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# Ecotech: A Potential Soul In Today's Textile Industries

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***ABSTRACT:***

*Nowadays, there is more demand for eco-friendly fabric. People are aware of the harm that synthetic fabrics are causing because of this people are using eco-friendly fabrics that does not cause much harm to the environment. This review paper highlights eco-friendly fabrics and their production process. Different types of bioprocessing are used during the production of the fabric. Eco-friendly textile provides different types of fabrics that are extracted from different things such as bamboo, cotton, corn, soybean, etc. Natural dyes are used on the fabric (Green dyes) also different types of chemical treatments are given to enhance the properties of natural fibers. Sustainable technologies and practices are included during the process of production such as wastewater treatment, eco-friendly bleaching, 3R's (reuse, recycle, and reduce). Sustainable eco-friendly textile fabrics are produced that are natural and organic in nature and are less harmful to the environment. The demand for such textiles will increase in future generations and such fabrics will be more valued and in demand.*

***Keywords: Eco textile, Environment-friendly, Sustainable fibres, Organic, natural fibres.***

## INTRODUCTION:

Technical textiles are fabrics designed for non-decorative purposes. Ecological Protection Textiles (Oekotech or Ecotech) are made using environmentally friendly materials and processes. These textiles aim to minimize pollution and waste and are often more comfortable, healthy, and durable than conventional textiles.

Consumers are increasingly demanding eco-friendly textiles due to rising awareness of the textile industry's environmental impact, greater availability of such products, and the growing popularity of sustainable fashion. The textile industry is a major polluter, contributing significantly to water and air pollution and greenhouse gas emissions. Ecotech textiles can help reduce this environmental impact.

Eco-friendly textiles represent a significant advancement in the fashion and textile industry, focusing on sustainability and reducing the environmental footprint. These textiles are produced using processes and materials that have a lower impact on the environment compared to conventional textiles. The aim is to create products that are not only durable and high-quality but also environmentally responsible.

One key aspect of eco-friendly textiles is the use of sustainable materials. This includes organic cotton, which is grown without harmful pesticides and synthetic fertilizers, and bamboo, which grows rapidly and requires less water and no pesticides. Additionally, recycled materials, such as polyester made from recycled plastic bottles, are increasingly being used to reduce waste and decrease reliance on virgin resources.

The production process of eco-friendly textiles also emphasizes reducing water and energy consumption, minimizing waste, and avoiding toxic chemicals. Innovations such as waterless dyeing techniques, closed-loop production systems, and biodegradable fibers are pivotal in achieving these goals.

Moreover, eco-friendly textiles often incorporate fair trade and ethical labor practices, ensuring that workers involved in the production process are treated fairly and work in safe conditions. This holistic approach not only benefits the environment but also promotes social responsibility.

In addition to being eco-friendly, Ecotech textiles are usually more comfortable and healthier. They are made from natural fibers that are breathable and moisture-wicking and are not treated with harmful chemicals. Eco-friendly clothing is becoming popular due to its benefits to the environment and fashionable appeal. These include items like t-shirts, polo shirts, and hats made from bamboo or recycled plastic bottles. Although eco-friendly clothing can be more expensive, its benefits often outweigh the cost. Ecotech products are still emerging in the apparel and textile industry, but they are expected to become more mainstream over time as more products become available for environmentally conscious consumers. ( Mazharul islam kiron, 2022)

Siengchin, et.al., (2019). “Natural Fibers as Sustainable and Renewable Resource for Development of Eco-Friendly Composites: A Comprehensive Review.” The study of natural fibers is very essential to develop eco-friendly composites. Natural fibers come from various sources and undergo chemical treatments to enhance their properties. These treatments reduce the fibers' natural tendency to absorb water and improve their bonding with other materials. The treatment process removes non-cellulosic substances, leading to structural and morphological changes in the fibers. As a result, the properties of composites made with these treated fibers improve, including increased thermal stability.

Using polymers and synthetic materials with natural fibers further enhances their properties, leading to the development of hybrid composites. Chemical treatments improve the adhesion between the fibers and the matrix, enhancing the mechanical properties of the composites. In the future, natural fibers are expected to become a sustainable and renewable resource in the composite field, potentially replacing synthetic fibers in many applications.

