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A REVIEW ON NATURAL FIBERS REINFORCED COMPOSITE AND ITS APPLICATIONS

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ABSTRACT
Globally, the consumption of natural fibres has been continuously growing for the last few decades as a result of the expanding world population and improvement in living standards, which has increased the amount of post-industrial and post-consumer fibre waste. Reinforced composites made from natural fibres are gaining popularity due to their attractive characteristics, such as low weight, increased rigidity, and low cost. Therefore, the ever–growing amount of textile wastes makes it necessary to utilize these waste materials and develop further processing technologies for their beneficial applications. This paper summarized an overview of natural fibre and textile recycling to produce biodegradable products, which account for a large part of textile waste. Observations on future trends and needs for further developments are also discussed.
Keywords:- Fibers, Textiles Waste, Recycling, Utilization, etc.

1. INTRODUCTION

The increase in environmental awareness and public concern, new environmental laws, and the unsustainable use of petroleum have all prompted people to consider using environmentally friendly materials. When compared to synthetic fibre, natural fibre is recognized of as one of the more environmentally friendly materials [1].

Today, scientists around the world are concerned to the protection of the atmosphere and the biodiversity, by enhancing the sustainability and quality of eco-friendly products. People are switching back to natural fibres in replacement of synthetic and hazardous materials because of their bio renewable qualities and eco-friendly techniques. Some disadvantages of natural fibre, such as biocompatibility and hydrophilic properties, can be overcome by several surface modifications and methods of treatment of chemicals to achieve sufficient uses. They have been utilised successfully for a variety of applications, including textile, biomedical, biopolymer, biosensors, composite materials—despite having a lower density than glass fibre—composite materials for development and engineering, and smart packaging. The utilization of natural fibres would help to mitigate pollution issues, such as waste, landfill, toxic, and greenhouse gases emissions [1 - 3].

Intact, long, thin, and easily bendable fibre is a type of material that can be made into an elongated tissue [4]. Fibres are divided into three classes based on the origins of the materials: natural, semisynthetic, and synthetic sources. Natural fibre has many advantages over synthetic fibre, including lower density and density requirements, renewability, no skin irritation, a higher strength-to-weight ratio, an aspect ratio of length to diameter (L/D) of about 100, and a higher strength and elasticity modulus, all of which indicate that natural fibre has a great deal of potential as a replacement for glass, carbon, or other synthetic fibres. Also, these advantages have encouraged the use of natural fibre for both industrial raw materials like textiles, pulp and paper, accessories, bio-composites, and crafts as well as for human needs. [5]. Natural fibres remain in demand and compete for consistency, longevity, colour, and shine with wool, silk, and synthetic fibres.

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Natural fibre consists of plant, mineral fibres, and animal. Animal and plant fibres are mostly made of protein and cellulose, respectively. The fibre plant also has stems, leaves, seeds, xylem, bark, and fruit. Depending on the species, these fibres originate from primary or secondary meristematic tissue. The stem fibre also includes wheat, bagasse, rice, bamboo, corn stem, and corn. Fruit fibre examples include coconut and oil palm, whereas leaf fibre examples include abaca, pineapple, sisal, and agave. Moreover, cotton, kapok, and wider are examples of seed fibres. Animal fibres include wool, silk, bird feather, hair, and collagen fibres, whereas bark fibres include rosella, jute, hibiscus, abaca, soybean fibre, and ramie. Mineral fibres include materials like glass, carbon, and asbestos [6–10].

Indonesia produced 1,200, 1023, 6,8 million, 1,8 million, and 1,8 million tonnes of cotton, ramie, abaca, and pineapples year from 2013 to 2015, respectively [11]. Malaysia has a high potency of natural fibre, similar to Indonesia. Over 600 tonnes of kenaf fibre are used each month to create fibre board at the "Panasonic Electric Works Kenaf" in Malaysia [12]. According to information from the Malaysian Pineapple Industry Board (MPIB), there were approximately 1,022,319 ha of pineapple plantations around the world in 2014. These plantations produced 25, 439, 366 MT of pineapple. Furthermore, Malaysia has a plenty of pineapple raw material waste to meet the needs of composite manufacturers and research and development departments [13]. Oil palm is the most economical oil crop in Malaysia. In 1971, Malaysia became the world's largest producer and exporter of palm oil with 352,385 ha of plantations. In 2004, the total area under cultivation increased by 3.87 million hectares. Oil palm expansion will produce a significant amount of trash, which is predicted to be over 30 million tonnes of oil palm biomass annually and consist of empty fruit bunches, fronds, and trunks that can be used as fibres [14].

