Abstract: The benefits of natural fiber-reinforced thermoplastic composites has grown due to the depletion of petroleum supplies and the damaging environmental effects of traditional materials. Thermoplastic composites reinforced with natural fibres provide remarkable qualities, including high specific strength, lightweight, and good acoustics. Great sustainability and modern applications for natural fiber-reinforced green composites include aerospace, autos, and household items. In a variety of applications, green composites have taken the place of metals, alloys, wood, and different not degradable polymer composites. This review offers a thorough analysis of composites made with thermoplastic-based natural fibers. In order to examine how these elements affect the qualities of natural fibre-reinforced thermoplastic, a number of factors have been explored, including fiber orientation, processing parameters, fiber surface modification, etc.

Keywords - Composites, Epoxy, Natural Fibers, Mechanical strength, Hardness, Water Absorption

1. INTRODUCTION
Due to the advantages that natural fiber composites offer over traditional synthetic reinforcing fiber, these materials are garnering researchers at Lightweight, environmentally friendly, bio-degradable, and non-abrasive features are just a few of the benefits of natural fibers. Some natural fiber composites encounter difficulty due to limitations like poor moisture resistance, reduced stability, hydrophilic nature, shorter life cycle, and poor fire resistance qualities. The development of innovative surface treatments holds the promise of improving the mechanical characteristics of natural fibers, rendering them applicable to a wide array of industrial uses. Numerous investigations have been carried out to optimize the fiber content in composites, aiming to elevate their mechanical properties. This is crucial because the concentration of reinforcement in composites significantly influences their mechanical performance during usage.

2. LITERATURE REVIEWS
Gauri S. Deshmukh et al. [1] The researchers aims to use natural fibres like hemp fibres as reinforced composite materials because of their ecological concerns & technological advancements. They want to analysed the limitation to use hemp fibers composites these limitations like incompatible with polymer matrix & hydrophilic characteristics of hemp fibers but these limitations can be overcome by physical/mechanical modification which improves the interfacial interaction between fibers - matrix interface. The fabricated reinforced composites have the potential to be used in advanced engineering applications, consumer goods & automobile applications etc. They also examined the mechanical and chemical composition of various natural fibers, as depicted in Table 1, which showcases lignocellulosic fibers obtained from different parts of plants. In contrast, Table 2 underscores the effective utilization of fibers like hemp, jute, kenaf, flux, and sisal as reinforcements in both thermoplastic and thermoset matrices.
Upon review and analysis, it has been determined that natural fiber-reinforced composites exhibit superior characteristics compared to synthetic fibers, such as glass fiber-reinforced composites. This preference arises from the eco-friendly nature, durability, decomposability, and the ability to achieve high fiber contents for equivalent performance associated with natural fibers.

The goal of the work by Akash et al. [2] was to create hybrid composites by mixing hemp and sisal fibers with epoxy resin. To improve the bonding between the fibers and epoxy resin, various weight percentages were used and a 10% NaOH solution was applied to the fibers. When the researchers analyzed the mechanical characteristics of the manufactured composites, they found that, in comparison to other composites, the hybrid composite that had 40% weight percentage of sisal and hemp fibers had better flexural and compression strength. The experimental data shows that water absorption capacity increases with fibre loading. SEM images shows that sisal/hemp fibers are uniformly mixed with epoxy resin. The specimens' mean values were taken into account in the flexural strength test. Figure 1 shows the flexural strength of hybrid composites reinforced with sisal and hemp fibers at different weight percentages of fiber loading.
The findings show that there is an increase in flexural strength at a 40-weight percent fiber loading. But when the weight % of fiber loading increases higher, the addition of fibers causes a subsequent drop in flexural strength, as Figure 1 illustrates. This tendency is consistent with the kenaf fiber loading results reported by N. Saba et al.

Similarly, as Figure 2 shows, the weight % of fiber loading affects the Shore-D hardness value. The figure shows that the hardness number of the composites grows in tandem with the weight % of fiber loading.
With an increase in fiber content, the water absorption of hybrid composites reinforced with sisal and hemp fibers exhibits an increasing trend. According to Figure 3, which shows the proportion of water absorption versus time (days): moisture absorption increases from the first day to 25 days and then stabilizes after that.

![Figure 3. Water absorption of different wt% of Fiber [2].](image)

The hydrophilic character of cellulosic fibers and the degree of chemical compatibility between the fibers and the matrix are the main factors responsible for the susceptibility of cellulose fiber-reinforced polymer composites to moisture absorption. Together, these elements weaken the composites' ability to withstand moisture absorption.