Sharma (2013). " ECO-FRIENDLY TEXTILES: A BOOST TO SUSTAINABILITY." In recent times sustainability is a leading characteristic of textile fashion products. Textile fashion companies are focusing more on sustainable products these days so that they can meet the environmental and social aspects. To get a competitive advantage in the fashion business companies must take care of social, political, and economic issues, and they must be aware of current trends in the market. The most suitable definition of sustainability recommended by the World Commission on Environment and Development is to 'meet the needs of the present without compromising the ability of future generations to meet their needs and desires'. (World Commission on Environment and Development u.d.). This research is all about sustainable textiles such as organic cotton, hemp, bamboo, etc. It also introduces rare eco-friendly fibres that are extracted from milk protein, banana, and stinging nettle. Sustainable technologies and practices are used on the fibers to enhance their properties. Such as bioprocessing, wastewater treatment, dyes, etc. All this process helps to create an environment-friendly fabric and also to generate new fabrics.

Kumari, Singh and Rose (2013). " Eco – Textiles: For Sustainable Development." It becomes essential to study the uses of chemicals and their eco substitutes in detail from an environmental point of view. The reason for eco-friendliness is not only for the exports but even for the domestic market. It has been reported that about 8,000 various chemicals were used in textiles. The chemicals used which are responsible for polluting the air are chlorine gas, acetic acid fumes, kerosene, diazotization fumes, acid fumes, etc. This research gives a brief understanding of the chemicals used during the cultivation of fibres. It also gives an understanding of toxic substances that should be avoided in the process of producing yarns. "Eco-friendly textiles" are gaining importance in the consumer market. Consumers who initially considered only the aesthetic value are now looking at the harmful effects created by various chemicals. "It is better for society to prevent pollution than to cure it after its creation." Therefore, the textile industry become aware of it and efforts are being initiated in the production and export of "Eco-friendly textiles."

Kavitha and Soundri (2015). "ECO-FRIENDLY TEXTILES AND CLOTHING." There are increasing numbers of cases of people experiencing health problems such as rashes, allergies, and respiratory and concentration problems due to chemical sensitivities. Many people find that organic clothing helps reduce exposure to toxic chemicals encountered daily. Sustainable and eco-friendly fabrics and textiles are crucial today. Organic cotton is grown without chemicals, benefiting both the environment and workers, though it is more labor-intensive and requires fields to be chemical-free for three years before certification.

Hemp is another eco-friendly fabric, grown without chemicals, pesticides, herbicides, or fertilizers, and harvested traditionally. Hemp fibers are separated, washed, and processed to break down natural binders. Bamboo, a highly renewable grass, is considered eco-friendly due to its sustainability. Bamboo is processed into viscose by regenerating cellulose fibers, similar to how rayon is made from plants and trees.

Ramie is a sustainable and strong fiber, eight times stronger than cotton and even stronger when wet. Soy silk is made from tofu production by-products, with proteins extruded into fibers for weaving or knitting. Tencel, an eco-friendly fabric, has revolutionized sustainable textiles. It is certified by the International Forest Stewardship Council and is 100% biodegradable.

The demand for eco-textiles is growing. To meet this demand while protecting human health and the planet, sustainable textile solutions are necessary.

Suparna and Antony, (2016). " ECO-FRIENDLY TEXTILES." Natural fibres have intrinsic properties such as mechanical strength, low weight, and healthier to the wearer which has made them particularly attractive. The word „eco" is short for ecology. Ecology is the study of the interactions between organisms and their environment. Therefore „eco" friendly (or ecology friendly) is a term to refer to goods and services considered to inflict minimal or no harm on the environment. "Think globally, act locally" is the slogan of tomorrow for the world textile industry. Any textile product, that is produced in an eco-friendly manner and processed under eco-friendly limits, is known as an eco-friendly textile. It is also known as sustainable fashion, eco fashion, and Ecotech. The eco textile is classified into four categories organic, manmade, recycled, and natural. Even though many fabrics are available we can bring out innovations in the field of eco-textiles that protect our environment from further depletion. “Fashion is not something that exists only in dresses. Fashion is in the sky, in the street; fashion has to do with ideas, the way we live, what is happening.” So let us go green and make fashion more eco-friendly.

