatment. Padma priya et al. [93] composed the waste silk fabric reinforced epoxy composite and analyzed the compression, density, impact and void content of the composite.

Ramakrishna et al. [94] studied the mechanical and water absorption properties of granite powder/epoxy toughened with PMMA and fly ash/epoxy toughened with PMMA composites.

Maries Indicula et al. [95] observed the effect on mechanical properties of short fiber oriented randomly of banana and sisal fiber reinforced polyester composites. It was observed the mechanical properties increases with increasing concentration of short fiber over
the long fiber. Alvarez et al. [96] observed the mechanical behavior of the sisal fiber reinforced with polyester.

Luyt et al. [97] composed with short sisal fiber reinforced with low density polyethylene and studied the effect adding wax and peroxide treatment on thermal properties. It was observed that with increasing wax content the thermal properties of the composite also increased. H.V. Ramakrishna et al. [98] studied the mechanical and water absorption properties of granite powder/epoxy toughened with PMMA and fly ash/epoxy toughed with PMMA composites. Kumar et al. [99] studied the chemical and tensile properties of PU and PU/PAN coated bamboo fibers.

Chabba and Matthewa [100] prepared green composites using cross linked soya for flax yarns. In this, used glutaraldehyde as cross-linking agent and studied the tensile and thermal properties. Their studies showed improvement tensile properties and thermal stability, compared to unmodified soya flour. Murali mahanarao [101] fabricated the composite with vakka, bamboo fibers, and dates and discussed the knitting and tensile properties of these natural fibers. It was observed that the tensile properties would be high comparing other natural fibers.

Antich and Mondragon [102] Manufactured the composite with short sisal fiber reinforced with polystyrene and observed the mechanical behavior of the composite should be increased by increasing the volume fraction of the fiber and the tensile strength
and deformation at break decreased. John et al. [103] developed sisal/glass fiber reinforced with unsaturated polyester hybrid composites. They identified the tensile properties of had increased with increasing glass fiber content because the synthetic fiber has higher strength compare with natural fibers.

John et al. [104] developed the sisal fiber and glass fiber reinforced with polyester matrix. It was observed with increasing the volume fraction of fiber and fiber treatment the flexural properties are also increasing with glass fiber. Further they observed that no significant effect on the flexural properties by silane treatment but a small increase in these properties by alkali treatment.

John et al. [105] Fabricated sisal and glass fiber reinforced polyester hybrid composites and discussed the variation in impact and compression properties with change in volume fraction of fiber content. It was also observed effect on properties with NaOH treatment of the fiber and found properties in treated fiber composite was higher than the untreated fiber composite.

Alvarez et al. [106] studied the melt rechological behavior of Starch-based matrix composites reinforced with short sisal fibers. Alvarez et al. [107] developed alkaline treated sisal fiber reinforced with biodegradable matrix and analyzed the water absorption and mechanical properties of composite. It was identified the improvement seen in composite and act repellent of water.
Amanulla et al. [108] studied novel natural fiber composites based on resol/hildegurdia fibers. The SEM analysis of fractured surfaces reveals that the hildeguardia fibers from very good bonding with the matrix on other hand sisal fibers cannot from good bonding with matrix compared to hilderguardia fibers.

Varadarajulu et al. [109-110] manufactured Hildeguradia populifora fiber reinforced polycarbonate and epoxy composite and discussed that the flexural and tensile properties were increased with variation in fiber content. Paiva junior et al. [111] discussed the analyzed that ramicotton fabric reinforced with polyester composite have good tensile strength and also studied miscibility of composites. Varadarajulu et al. [112] observed that Hildegardia populifolia reinforced with epoxy and discussed tensile properties of composite.

Krstyna et al. [113] developed woven aramid-glass fiber reinforced epoxy composite and discussed the effect water immersion ageing on low velocity behavior. Seena Joseph and Sabu Thomas [114] developed the banana fiber reinforced PF composites for structural applications and analyzed mechanical and dynamic properties of the composites.

