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REVIEW

Various Applications of Eco-friendly Jute and as an Alternative of Environmentally Hazardous Plastic - A Review

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Abstract

Jute is an amazing, incredibly sustainable, affordable and breathable fiber. Its fiber are long, soft and shiny and can spun into course, strong and durable yarn or thread which can be used to make sturdy hessian or burlap, gumy cloths and many other useful value added materials substituting hazardous plastics. Jute is an eco-fiber due to having natural UV protection, grows without the use of pesticides and fertilizers, completely biodegradable and recyclable fiber. It enhances the fertility of the soil it grows on for future crops. In engineering field, extensive research is going on due to its sustainability, durability, strength, elasticity and weight.

Keywords: Jute; Eco-friendly; Alternative; Environment; Hazard; Plastic**Introduction**

Jute is a long, soft, golden and silky shiny vegetable fiber known as 'Golden Fiber'. There are two varieties of jute trees - white jute (*Corcoras capsularis*) and Tosa jute (*Corcoras olitorius*). It is a low cost crop which is mainly grown in India and Bangladesh. The fiber has been used extensively in making ropes, yarns, hessian bags, rugs, etc. for thousands of years. Jute is the second most important vegetable fiber after cotton in terms of use, production and availability. Jute, although it is still widely used around the world, it is not as popular as it should be.

Eco-friendly effects of jute

Jute is an annual renewable resource with high biomass production per unit of land and jute products are biodegradable. Many of the farmers who cultivate jute do not use chemicals and cultivate in naturally grown areas. Jute cultivation method enhances soil organic matter by increasing leaf fall and improves soil nutrient availability. Multiple jute based crops not only increase agricultural production but also maintain soil fertility. When jute is mixed with other crops, it can improve the health of other crops and reduce their risk of insect infestation and disease. Jute composites are applied in the automobile sector and in vehicles. These composites can be used to prevent large amounts of carbon dioxide emissions into the environment, saving an average of 21% of fuel costs (Alam et al., 2014; Whitlock et al., 2003). Jute production is much less harmful and environmentally friendly than synthetic fiber production.

1) Air Purification- Jute emits oxygen at a much higher rate than most plants while absorbing carbon dioxide from the environment, which leads to purification. On an average, 7302 thousand tons of carbon dioxide is absorbed and in return 5309 thousand tons of oxygen is released by the jute plant. According to one research, throughout the jute growing season, 1 hectare of raw jute may absorb up to 15 tonnes of carbon dioxide and release 11 tonnes of oxygen, lasting a little over 3 months (about 100 days) (Mandal and Srimani 1987).

2) Biodegradability- Jute is 100% biodegradable, recyclable and poses no threat to the environment. It can be grown in large quantities without the use of pesticides or fertilizers. Jute requires less land for cultivation, which preserves more natural habitats and deserts. (Kirubadevi and Pavithra 2020).



3) Forest conservation- One of the major causes of deforestation is the growing demand for timber and timber for furniture and fuel purposes. Deforestation is threatening the biodiversity of forests. Jute matures in less than 6 months and yields a good crop for the land on which it is grown. Thousands of trees are cut down each year for the paper and furniture industry. If we choose jute bags and furniture, we can save millions of trees. Natural fibers play a great role in preserving native forests because composites made from fiber are a good alternative to wood and wood (Mohammad and Sheikh 2012).

4) Fertility of land- Fertility of land is increased with rotten leaves and roots of jute tree. On an average, 956 thousand tons of pulses are produced from jute tree every year. The jute tree also produces 423 thousand tons of roots annually. These roots and leaves mix with the decaying soil and these decaying leaves supply the soil with various natural fertilizers like urea, sulphate, dolomite. When planting jute, farmers usually use dung which is a natural fertilizer. Jute can be cultivated without the need to use pesticides or fertilizers. Where these chemicals are used, they require much less than other jute crops. So jute is planted naturally without any damage to the soil (Mohammad and Sheikh 2012).