**Bioprocessing** can simply be defined as the application of living organisms and their components to industrial products and processes, which are mainly based on enzymes. Like- Enzymatic Desizing - by using Amylase bacteria. **Enzymatic bio scouring ( by using lipase/cellulase enzyme)** - saves water by 30% and energy by up to 60%, less fabric weight loss & strength loss, better fabric quality, and enhanced color brightness after dyeing & low TDS in discharge. **Enzymatic bleaching** - Catalases/lactases for removal of H2O2) saves water, and energy, shortens the bleaching process cycle, eco eco-friendly process and consistent bleaching result, and saves chemicals. **Bio polishing and Eznymatic-based** softeners (Cellulase) etc- enzymatic finishing yields a cleaner surface, and softer hand feel, reduces pilling, and increases luster. **Bio-Stone Washing (Denim Finishing)**- Using a special cellulase enzyme instead of pumic stones. Cellulase works by loosening the indigo dye on the denim in a process known as ‘bio-stone washing’. A small dose of enzyme can replace several kilograms of pumice stones. The use of fewer pumice stones results in less damage to the garment, and machine and less pumice dust in the laundry environment; in addition, it’s possible to fade denim without risk of damaging the garment. Decolorization of **Dye House Effluent by Enzyme** - Laccase enzymse produced from fungi like Trametes Modesta or Trametes Versicolo etc as Fungi are used for dye decolorization in effluent treatment which is a major factor for environmental issues.

**Air Dye technology** manages the application of color to textiles without the use of water. It was developed and patented by Colorep, a California-based sustainable technology company. Making textiles can require several gallons of water per pound of clothing. The Air Dye process uses air instead of water to apply dyes, which saves water and energy, and only works on synthetic materials. This method doesn't pollute water, emits no hazardous waste, and significantly reduces energy needs, lowering costs and meeting global responsibility standards. It eliminates the need for boilers, screen printing machines, drying ovens, and cleaning chemicals, cutting major pollution sources. The process simplifies dye application, creating opportunities for new industries and jobs in arid regions. It allows consumers to choose sustainable styles at realistic prices, promoting global change.

**Herbal Textile** is dyed entirely with herbal extractions, without using any sort of chemicals. Herbs used in textile dyeing differ from vegetable dyes as they are natural and have medicinal value. These herbs are applied directly to the fabric with natural ingredients to preserve their medicinal properties. No chemicals are used in the dyeing process, and bleaching is done naturally by sunlight. These herbs do not pollute the environment or water resources near processing units. Various shades of red, yellow, brown, orange, and green can be created with these herbs. Herbal textiles, dyed with medicinal herbs, offer health benefits and can help fight diseases like hypertension, heart ailments, asthma, and diabetes, depending on the herb used.