Natural fibres from Malaysia have a wide range of applications. Many studies have been conducted on the utilisation of fibre, including the use of Malaysian Yankee Pineapple AC6 leaf fibre treated with silane in composites for a variety of industrial uses [13]. To make door panels, seat backs, different interior trim, and spare-wheel pans in particular, automakers have used kenaf, flax, abaca, and hemp. Jute-based composites, such jute thermoplastic board, are made from waste jute and plastic and can be used to construct sheets or boards, doors, furniture, window frames, fences, and other things. These materials may find new uses in the future [12].Natural fibre is an appealing option for unsustainable glass and carbon fibre reinforced composites due to its availability and technical viability, which also makes it an appealing bio-resource for raw materials. [15]. Scientists are concerned with eco-friendliness and sustainability in designing new bio- products [15 - 17]. However, due to the need to reduce resource consumption, environmental impact assessment (EIA) and life cycle assessment (LCA) should also be available in the future for the creation of new products [18]. The EIA is a similar procedure that aids in determining how products and services affect the environment, whereas the LCA is a tool for assessing the consequences of goods or services [19]. In order to increase the sustainability and economic worth of some natural fibres, this paper examines studies from 1995 to 2020 and describes the properties (physical, mechanical, chemical, and anatomical) and prospective usage of those fibres. This paper focuses on eco-friendly bio-composites.

2. TYPES OF NATURAL FIBERS AND THEIR UTILIZATION

Natural fibres are often categorised according to its botanical types. According to [20], five specific types of natural fibres are categorised by this approach, namely (i) bast fibres such as jute, flax, cannabis, ramie and kenaf, (ii) leaf fibres such as banana, sisal, agave, and pineapple, (iii) seed fibres such as coir, cotton, and kapok, (iv) grass and reeds such as wheat, maize, and rice, (v) all other types such as roots and wood. There are some crops that produce more than one type of fiber. In contrast, agave, coconut, and oil palm have both fruit and stem fibres. For instance, both bast and core fibres contain jute, flax, hemp, and kenaf. Cereal grains, in addition, have both stem and hull fibers [21].

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Recently, Suparno [5] reported potential and future efforts of Indonesia's natural fiber as raw material for various industries, and summarized in Table 1. Table 1 shows that the different types of natural fibres and ts end application with latest references. Authors Kumar and Hiremath [33], Sood and Dwivedi [34], and Lau et al. [35] have reported on the use of composites based on natural fibre in vehicle interior linings (roof, side panel lining, rear wall, furniture, building, packaging, and pallets for shipping). The presence of hydroxyl and other polar groups, dead cells, wax and oil, and low fire resistance makes natural fibers in raw conditions not compatible with polymers and causes the formation of aggregates. Moreover, natural fibre composites have lower interface strength than glass or carbon fibre composites due to their significant water absorption. Understanding the fundamental characteristics and parts of natural fibres is required to develop environmentally acceptable composite applications. Additionally, certain qualities like length, flexibility, and strength must be present for natural fibres to be used as textiles. The fibre ratio of length to width is one of the most crucial factors when using natural fibres in place of synthetic ones. A flexible and easily concatenated yarn is what natural fibre, yarns, or synthetic fibres with short (staple) or very long (filament) fibres are designed to provide[36]. Except for silk fibres, natural fibres are typically present as short staples that can be combined with semi-synthetic (semi-cellulose, protein, or mineral) or synthetic fibres. Viscose and acetate rayons, and kupri ammonium are semi-synthetic fiber. Whereas synthetic fibres like nylon, polyester, and spandex are created through condensation and the addition of polymers like acrylate[36].

Stretching, calendaring, and the creation of hybrid yarns, according to Dhaliwal[22], are alterations that could be utilised to alter the physical properties of natural fibres. Also, according to Sudjindro [37], abaca fibres have a significant potential for usage as raw materials in the textile industry since they are robust, humidity-resistant, and contain salty water. The hollow design of biduri fibres serves as an air/medium trap to restrict the transfer of heat [38]. They might be employed as organic, regenerative, and eco-friendly heat insulating materials. Mild and hydrophobic biduri fibre does not induce allergies[26].

Ramie bast fibre, pineapple, and sansevieria leaves, according to Munawar et al. [39], are potential high performance plant fibre composites due to their excellent mechanical qualities. According to Kandachar and Bruwer [40], this hemp fibre is also employed as reinforcement in biocomposites due to its high strength and stiffness. Composite material sof natural fibers have great potentials, especially in the auto-motive industry. The majority of the time, they are used in interior components including door panels, dashboard components, parcel shelves, seat cushions, back rests, and cable linings[41–43]. Because they have a very high initial modulus, pineapple fibres, copolymers, and composites are employed in textile industries, as well as in cars and railroad coaches[28,44].