Mohanty et al. [115] observed the effect of MAPP as a coupling agent on the performance of jute/pp composite. Anoop anand et al. [116] developed natural based composites with waste rayon firbre as reinforcement and studied their mechanical properties. Lovely Mathew and Rani Joseph [117] studied the effect of different bonding/coupling
agent on the mechanical properties of short isora fiber reinforce natural rubber composites. They concluded that modification of fiber surface and TDI coupling agents have increased the mechanical properties of rubber composites.

Muk Lee et al. [118] developed the novel silk reinforced poly (butylenes succinate) biocomposites with increasing fiber content. It was observed that the change in thermal and mechanical properties by varying the fiber content. Supriya mistral et al. [119] wrote the review on pineapple leaf fibers, sisal fibers, sisal fibers and their bio-composites. PALF and sisal reinforced composites were partially replace the conventional and pollution causing fibers, such as glass, carbon, borosilicate aramid composites etc.,

John et al. [120] studied blends of unsaturated polyester resin and investigated the mechanical properties based sisal/glass hybrid composites. Varada Rajulu et al. [121] studied chemical resistance and tensile properties of epoxy/unsaturated polyester blend coated bamboo fibers. They observed that blend coated bamboo fibers. They observed that blend coated bamboo fibers showed better chemical resistance and lower water absorption.

Liaok et al. [122,123] studied on mechanical properties of bamboo/glass fiber reinforced polymer matrix hybrid composites and showed that the reduction in tensile strength and modulus in hybrid composites is nearly half of the un-hybridized composites.
Takashi et al. [124] developed the kenaf reinforced biodegradable composites. It was observed that the mechanical properties and thermal properties were high compare with other fibers. Van de Weyenberg et al. [125] studied the effect of chemical treatment on flax fibers of their composites. With this treatment it was identified the properties were higher in treated composite comparing with untreated composite. Joseph et al. [126] developed the short sisal fiber reinforced polypropylene composites and observed the dynamic change mechanical properties. Fraga et al. [127] fabricated glass fiber reinforced with unsaturated polyester and vinyl ester. They discussed the relation between dynamical and mechanical properties and also found effect of water absorption. Mohammed Hassan et al. [128] studied the utilization of lignocelluloses fibers in molded polyester composites. Tserki et al. [129] studied the effect of compatabilization on the performance of biodegradable composites using cotton fiber waste as filler. Oksman et al. [130] developed the unidirectional sisal reinforced epoxy composite and analyzed the surface morphology with SEM and mechanical properties of the composite. They confirmed the longitudinal stiffness and strength would be higher for these composites.

Ismail et al. [131] made the bamboo fiber filled natural rubber composites. They reported of bonding agent on the filler loading and composite performance. Rong et al. [132] fabricated sisal reinforced epoxy composites and discussed the effect of impact performance on
the interfacial interaction in fibers. Leonard et al. [133] discussed the effect of alkalization on sisal, jute, hemp, and kapok fibers. In this process it was observed the strength of fibers were increased significantly. Cameron et al. [134] observed a transition from miscibility to immiscibility in the blends of poly (menthyl methacrylate) and styrene-acrylonitrile copolymers with varying copolymer composition.

Singh et al. [135] analyzed the effect of various coupling agents on the sisal fiber surface by FTIR microscopy. Shibata et al. [136] studied the biodegradable polyester composites reinforced with short abaca fiber. Rot et al. [137] examined the tensile strengths of polyester laminates with respect to E-glass fiber unsaturated polyester resin interfacial properties. Park and Kim [138] studied the effect of sizing treatment on glass fibers. Varada rajulu et al. [139] coated bamboo fibers with styrenenedated polyester and reported an improvement in tensile and chemical resistance of the coated fiber.