**FABRICS USED FOR OEKOTECH OR ECOTECH:**

**Organic Cotton:** Grown without harmful chemicals, organic cotton uses natural fertilizers and is not genetically modified. It has a smaller carbon footprint than regular cotton, using less fuel and energy and emitting fewer greenhouse gases. Recently, colored cotton and natural dyes have reduced chemical use even further. **Bamboo:** Bamboo is grown with minimal chemicals and has antibacterial and biodegradable properties. It's a renewable grass used for its comfort, softness, and absorbency. Often called the "Air Conditioning Dress" for its breathable fabric. **Hemp:** Hemp grows without fertilizers or pesticides and doesn't deplete soil nutrients. Used in textiles, rope, garden mulch, and more, hemp fibers are processed mechanically and used to make yarn or bundles. Hemp is one of the kinds of plant species grown mainly in Europe and Asia. It grows up to 1.2–4.5 m and 2 cm in diameter (Bhoopathi et al., 2014; Réquilé et al., 2018). The inner girth is surrounded by the core, and the outer layer is the bast fiber and it is attached to the inner layer by a glue-like substance or pectin. These fibers are used in rope, textiles, garden mulch, an assortment of building materials, and animal beddings. In recent developments, it has been used to fabricate different composites (Li et al., 2006; Martin et al., 2013; Väisänen et al., 2018). The hemp plants are harvested, and the woody core from bast fibers is separated by a sequence of mechanical processes. The woody core is cleaned to obtain the required core content and sometimes they are cut to the desired size. While the separated bast fibers are further processed to form yarn or bundles (Clarke, 2010; Duval et al., 2011; Fang et al., 2013; Raman Bharath et al., 2015; Sam-Brew and Smith, 2015). **Organic Wool:** Produced without chemicals, organic wool is sustainable and highly absorbent. A New Zealand innovation called WoJo exemplifies its versatility. **Lyocell:** Made from wood pulp, lyocell is biodegradable and produced using a closed-loop process with minimal chemicals. **Soybean Fibre:** A by-product of soy food processing, this fabric is made from soy protein fibers and is receptive to natural dyes. **Recycled Cotton:** Made from reclaimed cotton waste, this eco-friendly fabric repurposes materials that would otherwise be discarded. **Recycled Polyester:** Created by recycling plastic waste, typically bottles, into fibers for textiles and garments. **Lenpur:** An eco-friendly fiber made from sustainable white fir trees. **Ingeo Fibre:** Produced by fermenting corn plant sugars. **Corn Fibre:** Derived from plant sugars, corn fiber is strong, soft, and naturally flame-retardant, suitable for various apparel. **Banana Fibre:** Made from banana stems, this fiber is strong and used for diverse products like tea bags, car tires, and textiles. **Milk Fibre:** A synthetic fiber made from milk casein, containing amino acids and antibacterial properties, used for high-quality clothing. **Ayurvastra:** A type of cloth made from organic materials and dyed with medicinal herbs, beneficial for health conditions like skin infections and hypertension. Herbs used in Ayur vastra are known to cure allergies having anti-microbial, and anti-inflammatory properties. Ayur vastra is extra smooth & good for transpiration which helps in recovering various diseases. It may help treat a broad range of diseases such as skin infections, diabetes, eczema, psoriasis, hypertension, high blood pressure, asthma & insomnia (Suparna M G, Rinsey Antony VA, 2016). **Jute:** Grown in Asia, jute fibers are extracted from the plant's stalks through retting and are used in textiles, furniture, and more. The jute is an important natural fiber grown in parts of Asia including India, Bangladesh, China, and Myanmar (Khan and Khan, 2014; Das, 2017; Shahinur and Hasan, 2019a). The jute plant grows up to 15–20 cm in 4 months, and the fibers are extracted after harvesting which is about 4 months from cultivation. The retting process is done either with the help of chemicals (N2H8C2O4, Na2SO3, etc.) or biologically (Rahman, 2010). In biological retting, the stalks that are harvested are arranged in bundles and allowed to soak in water for about 20 days (Banik et al., 2003; Behera et al., 2012). This removes the pectin between the bast and the wood core which helps in the separation of the fibers. Then these fibers are allowed to dry. **Flax:** Used to produce linen, flax fibers are extracted from the plant's stems and have various applications in textiles and furniture. The flax fibers are produced from the prehistoric period. These fibers are separated from the stems of the plant Linum usitatissimum is mainly used to produce linen (Ruan et al., 2015; De Prez et al., 2018; Bourmaud et al., 2019). These are cellulosic plants, but they are more in crystalline form. These fibers measure up to 90 cm in length and diameter of 12–16 µm. Netherlands, Belgium, and France are the leading manufacturers of these fibers. These fibers are used in furniture materials, textiles bed sheets, linen, interior decoration accessories, etc. (Van de Weyenberg et al., 2003; Charlet et al., 2010; Angelini and Tavarini, 2013; Ramesh, 2019). The fiber extraction involves retting, and scorching this process will make some alterations in the properties of the fibers. The retting involves the enzymes that degrade the pectin around the flax fibers which results in the separation of fibers. Canada is the largest flax producer and exporter in the world, producing about 872,000 tons (Bos et al., 2006; Zafeiropoulos and Baillie, 2007; Martin et al., 2013; Zhu et al., 2013). **Ramie:** A strong, fast-growing plant fiber used in textiles, upholstery, and bio-based products. Ramie is one of the herbaceous perennial plants cultivated extensively in the region native to China, Japan, and Malaysia where it has been used for over a century as one of the textile fabrics (Nam and Netravali, 2006; Rehman et al., 2019; Yang et al., 2019). Ramie is a non-branching, fast-growing plant that grows up to 1–2 m in height. The fibers extracted from the stem are the strongest and longest of the natural bast fibers. They are used to make sweaters in combination with cotton, also it is used in upholstery, gas mantle, fishing nets, and marine packings, etc. (Cengiz and Babalik, 2009; Marsyahyo et al., 2009; Sen and Jagannatha Reddy, 2011b). In addition to this attempt has been made to develop bio-based products by utilizing them in the fields of automotive, furniture, construction, etc. The ramie fibers are extensively used to produce a wide range of textiles, pulp, paper, agrochemicals, composites, etc. The processing of the ramie fibers is like linen from flax (Angelini and Tavarini, 2013; Bunsell, 2018).**Nettle:** A herbaceous plant whose fibers are used in textiles, bioenergy, and animal housing. Nettle is the commonly grown herbaceous plant consisting of 35–40 different species generally grown in Europe, Asia, Northern Africa, and North America (Bacci et al., 2009; Akgül, 2013; Lanzilao et al., 2016). The plant usually grows up to 2 m in length, the leaves are soft and green and are 3–15 cm long. The leaves and stems are generally hairy and have stinging hairs on them (Cummings and Olsen, 2011; Fang et al., 2013; Bourgeois et al., 2016). The fiber extraction is done by harvesting the plants during the flowering period. The fiber is extracted either by retting the stalks or by decorticating. The typical applications of nettle fibers are in the textile industry, bioenergy, animal housing, etc. Nowadays attempts have been made to use the nettle fibers on an industrial scale (Bacci et al., 2009; Mortazavi and Moghaddam, 2010).