5) Biological efficiency- Jute is the second most important natural and vegetable fiber after cotton considering its use, availability, production, use and price. Jute has various properties, such as high tensile quality, low expandability and improved fabric breathability. It is a good source of renewable energy, which provides fuel wood in rural areas (Jaydev and Priyadarshini 2020, Mohammad and Sheikh 2012).

6) Geo-textiles- Geo-textiles are used to prevent low cost engineering landscape erosion. It is also used in the construction of river embankments, dams and roads. Jute geotextile (JGT) is considered environmentally friendly, which prevents soil damage. Therefore, the geotextile of jute contributes a lot to the protection of dams and hill slopes and to prevent erosion of river banks, canals and other waterways. It also helps to protect the dumps and piles of some fly-ash material in thermal power plants. It can be used as a cheap and eco-friendly product for river dams, road construction, dams etc. (Abdullah 2005).

7) Biogas emissions- Jute can produce 98 kg organic mass per day/ha, whereas other plants can produce 28 kg per day/ha. It is estimated that methane emissions from other solids can produce 1-2 cubic meters per kg and jute fiber 1.428 cubic meters per kg. This biogas is widely used in household, especially in rural areas (Laxmikanta et al., 2013).

8) Nursery bags- Traditionally nursery bags are made of polythene. However, when planting seedlings, polythene bags are removed because they are not biodegradable. On the other hand, nursery bags made of jute are biodegradable, do not need to be removed during planting and are not harmful to soil (Afrin, 2011).

9) Effect of jute on other crops- A small amount of fertilizer is required for cultivation of jute tree and the roots and leaves of jute tree are removed which increases the production of other crops and reduces the use of fertilizer (Hasan et al., 2019).

10) Food, vegetables and medicines- The leaves and roots of jute tree have also been used as food and medicine in some parts of India and Bangladesh. Jute leaves are used as a vegetable. Jute leaves are rich in antioxidants, beta-carotene, iron, and calcium and Vitamin-C. Jute leaves provide Vitamin-C, Iron, Calcium and are used in herbal medicines for gastric, diarrhea, fever etc. Since jute is grown all over the country, it can meet the demand of vegetables (Chen and Saad, 1981).

11) Needs Very Little Water and Less Need for Fertilizer, Herbicides and Pesticides - As a natural plant fiber, jute can be grown and harvested over and over again with very little water needed. In

this era of water conservation, this is great for our planet. Fewer chemicals are dumped into the soil since jute can grow with little help from chemicals like fertilizer, pesticides, or herbicides (Afrin, 2011; Teuten et al., 2007).

12) Grows Quickly, Improves Soil Quality and Cost Effective - The jute growing season is about 100 days, so there is a quick turnover and a constant supply of more fiber. Jute restores nutrients to the soil and lowers the threat of pests and disease so when crops are rotated after the jute has been harvested, future plants will be better off for it. Growing jute is fairly inexpensive since the plant doesn't require a lot of fertiliser, pesticides, or other inputs, and a little space may produce a lot of crop, making jute often a lucrative crop and can be very cost effective (Afrin, 2011).

13) Reduces Plastic Pollution and Recyclable - Reusable shopping bags constructed from jute reduce the need of single-use plastic bags. The bulk of these single-use plastic bags wind up in landfills or as trash; just a small fraction of them are recycled. By using a jute grocery bag, you may avoid using throwaway bags and the associated pollutants. Existing fibres may continually be given new life because to jute's endless recycling potential.

