

make sheet/boards, doors, furniture, window frames, fences, and other items, may be considered as new application for future development [12].

On the basis of this availability, technical viability makes natural fiber an attractive replacement for unsustainable glass and carbon fiber reinforced composites as an attractive bio-resource for raw materials [15]. Scientists are concerned with eco-friendliness and sustainability in designing new bio-products [[15], [16], [17]]. However, environmental impact assessment (EIA) and life cycle assessment (LCA) should also be accessible for the future in the production of new products due to the conservation of resource demand [18]. The LCA is a method for evaluating the effects of goods or services, while the EIA is an interrelated process that helps to determine the influence of products and services on the environment [19]. This paper reviews studies from 1995 to 2020 and describes the characteristics (physical, mechanical, chemical and anatomical), and potential use of some natural fibers mainly for eco-friendly bio-composites in order to improve their sustainability and economic values.

2. Types of natural fibers and their utilization

Botanical types are the most common classification for natural fibers. According to [20], five specific types of natural fibers are categorized by this approach, namely (i) bast fibers such as jute, flax, cannabis, ramie and kenaf, (ii) leaf fibers such as banana, sisal, agave, and pineapple, (iii) seed fibers 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. For instance, both bast and core fibers have jute, flax, hemp and kenaf, while agave, coconut and oil palm have both fruit and stem fibers. Cereal grains, in addition, have both stem and hull fibers [21].

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 the types and use of natural fibers that have been documented of various studies in latest references. Usage of composites based on natural fiber in automotive interior linings (roof, side panel lining, rear wall, furniture, building, packaging, and pallets for shipping have also reported by Kumar and Hiremath [33], Sood and Dwivedi [34], and Lau et al. [35],

Table 1. Types of natural fiber and their utilization.

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]
Bamboo	Lactic acid, construction, vinegar, charcoal, methane, composite reinforcement, shoes, food, textiles, pulp and paper production, shocks, and bioenergy sources.	[23]
Banana/Musa	Rope, place mats, paper cardboard, string yarn, tea bags, high-quality textile/fabric fabrics, currency note paper, mushroom, art/handicraft, cordage, cushion cover, table cloth, curtain, natural absorbent in colored wastewater, oil absorber, light weight composites, and bio-fertilizer.	[24,25]
Biduri	Heat insulation material	[26]
Coir	Filler, reinforcement in composite materials, light weight composites	[5,24]
Collagen fiber	Tissue manipulation, operating sewing thread	[5]
Cotton	Fabric, clothes, yarn, furniture industry as coating materials	[22]

Types of natural fibers	Utilizations	Latest references
<i>Derris scanden</i>	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, light weight composites, composites, geotextiles/geotextile insulation industry	[3]
Jute	Bags, sack, carpets, carpet upholstery, transportation or geotextile, electrical insulation and ropes, tarpaulins, packaging, furniture materials, fabric, light weight composites	[5]
Pineapple	Bags, table linens, mats, ropes, pulping material, handbags, composites, lightweight duck cloth, conveyor 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, biofuel, fabric, oil, resin, wax, seed food, composites, livestock, and agriculture,	[5]
Silk	Silk cloth, silk yarn	[5]
Wool	Cotillion, wool yarn	[5]
Sorghum bagasse	Particle board, sugar production sources, pulp, and paper	[[29], [30], [31], [32]]

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. Furthermore, the high water absorption of natural fiber causes low interface strength than glass or carbon fibre composites. For developing eco-friendly composite applications, basic properties and components of natural fibers need to be properly understood. Furthermore, in order to utilize natural fiber as textiles, some properties such as length, flexibility, and strength need to be fulfilled. The most important properties considered in substitution of synthetic fibers are fiber ratio of length and width. Natural fiber yarns or synthetic fibers consist of short (staple) or very long fibers (filament) and are intended to provide a flexible and easily concatenated yarn [36]. Generally, the natural fibers are present in the form of staples with few inches in length excluding silk fibers [36], and could be mixed with semi-synthetic (semi-cellulose, protein or mineral) or synthetic fibers. Viscose and acetate rayons, and kupri ammonium are semi-synthetic fiber. While synthetic fibers are produced by condensation (nylon, polyester and spandex) and addition of polymers such as acrylate [36].

Dhaliwal [22] stated that stretching, calendaring and production of hybrid yarns are modifications that could be used the change physical characteristics of natural fibers. Furthermore, Sudjindro [37] stated that abaca fibers have high potency to be used as raw materials in textile industries because they are strong, resistant to humidity, and have salty water. Biduri fibers have a hollow shape that functions as a medium/air trap in order to control the flow of heat flow [38]. They could be used as a natural, renewable and environmentally friendly heat insulation materials. Biduri fiber does not cause allergies, and are mild and hydrophobic [26].

Munawar et al. [39] stated that ramie bast fiber, pineapple and sansevieria leaves are prospective high-performance plant fiber composites based on their high mechanical properties. Kandachar and Bruwer [40] also reported that because of its high strength and stiffness, this hemp fiber is also used as reinforcement biocomposites. Composite materials of natural fibers have great potentials, especially in the automotive