**Pineapple Leaf Fibre:** A by-product of pineapple cultivation, used in textiles, mats, and advanced composites. Pineapple leaf fibers are multicellular and lingo cellulosic. The fibers were extracted by hand using scrapers (Kengkhetkit and Amornsakchai, 2012; Laftah and Abdul Rahaman, 2015; Todkar and Patil, 2019). The various applications are in automobiles, textiles, mats, construction, etc. The treated and surface-modified fibers are used for making conveyor belt cords, airbag, advanced composites, etc. (Paridah et al., 2004; Jawaid and Abdul Khalil, 2011; Reddy and Yang, 2015; Al-Maharma and Al-Huniti, 2019).

**Sisal:** A strong fiber from the agave plant, used in automotive, construction, and agriculture industries. Sisal is one of the most used natural fibers and Brazil is one of the largest producers of this fiber. It is a species native to south Mexico and consists of a rosette of leaves that grows up to 1.5–2 m tall (Naveen et al., 2018; Sanjay et al., 2018; Senthilkumar et al., 2018; Devaraju and Harikumar, 2019). The sisal produces about 200–250 commercially usable leaves in a life span of 6–7 years. Sisal fibers have a good range of mechanical properties and are used in the automotive industry, shipping industry (for mooring small craft and handling cargo), civil constructions, used as fiber core of the steel wire cables of elevators, agricultural twine or baler twine, etc. (Mihai, 2013; Ramesh et al., 2013; Nirmal et al., 2015; Aslan et al., 2018).

**Date Palm:** Fibers from date palm leaves and rachis are used as reinforcement in polymers and have potential in automotive applications. The date palm is known as a palm extensively grown for its fruit. The biodiversity of the date palm is all over the world comprising around 19 species with more than 5,000 cultivators all around the world (Wales and Blackman, 2017; Alotaibi et al., 2019; Rivera et al., 2019). The date palm trees (Phoenix dactylifera L.) are the tallest among the Phoenix species and can grow up to 23 m in height (Al-Oqla and Sapuan, 2014; Gheith et al., 2018; Masri et al., 2018). The date palm rachis and leaves accumulate in large quantities after the harvesting of the date farm fruits every year in the farming lands of different countries. These fibers can be used as potential cellulosic fiber sources. These fibers from leaves and rachis can be used as reinforcement for thermoplastic and thermosetting polymers. Some researchers have found ways to use date palm fibers in the automotive application (Alawar et al., 2009; Arunachalam, 2012; Liu et al., 2018).

**Kenaf:** A bast fiber used for paper, rope, and eco-friendly woven fabrics, with applications in automotive and construction industries. The kenaf fibers are one of the important fibers belongs to bast fibers and it is mainly used for paper and rope production (Hamidon et al., 2019; Omar et al., 2019). Kenaf is a fibrous plant. They are stiff, strong, and tough and have high resistance to insecticides. These plants are cultivated 4,000 years ago in Africa, Asia, America, and some parts of Europe (Saba et al., 2015; Zamri et al., 2016; Shahinur and Hasan, 2019b). The fibers are extracted from flowers, outer fiber, and inner core. The outer fiber is known as bast which makes up 40% of the stalk's dry weight and the inner core comprises 60% of the stalk's dry weight. The kenaf plants upon harvesting are processed by using a mechanical fiber separator and the whole stalk is used in pulping. The extracted fibers must be treated chemically or bacterially to separate it from the non-fibrous substances like wax, pectin, and other substances (Suharty et al., 2016; Arjmandi et al., 2017). These fibers can be converted into fine woven fabrics. Kenaf fibers are environmentally friendly as they are completely biodegradable. In the olden days, these fibers were used for textiles, cords, ropes, and storage bags, and Egyptians used it for making boats. Nowadays these fibers are made as composites along with other materials and are used in automotive, construction, packaging, furniture, textiles, mats, paper pulp, etc. (Nishino et al., 2003; Anuar and Zuraida, 2011; Atiqah et al., 2014; Kipriotis et al., 2015).