Harmful effects of plastic bags

Among the environmental problems, plastic pollution has become one of the major problems, as its disposable rapidly increasing production of plastic products. One million plastic bags are being used every minute around the world. Plastic carrier bags produce 3.4 million tons a year in Europe, and Europeans use about 500 plastic bags each year, which takes about 100 years to decay. Although plastic bags are very useful in our daily life but plastic bags pose a threat to the environment; and we can't seem to think without them (Eriksen et al., 2014; Ferguson et al., 1992; Ojeda et al., 2009; Roy et al., 2008; Teuten et al., 2007). Significant harmful effects of plastic bags are as follows-

- 1) Plastic bags kill about 100,000 animals a year. Many animals mistakenly think of their food and eat plastic bags. Many of these marine animals are at risk of extinction due to excessive consumption of plastic. In addition, the plastics taken remain intact even after the dead animal has decomposed, which can be swallowed by other animals and eventually suffer the same consequences.
- 2) Non-biodegradable plastics can take up to 1000 years to decompose completely. In fact, all the plastics made so far remain in the environment.
- 3) The world's oil reserves are depleted by 60 million to 100 million barrels each year due to the manufacturing of plastics produced from petroleum products. Therefore, plastics contribute significantly to the depletion of these valuable resources, resulting in rising prices of petroleum products every day.
- 4) Bisphenol-A (BPA) is used to make plastics more flexible and durable. BPA can lead to serious health risks, especially when it comes to food. Eating or heating up food can cause ulcers, asthma, obesity and certain cancers. High levels of BPA have the potential to impair the reproductive development and efficacy of animals.
- 5) Plastic bag ingredients contain an excess of neurotoxic, carcinogenic and hormone-disrupting chemicals. Some of these chemicals are also emitted as by-products of plastic production; which can affect our ecosystem through land, water and air pollution.
- 6) Plastic bags are one of the most common causes of stuck drainage system. Developing countries are the most affected by this problem.
- 7) The World Health Organization claims that pregnant women who are exposed to Phthalates and BPA at high levels risk developing birth defects which are found in plastic chemical

compounds, they can give birth to a child with lung problems. These kids might be at a higher risk of growing up with asthma.

8) Some chemicals used in making plastic bags, especially BPA, act like estrogen. In the long run, these chemicals can interfere with a woman's hormonal balance and affect fertility. In addition, studies have shown that BPA can cause breast cancer in animals, thyroid problems, and neurological disorders in humans.

9) Men are also at danger, although though toxins associated with plastics mostly affect women and children. Men who are often exposed to phthalates and BPA have an increased chance of acquiring prostate cancer, per a World Health Organization research. Their reproductive health may potentially be harmed by these substances.

10) Plastic bags at the dump site usually release chemicals, which enter the soil and end up in the groundwater reservoir. Then, the harmful effects of plastics enter our bodies through the soil through the plants we eat and the water we drink.

11) Pollution of plastics affects the natural food chain. This is due to the fact that all organisms in the food chain, from giant terrestrial animals to microscopic plankton, are affected negatively by its impacts. Plastics can directly affect these organisms when they receive plastic toxins.

12) In addition to polluting our water supplies, plastic bags use a significant amount of water during manufacture. One pound of plastic requires about 22 gallons of water.

Versatile use of jute

During the Industrial Revolution, jute yarn basically replaced flax and flax fibers in jute cloth. A major feature of jute is its ability to be used independently or to blend with other fibers and materials. Nevertheless, synthetic materials are increasingly replacing jute in these applications. Jute's benefits include low heat conductivity, excellent insulation, antistatic qualities, and moderate moisture retention (Abdullah, 2005). Jute may be used to create hessian textiles that will be utilized for electrical work since it is an insulating fibre.

1) Textile: The main products produced from jute fiber are: yarn, sack, hessian, carpet backing cloth, etc. It has high tensile strength, low expandability and ensures good breathability of the fabric. The fibers are mixed with curtains, chair covers, carpets and often other fibers. Fake silk can be made by separating the best threads from it (Abdullah, 2005).

2) Packaging and By-products: Jute is widely used for packing for agricultural products. Jute is used in a range of byproducts, including as cosmetics, medicines, dyes and other products. These are good alternatives to particle board, decor and bamboo (Hasan et al., 2019).