In order to create and understand how chemical treatment affects the mechanical and physical characteristics of natural fibers, such as areca frond fibers, banana fibers, and flax fibers, Heckadka et al. [3] carried out research. For surface changes, chemical reagents such as potassium permanganate, sodium bicarbonate, and chromium sulfate were used. According to the experimental findings, all of the fibers' diameters shrank after chemical treatment. Nevertheless, there was a relative increase in the fibers' diameter following the two stages of chromium sulfate treatment.

Moreover, the densities of all the fibers decreased as the duration of sodium bicarbonate treatment increased. Areca and flax fibers exhibited positive outcomes for a single-stage treatment of chromium sulfate, while sodium bicarbonate proved to be the most effective treating agent for banana fibers at a duration of 72 hours. The researchers also observed that the tensile strength of all fibers decreased when treated with potassium permanganate.

An epoxy composite based on non-woven banana fiber was used in research by Gairola et al. [4]. They investigated the mechanical and physical characteristics at various fiber loads and weight percentages of fiber content. The highest values for flexural and tensile strength, which occurred at 30 weight percent of fiber, were found by the researchers to be 38.1 and 65.6 MPa, respectively. Nonetheless, at 40 weight percent of fiber, the maximum impact strength and hardness were measured, with values of 2.8 Joules and 45.6 HV, respectively. Furthermore, it was shown that the composites' ability to absorb water increased with both fiber loading and elapsed time.
In order to examine the effects of mechanical qualities, Bhoopathi et al. [5] carried out experimental work in which glass fiber was incorporated into a matrix of treated banana-hemp fibers reinforced with epoxy. The experimental data show that when hemp-banana-glass fiber was chemically treated get better tensile strength (60.99 MPa) compared to chemically treated glass-banana fiber hybrid laminates which have a tensile (0.45 MPa) but chemically treated hemp-glass fiber hybrid laminates have maximum flexural strength as 1.2 KN, compared to chemically treated hemp-banana glass fiber hybrid composites has the flexural strength as 1.17 KN. The results of the impact test indicate that the composites’ ability to absorb impact energy falls between 7.33 and 9.33 Joules. They concluded that chemically treated hemp-banana-glass fibers hybrid composites can replace synthetic fibers in polymer composites because it has good mechanical properties like decomposable, light in weight, low cost, durable etc.

Rajendran et al. [6] aimed to find alternative materials for wooden construction products. In their experimental work, natural plant fibers such as jute fiber and banana fiber, along with industrial fly ash and groundnut shell ash, were incorporated to create value-added composite materials. The experimental data revealed that the addition of these bio-composites improved fracture toughness by offering more resistance to fiber debonding. However, the introduction of groundnut ash reduced impact resistance due to its susceptibility to brittle failure. It was observed to be prone to brittle failure under impact conditions. On the positive side, the abrasion resistance of the bio-composites increased by a quarter compared to conventional wood materials. This enhancement was attributed to the hard surface of groundnut shell ash and chopped banana fiber in the composite.

In order to develop a composite, Bhoopathi et al. [7] combined reinforced hybrid composites of hemp, banana, and glass fibers that were treated with NaOH solution. The tensile strength of the banana-glass fiber composites was found to be 49.5 MPa, which was greater than the tensile strength of the other hemp-glass fiber reinforced composites, which was 47.5 MPa, as per the experimental results. Additionally, the banana-glass fiber reinforced composites showed a maximum flexural strength of 0.72 kN, which was marginally greater than the 0.71 kN value of the banana-hemp-glass fiber reinforced composites. On the other hand, the hybrid composites’ impact strengths ranged from 7.52 to 11.08 Joules. The internal structures, shattered surfaces, and fiber failure mode of the manufactured hybrid reinforced composites were examined using scanning electron microscopy.

In order to create a hybrid composite, Mohanavel et al. [8] mixed epoxy resin, fine hemp fiber, and cotton fibers in different weight percentages. They then evaluated the mechanical and physical properties of these composites. The findings showed that the composite with 20 weight percent of fine hemp fiber had better properties than other weight percentages of fine hemp fiber added to the epoxy resin matrix/cotton fiber composites. At 30 weight percent of fine hemp fiber, however, the composite showed better properties like flexural modulus, flexural strength, flexural load, and impact energy characteristics when compared to composites with different weights.