**Coconut Fibre:** Obtained from coconut husks, coir fiber is used for ropes, mats, mattresses, and more, valued for its resilience and strength. The coconut fiber is obtained from the husk of the coconut fruit. Among the different natural fibers, coconut fiber is the thickest. Coconut trees are mainly grown in tropical regions (Nair, 2010; Arulandoo et al., 2016; Danso, 2017). The major share of commercially produced coconut fiber comes from India, Sri Lanka, Indonesia, the Philippines, and Malaysia (Pham, 2016). Coir fiber, in particular, is a light and strong fiber that has attracted scientific and commercial importance due to its specific characteristics and availability (Sen and Jagannatha Reddy, 2011a). Compared to other typical natural fibers, coconut fiber has higher lignin and lower cellulose and hemicellulose, together with its high microfibrillar angle, offers various valuable properties, such as resilience, strength, and damping, wear, resistance to weathering, and high elongation at break. The coir fiber is used for making ropes, mats, mattresses, brushes, in the upholstery industry, agriculture, construction, etc. (Al-Oqla and Sapuan, 2014; Verma and Gope, 2014; Sengupta and Basu, 2016; dos Santos et al., 2018).

**Kapok:** A lightweight, hydrophobic fiber from tropical regions, used for buoyancy, oil absorption, and reinforcement materials. Kapok belongs to the Bombacaceae family. It grows in tropical regions (Arumugam, 2014;

Zheng et al., 2015). Kapok fiber is silk cotton, and the color of the fiber is yellowish or light brown. The fibers enclose the kapok seeds. Kapok fibers are cellulosic fibers, lightweight, and hydrophobic (Prachayawarakorn et al., 2013; Wang et al., 2019). Conventionally, kapok fiber is used as a buoyancy material, oil-absorbing material, reinforcement material, adsorption material, biofuel, etc. (Tye et al., 2012; Dong et al., 2015; Zheng et al., 2015).

**RECENT INNOVATIONS OF ECO FABRICS:**

**1. Samatoa/Lotus Fabric:** Fabrics made from lotus flowers, known as Samatoa, are believed to have healing properties. Wearing lotus fiber fabrics is said to provide a sense of calm and can help with headaches, heart ailments, asthma, and lung issues. These fabrics are 100% organic and environmentally friendly. The process of making the fabric is entirely handmade, involving the collection, cutting, snapping, and twisting of lotus stems to expose their fibers. This labor-intensive process limits production quantity. (Suparna M G, Rinsey Antony VA, 2016).

**2. Fabrics from Fermented Wine:** Scientists at the University of Western Australia have created fabric using microbes in wine. By adding Acetobacter bacteria to cheap red wine, the alcohol is fermented into fibers that float on the surface. These fibers are extracted and made into clothing, though the garments have a vinegar odor due to the bacteria's byproduct. (Suparna M G, Rinsey Antony VA, 2016).

**3. Hagfish Slime Thread:** Hagfish, deep-sea creatures with a skull but no vertebral column, produce slime with proteins similar to spider silk. These proteins can be turned into high-performance bio-materials. (Suparna M G, Rinsey Antony VA, 2016).

**4. Cocona Fabrics:** Made from fibrous coconut husks, Cocona fabric uses activated carbon from coconut shells. This natural technology enhances evaporative cooling, odor adsorption, and UV protection. Cocona fabrics are lightweight, comfortable, and retain features like stretch and washability. (Suparna M G, Rinsey Antony VA, 2016).

**USES OF OEKOTECH OR ECOTECH:**

**1. Environmental Protection:** Oekotech textiles are used for environmental protection to prevent and minimize environmental pollution1. They are used for floor sealing, erosion protection, air cleaning, prevention of water pollution, water cleaning, waste treatment/recycling, depositing area construction, product extraction, and domestic water sewerage plants.

**2. Garbage Management:** Oekotech textiles are used in garbage management of waste, which refers to using geotextile materials to secure landfills against leaking toxic materials.