3) The potential of jute on plastics: Many countries are working to reduce the use of plastic products, especially plastic bags. Jute bags will be an alternative bio-digestible and environmentally friendly product. The demand for polythene bags will decrease and the demand for plastic bag alternatives from renewable sources will increase (Hasan et al., 2019).

4) Automobile sector: Since the 1990s, jute fibers with synthetic polymers or resins have been incorporated to partially replace expensive synthetic fibers for low load bearing applications. Famous car manufacturers such as Mercedes Benz and Daimler, Toyota, Suzuki-Maruti and Hyundai are already using jute composites (Hashmi et al., 2014).

5) Housing Infrastructure Sector: Jute composites are used in housing panels, door and window frames, wall panels, etc. Jute thermoplastic boards are made using jute and plastic waste. Tin is used as an inexpensive and stable housing material for roofs in rural areas. Chairs and school benches can also be made from jute that will be eco-friendly (Lu et al., 2022).

6) Biodegradable packaging "golden bag": The bag is capable of carrying 1.5 times more load with improved thermal properties. The microorganisms in this bag can easily decompose, so it is biodegradable. The bag is compostable and can be used in fertile soil to grow plants. It is also soluble in water depending on the surface and time, for example, it may submerge in water within hours or it may take several months (Hasan et al., 2019).

Jute bags vs. plastic bags

Many turtles eat jellyfish mixed with plastic bags. Feather animals and fish fall into particles or hit with plastic which is dangerous (Prateek and Amber, 2018). The production of polypropylene fabrics uses 84 gigajoules / ton of energy, which is at least six times the energy required for the production of jute fabrics. Jute poly bags can be an alternative to conventional poly bags. Bio-plastics made from jute are bio-degradable. There are several benefits to using jute bags instead of plastic bags (Pavel and Supinit, 2017), including: 1) Jute bags are durable, 2) Jute has very low carbon-dioxide footprint, 3) Jute water footprint is very low, 4) The environmental footprint of jute is very low, 5) Jute is cradle to cradle, 6) Jute bags are biodegradable and 100% compostable, 7) Jute bags are extremely strong, 8) Jute bags are recyclable and therefore eco-friendly and 9) Jute bags hip and trendy (Ahmed and Kader 2014, Abdullah 2005). The greatest option to stop dangerous items is jute bags. Plastic bags have been adequately banned in India and in various countries. Jute cultivation requires less acres of land to grow. When a jute crop is rotated on the same land with other crops, the productivity of other crops increases. Many complementary renewals are made in the field soil during jute harvest, making the field ripe for profit after harvest. Rotation of jute along with other crops contributes to increase soil fertility. Thousands of trees are cut down every year for the furniture industry. Choosing jute bags and furniture can save millions of trees. The growing level of awareness about the environment and the benefits of jute make more people choose jute and make their life greener and more environmentally friendly (Sumathi et al., 2016; Wilcox et al., 2015). Trees are important for our planet to maintain the natural balance of the earth. Using jute items will protect these trees and add biological balance to the planet. We should encourage the use of jute bags so that we can contribute to our environment as well as make our planet clean and healthy.

Comparison

1. Jute is a fiber that is not just affordable but is also readily available on the market. Jute is a biodegradable, extremely durable natural fiber. Plastics take up to 400 years to break down and are not biodegradable.
2. Plastic bags are immensely popular with both consumers and merchants since they are light, efficient, affordable, and durable, making them perfect for carrying goods. However, plastic bags cannot be recycled, and a great deal of plastic waste is disposed of and recycled in landfills, which contributes significantly to pollution.
3. Petroleum, a non-renewable natural resource that is depleting a vital natural resource, is consumed in the production of plastic bags. Only natural jute is required for jute bag manufacture. Jute bags are considerably more environmentally friendly than plastic bags, allowing us to preserve the natural resources.
4. Jute bags outperform plastic bags because they are tough, reusable, and fashionable for a long time. However, plastic bags and polybags are less resilient and lose their appeal sooner. Plastics have a shorter lifespan than other materials and a larger percentage of them wind up in landfills, harming both the environment and the general health and welfare of living things.
5. Jute bags degrade in a matter of weeks, however plastic bags take far longer to break down in the ecosystem and pollute the environment for a longer time. Finally, it is advised that we make use of the jute bags.