Bureah et al. [140] studied the fragility of unsaturated polyester resin cured with styrene. They studied the influence of styrene concentration on the preparation of the matrix. Mwaikambo and Ansell [141] developed the chemically treated kapok fabric and they investigated the fabric properties with different techniques. Yan Li et al. [142] studied the sisal fiber and its composites, a review of recent developments. Hill et al [143] studied the effect of fiber treatments on
mechanical properties of coir or oil palm fiber reinforced polyester composites.

Mwikamboo et al. [144,150] studied the performance of cotton-kapok fabric-polyester composites and found that the tensile properties of untreated composite have better properties than treated composite, where as flexural properties increase with increasing fiber volume fraction of cotton/kapok. Varada Rajulu et al. [145] reported chemical resistance and tensile properties were improved in coated bamboo fibers with epoxy/poly (methyl methacrylate) blend composites.

Kitano et al. [146] studied the mechanical properties of glass fiber/organic fiber mixed mat reinforced thermoplastic composites. They investigated the influence of influence of different types of fibers on the mechanical properties for hybrid composites materials. Urreaga et al. [147] studied the effect of coupling agents on the oxidation and darkening of cellulose materials used reinforcements for thermoplastic matrices in composites at the process temperature of thermoplastics.

Kumar et al. [148] studied the morphology and melt rheological behavior of short sisal fiber reinforced SBR composites. They investigated the effect of fiber breakage; length concentration and shear-rate/stress on melt viscosity. Naveen et al. [149] studied the mechanical behavior of knitted glass-epoxy composites. In this composite the tensile strength and modulus were shown in good agreement.
Pothan et al. [151] studied the variation in tensile and impact properties of banana/glass fiber hybrid composites. They concluded that the tensile and impact properties increased linearly with the addition of glass content to the composites. Hattum and Bernardo [152] developed the modal to know the strength of short fiber composites. In this orientation of the fibers the mechanical and thermal properties were greatly depend on this orientation of the composite.

Riccieri et al. [153] studied the water absorption effect on interfacial properties of Unidirectional vegetable fibers reinforced with polyester. In this effect the properties were significantly improved and observed pure resistant of water of these fibers. Dash et al. [154] studied the novel, low-cost jute-polyester composites. They determined the mechanical properties and carried SEM analysis. They determined the mechanical properties and fiber-resin bonding.

Saha et al. [155] carried out the effect of impregnation jute fiber into polyester and discussed the mechanical analysis of the composite. Gassan et al. [156] studied the influence of the cyclic effect on water absorption and desorption properties on mechanical properties of saline treatment of jute reinforced epoxy composites.

Gowda et al. [157] studied tensile and impact properties of jute reinforced with unsaturated polyester composites. It was observed that properties of this composite were higher over other matrix. Chotra and paul [158] studied the moisture transmission through
aramid polyethylene and glass fiber reinforced epoxy laminates. They reported that polyethylene fiber reinforced epoxy materials were most resistant to moisture transport.

Varada Rajulu et al. [159,160] studied chemical resistance and tensile properties epoxy blend coated bamboo fibers and bamboo fiber reinforced epoxy composites. Padmavati and Venkata Naidu et al. [161] studied the chemical resistance and tensile properties of sisal fibers. It was observed that this fiber reinforced composites were good chemical resistive and best tensile properties.

Pothan and Thomas et al. [162] studied the effect of mechanical and ageing properties of banana fiber reinforced polyester composites. In this composite it is observed that properties increases with increasing volume fraction of fiber. Sahoo et al. [163] studied the effect of several types of chemical effects of jute on the presentation of polyester resin based jute composites. The mechanical properties improved substantially when fibers were treated with chemicals.

Misra et al. [164] fabricated polyester composites reinforced with chemically modified pineapple leaf fiber and showed that the tensile strength and elongation at break increased when the fibers grafted with 10% acrylonitrile where as the increase in Young’s modulus is marginal. Kala Prasad et al. [165,166] have studied the low-density poly ethylene-based short sisal-glass hybrid composites and found a considerable enhancement in the mechanical properties.
Satyanarayana et al. [167] fabricated some biodegradable fiber reinforced polyester composites and studied their properties.