**3. Fashion and Apparel Industry:** Oekotech textiles are used in the fashion and apparel industry to produce clothes that are comfortable, durable, and environmentally friendly.

**4. Home Furnishing and Textile Industry:** Oekotech textiles are used in the home furnishing and textile industry to produce items like carpets and furniture.

**5. Healthcare Industry:** Oekotech textiles are used in the healthcare industry to produce items that are safe and non-toxic.

**6. Automotive Industry:** Oekotech textiles are used in the automotive industry to produce items that are durable and environmentally friendly.

**7. Packaging Industry:** Oekotech textiles are used in the packaging industry to produce packaging materials that are biodegradable and environmentally friendly. (Shubham Anil Jain, Mazharul Islam Kiron, 2022)

**EFFECT OF TREATMENTS ON NATURAL FIBERS:**

Chemical treatments of natural fibers enhance their properties by modifying their structure, improving wettability, surface texture, chemical groups, and tensile strength(Saba et al., 2014; Dolez et al., 2017; Preet Singh et al., 2017; Halip et al., 2018; Yu et al., 2019). These treatments improve the bond between the fiber surface and polymer matrix, enhancing the composite's thermomechanical properties. For example, treating ramie fibers with alkaline or saline solutions, or both, increases their tensile strength. Chemical treatments reduce the natural fibers' water absorption and improve their adhesion to the matrix. These treatments remove non-cellulosic substances from the fibers, resulting in structural and morphological changes. Overall, chemical treatments significantly improve the properties and thermal stability of composites reinforced with natural fibers. The chemical treatment on ramie fibers has shown that the treatment of fibers with alkaline or saline or the combined treatment results in the improvement of the tensile strength (Gassan and Bledzki, 1997; Thakur and Thakur, 2014; Varghese and Mittal, 2017; Debeli et al., 2018; Sanjay et al., 2019a). The significant improvements of the properties of the composites are reported after different chemical treatments along with the increase in the thermal stability of the composites reinforced with natural fibers (Singh et al., 1996; Xie et al., 2010; Xu et al., 2013; Chen et al., 2018).

**PRESENT & FUTURE OF ECO-FRIENDLY TEXTILE:**

The present scenario of eco-friendly textiles is marked by a growing awareness and demand for sustainable fashion practices. Current efforts in the industry focus on reducing the environmental impact of textile production through the use of sustainable materials such as organic cotton, bamboo, and recycled polyester. Techniques like waterless dyeing, closed-loop production systems, and the elimination of toxic chemicals are becoming more common, as highlighted by Fletcher (2008) and Gwilt (2014). These advancements are complemented by a shift towards ethical labor practices, ensuring fair wages and safe working conditions for textile workers, as noted by Kozlowski et al. (2012).

In addition, the life-cycle analysis of textile products, as explored by Chen and Burns (2006), is gaining importance. This approach assesses the environmental impact of textiles from production to disposal, aiming to minimize waste and promote recycling. The industry's response to the environmental crisis of fast fashion, documented by Niinimäki et al. (2020), shows a move towards slower, more mindful consumption patterns. Consumers are increasingly valuing quality over quantity, leading brands to adopt more sustainable practices.

Looking to the future, the eco-friendly textile sector is expected to see significant innovations and improvements. As detailed by Allwood et al. (2006), future trends will likely include the development of new sustainable fibers and materials, advanced recycling technologies, and more efficient production methods. The integration of digital technologies and artificial intelligence could revolutionize supply chain management, reducing waste and improving resource efficiency. The emphasis on circular economy principles will grow, with companies designing products for longevity, repairability, and recyclability.

Moreover, the future of eco-friendly textiles will be shaped by stronger regulations and policies promoting sustainability. Governments and international bodies are likely to implement stricter environmental standards and incentivize sustainable practices. Consumer demand for transparency and accountability will continue to drive brands towards greater sustainability. Education and awareness campaigns will play a crucial role in fostering a culture of sustainability within the fashion industry and among consumers.

The future of eco-friendly textiles in India is poised for substantial growth, driven by a blend of traditional practices and modern innovations. India, with its rich history of textile production and natural fibers, is uniquely positioned to lead in sustainable textile manufacturing. The country's abundant resources, such as organic cotton, jute, and bamboo, provide a solid foundation for developing eco-friendly fabrics. These materials are not only sustainable but also offer significant environmental benefits, such as reduced water usage and lower chemical inputs compared to conventional cotton.