The goal of Gupta et al. [9] was to develop hybrid composites reinforced with sisal and hemp fibers while assessing their mechanical characteristics. In contrast to conventional composite materials, the experimental results showed that the hybrid composite reinforced with sisal and hemp fibers and loading at 40 weight percent had higher tensile and flexural strength values (tensile strength: 53.13 MPa, flexural strength: 82.07 MPa). The hardness strength of sisal/hemp fiber-reinforced epoxy resin hybrid composites increased in proportion to an increase in the weight % of fiber content, according to the researchers’ observations.
The aim of Shahzad et al.’s study [10] was to replace synthetic fibers—like glass fibers—with hemp fibers for reinforcement in composite structures. Hemp fibers were selected because they are sustainable, have strong tensile and flexural strength, and are environmentally benign. The researchers observed that the characteristics of hemp fibers vary, a problem that may be solved by surface treatment techniques. Improved mechanical characteristics result from these treatments’ enhancement of the interfacial adhesion between hemp fibers and the matrix.

In order to create a unique material, Bhoopathi et al. [11] combined glass and hemp fibers in an epoxy resin polymer matrix for composites. They next looked at the material’s mechanical and physical characteristics. Remarkably, when compared to the treated hemp and glass fiber composites, they discovered that the untreated hemp and glass fiber composite showed superior tensile and flexural strengths. More tensile strength (38.47 MPa), flexural strength (0.29 kN), and maximum impact energy (4.99 Joules) were attained by the hemp/glass fiber composite in particular. This implies that the amalgamation of glass and hemp fibers with epoxy resin have the capability to function as an alternative to composite materials including synthetic or artificial fibers.

Karthick et al. [12]. In his experimental works, researchers are concerned with the use of natural fibers in engineering & medical applications because natural fibers have better thermal, mechanical, static & dynamic properties. So, researchers use fibers like banana fibers, and glass fibers with epoxy resins for making composites & take the parameters for their study, by varying fiber length & fiber loading. He evaluates that 20% fiber loading & fiber length at 15 mm gives highest tensile strength (19MPa) but maximum flexural strength obtained at 15% fiber loading & fibers length at 10 mm (32.5 MPa) & the maximum impact strength 2 J was obtained 15% fiber loading & fiber length at 10 mm.

Srinivasan et al. [13] aim to incorporate natural fibers into engineering and industrial applications due to their eco-friendly, cost-effective, lightweight, and recyclable properties. In their experimental study, calcium carbonate was added to the epoxy matrix to increase the composite's strength, and banana fibers were used as reinforcement. The researchers noticed that different results were obtained from banana fibers treated with epoxy resin at different calcium carbonate concentrations (3% and 6%). The sample with the calcium carbonate content of 6% showed better tensile strength. On the other hand, tensile stresses rose by 9% in specimens with 3% particulate matter compared to those without it. Among other set of filled and unfilled particulate composite specimens, the specimen loaded with 3% particulate matter showed better values for flexural strength.

K. Murugan et al. [14], the researcher aims to fabricate mudguards with natural fibers compared to existing steel mudguards. Mudguards on two-wheelers are used to protect the front and rear wheels from dirt and precipitation. The construction involves fabricating composite mudguards using A-Glass/epoxy fiber along with reinforcement from kenaf and banana polymers. The experimental result shows that composite mudguards reduce weight up to 53.8%, reduction in cost up to 80 % & achieve higher factor of safety up to 64% without sacrificing their length compared to steel mudguards. So, composite mudguards easily replaced conventional steel mudguards.

3. REVIEW OBJECTIVE

The primary objective of the current review is to pinpoint the essential qualities of natural fibers, including those found in maize, hemp, banana, and kenaf. The evaluation also attempts to evaluate the hybrid composites’ mechanical, thermal, and physical characteristics. The desire to create a new material that can completely replace traditional materials and the scarcity of knowledge are the driving forces behind closely examining the characteristics of natural fibers. As we know that conventional materials are costly & harmful for the environment that is why we want to get more knowledge to develop a new material with the help of natural fibers & same the environment.
4. CONCLUSION

This review delves into the potential of hemp & banana fibre composites & other natural fibres composites, highlighting their chemical composition and mechanical and physical qualities. Compared to other natural fibres, banana & hemp fibres have better properties.

With the advent of composite technology, it has become feasible to employ more cost-effective materials in high-performance applications. The amalgamation of advantageous traits from two distinct materials, such as reduced manufacturing costs and enhanced adaptability, renders them valuable across various engineering domains and high-performance applications. This includes sectors like sporting goods, recreation, the shipping industry, aerospace, etc. Banana fibers, in particular, hold a promising future in comparison to glass fiber or other synthetic composites due to being less expensive, lighter, and more environmentally friendly.

REFERENCES