Table 1. Properties and mechanisms of action of jute

PROPERTIES	MECHANISMS
Antinociceptive/Anti-inflammatory	Study showed the extract of <i>Corcoras capsularis</i> exhibited significant antinociceptive and anti-inflammatory activities confirming its traditional use for ailments associated with inflammation and pain. It is used traditionally to address concerns related to inflammation and pain. It is also been connected with curing the chronic inflammation of the urinary bladder.
Galactolipid / Anti-Tumor	Galactolipid 1 has been shown to be responsible for the anti-tumor promoting activity of jute (<i>C. capsularis</i> and <i>C. olitorius</i>).
Antipyretic / Antinociceptive / Anti-inflammatory	Study on the aqueous extract of jute plant leaves <i>C. capsularis</i> , exhibited significant antinociceptive, anti-inflammatory and anti-pyretic activities in a dose-dependent manner and supports its claim of traditional use to treat various ailments.
Capsugenin	Study yielded a glycoside-capsugenin-30-o-B-glycopyranoside, from the leaves of <i>C. capsularis</i>
Headaches, Liver disorders	Before consuming, sieve the dried, powdered leaves mixture after steeping it for 3 to 5 minutes with a cup of water.
Dysentery, coughs and phthisis, and poulticing sores	Malays use a decoction of the leaves for dysentery, for coughs and phthisis, and as a tonic for children. Used as a poultice as well.
Antiseptic	Finely carded fibre serves as the foundation for sterile surgical bandages.
Acute dysentery	Patients recuperating from severe dysentery use a bitter tonic made from the leaves when infused cold
Atonic dyspepsia, liver disorders, chronic cystitis, gonorrhoea, dysuria, worms in children, hepatic and intestinal Colic and gastric catarrh.	Patients recuperating from severe dysentery use a bitter tonic made from the leaves when infused cold, hepatic and intestinal worms in youngsters, atonic dyspepsia, persistent cystitis, gonorrhoea, dysuria, and liver problems gastrointestinal catarrh and diarrhoea.
Eyesight	Its vitamin content is good for eyesight, as the vegetable contains beta-carotene
Swine flu	In order to build resistance against the threat of swine flu, the public is advised by the Philippine Department of Health to increase their intake of jute leaf vegetables, including malunggay and banana as well.
Carminative, demulcent, laxative, stimulant and stomachic	The leaves have digestive, stimulant, laxative, demulcent, carminative, and demulcent properties. Treatment for diarrhoea, fevers, dyspepsia, and liver

Biological importance of jute leaf***Antinociceptive and anti-inflammatory activity***

The chloroform extract of *C. capsularis* leaves was investigated for antinociceptive activity using acetic acid-induced abdominal constriction and hot plate tests in male Balb-C mice and the formalin tests in rats. When compared to acetylsalicylic acid (100 mg/kg), the chloroform extract showed efficient antinociceptive efficacy at 100 mg/kg and considerable anti-inflammatory activity, both of which have the potential to inhibit the inflammatory phase of the formalin test. The antinociceptive and anti-inflammatory properties of *C. capsularis* supported the traditional claims that it may be used to treat a variety of conditions marked by inflammation and discomfort (Ahmed 2019; Ali et al., 2019).

Antitumor promoting activity

Phytol and monogalactosyl-diacylglycerol from *C. capsularis* showed activity against tumor promoter-induced Epstein-Barr virus (EBV) activation in Raji cells. Both components increased gradually with an increasing in the period of treatment with hot water, indicating that they were not easily decomposed by high temperature. These findings suggest that treatment of vegetables with hot water effectively increased the amount of active components with activity against tumor-promoting chemicals that may be consumed together with food (Ahmed, 2019; Ali et al., 2019).