Indian researchers and industry leaders are increasingly focusing on innovative practices and technologies to enhance sustainability in textiles. For instance, advancements in natural dyeing processes, which utilize plant-based dyes and water-saving techniques, are gaining traction. Additionally, the adoption of closed-loop systems in textile manufacturing, where waste materials are recycled and reused within the production process, is becoming more common.

The Indian government's initiatives, such as the 'Make in India' campaign and various policies promoting organic farming and sustainable practices, are further supporting the growth of eco-friendly textiles. These efforts are complemented by the rising consumer awareness and demand for sustainable fashion, both domestically and internationally. Indian textile brands are increasingly embracing eco-friendly practices, from using biodegradable packaging to ensuring fair labor practices, thereby appealing to environmentally conscious consumers.

Furthermore, collaborations between academic institutions, industry players, and government bodies are fostering research and development in sustainable textiles. For example, projects focused on developing biodegradable textiles and enhancing the efficiency of water and energy use in textile production are paving the way for a more sustainable future.

According to Fletcher (2008) in *Sustainable Fashion and Textiles: Design Journeys*, the journey towards sustainability in fashion involves not only the adoption of environmentally friendly materials but also innovative design practices that reduce waste and enhance the lifecycle of products. Gwilt (2014) emphasizes that future trends will likely see an integration of sustainable design principles at every stage of the textile production process, from raw material sourcing to end-of-life recycling.

Chen and Burns (2006) highlight the significant environmental impact of traditional textile production and project a shift towards processes that minimize water and energy consumption, such as waterless dyeing and closed-loop systems. This is corroborated by Kozlowski, Bardecki, and Searcy (2012), who propose a life-cycle and stakeholder framework to address the environmental impacts of textiles, suggesting that future practices will involve a more holistic approach that includes stakeholder engagement and a focus on circular economy principles.

Niinimäki *et al.,* (2020) in their analysis of the environmental price of fast fashion, point out that the future of eco-friendly textiles will necessitate a move away from the fast fashion model towards more sustainable consumption patterns. This involves promoting slow fashion, where products are designed for longevity and durability. Additionally, the use of recycled and biodegradable materials is expected to become more prevalent, reducing reliance on virgin resources and minimizing waste.

Allwood *et. al.,* (2006) provide a comprehensive view of the present and future sustainability of clothing and textiles in the UK, suggesting that regulatory frameworks and consumer behavior will play critical roles in driving the industry towards sustainability. They predict that future policies will likely incentivize sustainable practices and penalize environmentally harmful ones, further pushing the industry towards eco-friendly innovations.

**CONCLUSION:**

Eco-tech or Eco-friendly textiles, also known as sustainable textiles, are gaining recognition for their significant role in promoting environmental sustainability. Sustainable textile production seeks to lessen its negative effects on the environment. Eco-friendly practices in textile production include the use of sustainable fibers such as organic cotton, hemp, and bamboo. The industry is also adopting water and energy-efficient processes, minimizing textile waste, and implementing recycling and upcycling initiatives. The industry is also exploring eco-friendly processes in the textile wet industry such as coating, microencapsulation, plasma applications, ultrasonic and microwave energy, using supercritical carbon dioxide and ozone treatment (Johnny Bailey,2023). By embracing eco- friendly materials, supporting ethical practices, and making informed decisions, we contribute to a fashion industry that cares for both style and the planet. Eco-tech textile is also called Oekotech textile, it is also produced to minimize pollution and waste. It is beneficial for the environment, it doesn't cause much harm, and is also sustainable. Nowadays, people are more health conscious and are using sustainable and organic clothing. This has increased the demand for eco–friendly clothing and fabrics. Ecotech textiles have many processes that it goes through from fibre to fabric after which the final product is produced such as Bio processing, air dye, chemical treatments, etc. The fabric is not just made from natural fibres but also from man-made fibres.

Bio-processing of textiles by using different methods such as enzymatic bio sourcing, enzymatic bleaching, bio polishing and enzymatic-based softeners, bio–stone, etc. Eco-friendly textile provides different types of fabrics that are extracted from different things such as bamboo, cotton, corn, soybean, etc. Natural dyes are used on the fabric (Green dyes) also different types of chemical treatments are given to enhance the properties of natural fibers. Sustainable technologies and practices are included during the process of production such as wastewater treatment, eco-friendly bleaching, and 3Rs (reuse, recycle, and reduce). Sustainable eco-friendly textile fabrics are produced that are natural and organic and are less harmful to the environment.

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