TABLE 1: DIFFERENT NATURAL FIBER UTILIZED

Types of natural fibers	Utilizations	Latest references
Abaca	Textiles, clothes, and useful papers such as money, journal, and check paper, as well as composites.	[22]

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Bamboo	Lactic acid, construction, vinegar, charcoal, methane, composite reinforcement, shoes, food, textiles, pulp and paper production, shocks, and bio energy sources.	[23]
Banana/Musa	Rope, placemats, paper cardboard, string yarn, tea bags, high-quality textile/fabric, currency note paper, mushroom, art/handicraft,cordage,cushioncover,tablecloth,curtain,naturalabsorbentincolored wastewater, oil absorber, lightweight composites, and bio-fertilizer.	[24,25]
Biduri	Heat insulation material	[26]
Coir	Filler, reinforcement in composite materials, lightweight composites	[5, 24]
Collagenfiber	Tissue manipulation, operating sewing thread	[5]
Cotton	Fabric, clothes, yarn, furniture industry as coating materials	[22]
Derrisscanden	Reinforcing agent alternatives for synthetic fibers in polymer matrix Composite	[27]
Hemp	Bags, tarpaulins, carpets, rope, furniture materials, fabric, textile, garden mulch, fleeces and needle felts, lightweight composites, geo-textiles/geo-textile insulation industry.	[3]
Jute	Bags, sack, carpets, carpet upholstery, transportation or geo-textile, Electrical insulation and ropes, tarpaulins, packaging, furniture materials, fabric, lightweight composites	[5]
Pineapple	Bags, table linens, mats, ropes, pulping material, handbags, composites, Lightweight duck cloth, convey or belt cord, coasters and many other. Interior design products, and livestock and agriculture	[28]
Kenaf	Pulp and paper product	[5]
Ramie	Textile, paper, pulp, yarn, bio-fuel, fabric, oil, resin, wax, seed food, composites, livestock, and agriculture.	[5]

Fiber is extracted using the water retting method from natural sources like the Sansevieria trifasciata plant. The outcomes demonstrated that the fibre had low elongation and good strength. Due to its greater strength, cost-effective and renewable source, it could be used to make products like sacks, ropes, handicrafts, mattresses for bedding and other wider application soft textiles[45].Furthermore, Sisal fibres are utilised as an effective application of polypropylene reinforcement[46]. Ilaiya Perumal and Sarala extracted fibres from the stem of a Derris scanden tree [27]. These fibres may present viable alternatives to synthetic fibres in polymer matrix composites based on their physical characteristics, adding economic value to the plant while also benefiting society and the environment.

The potential use of the centre core, banana fibre, and leftover materials during fibre extraction, which make up the three components of the banana pseudo-stem. Considering the potential use of pineapple leaves. Banana fibres have been used in a variety of applications, such as papermaking [48, 49], fiber-cement composites [50–52], and animal feed due to their high cellulose and starch content [53], fiber-polymer composites [25,47,54],binder less fiber board [55], rope, place mats, paper cardboard, string thread, tea bags, high-quality textile/fabric materials, currency note paper, mushroom, art/handicraft, cordage[47,56], cushion cover, table cloth, curtain [57]. These fibers are also used as natural absorbent in colored wastewater from dyes of textile industries and an absorbent for oil spillage in refineries [58,59].Furthermore, banana pseudo-stem has antimicrobial properties [58], and could be used as bio-fertilizers[60].

3. CONCLUSION

In the development of human civilization, natural fibres that are renewable and environmentally benign have been a significant source of raw materials. The two most common applications for natural fibres in Indonesia are eco-friendly composites, particularly lightweight composites, and textiles. Ramie and kenaf are the most promising for usage in textile and automotive components. Natural fibres including kenaf, pineapple, and biomass waste from the oil palm industry are attractive for being developed further for eco-friendly composite in Malaysia. The fascinating properties of natural fibers include lesser density thus lighter weight, more considerable cost, biodegradable, abundantly available, minimal health hazards during processing, reasonably good specific strength and modulus, good thermal, good acoustic insulation characteristics, good physical properties, and ease of availability. To enhance and improve its sustainability, the physical, mechanical, chemical, morphological, and anatomy properties of natural fiber should be considered for appropriate optimal utilization.

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