As food/vegetable diet

Jute leaves are consumed in various parts of the world. It is referred to as "rama" by the Hausa people of Nigeria and their Fulbe neighbours. It is known as "Khudra" in the Northern Sudan, which is Sudanese Arabic for "green." Furthermore, Tunisians refer to it as mulukhiyah whereas the Songhay of Mali call it "fakohoy". Young fresh leaves are eaten as vegetable in various parts of the world - Bangladesh, Middle East, Africa, SE Asia. It is eaten along with "ugali," another common food in Kenyan villages. In Bengal, where it is considered a tonic, leaves are used as a condiment. After irradiation, the dwarf mutant CM-18 was chosen because it produced more leaves. For the most part, southern Asia, the Middle East, and North Africa employ *C. olitorius*, whereas Japan and China use *C. capsularis*. It has a mucilaginous (somewhat "slimy") texture, similar to okra, when cooked. The juvenile leaves of *Corchorus* species are referred to in Arabic as malukhiyah throughout North Africa and the Middle East. Lebanese, Palestinian, Syrian, Jordanian, and Tunisian cuisines also use it. In Turkey and Cyprus, the plant is known as molohiya or molocha. It is referred to as rama by the Hausa people of Nigeria and their Fula neighbours. The Songhai people of Mali refer to it as fakohoy, whereas it is known as krain krain (or crain crain) in Sierra Leone. Locally, it is referred as as nalta sag in India. In Thai cooking, blanched *C. olitorius* leaves, also known as bai po locally, are served with plain rice congee. The flavour is similar to samphire and spinach. It has been suggested that the leaves of *C. capsularis* have stimulant, demulcent, laxative, appetiser, and stomachic properties.

Jute future prospects

It is possible to create thick, stiff strands from jute, a natural vegetable fibre that is long, soft, and lustrous. It is derived from a plant belonging to the genus *Corchorus*, which belongs to Malvaceae. Jute fibers are mainly composed of plant material, cellulose and lignin. Bangladesh has been successfully contributing to the jute sector for many years. (Shahinur et al., 2022; Ulf and Friedrich, 2015). Jute fiber is also compared to glass fiber. Jute can be a potential medicinal product for the treatment of many diseases. In traditional medicine, it is used to treat constipation, dysentery, worms, carminative anthelmintic, intestinal antiseptic, ascites and piles (Mohajershajaei et al., 2015; Sarkar and Ahmed, 2022). The major phytochemical compounds are cardiac glycosides, curcorin, curcotoxin and helveticosides. Jute leaves contain L-ascorbic acid (vitamin-C) which is an essential nutrient that the human body cannot produce and replenish through food. The leaves can be used to make charcoal and activated carbon (Sarkar and Ahmed, 2022; Sarkar et al., 2022), which may be utilized for a variety of processes, including odour removal, metal purification, sewage, radio wave capture, frost control, municipal drinking water, industrial pollution control, methane solvent recovery, and food and beverage processing. Nanotechnology has multiple applications across the financial sector and enables development to facilitate scientific endeavors with wide commercial potential. Nanomaterials, particularly those with biological and other health-related features, have given nanotechnology new directions (Velmurugan and Incharoensakdi, 2018). The scientific community has paid close attention to the utilization of biological resources in nanotechnology because of their affordability, availability, and environmental friendliness. Jute has a lot of possibilities in this situation. It has also been used as a source in the evolution of nanomaterials used in various applications. There is a promising potential to increase jute use in many developing countries.

Conclusion

Jute production can have a huge positive impact on the environment, which can overcome the environmental threat. Jute increases soil fertility, absorbs carbon dioxide, preserves the ozone layer, and releases oxygen to clean the air. Global awareness for environmental protection creates opportunities for jute exploration. There is ample scope for future research on this economics and eco-friendly issue.

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