

An Overview of the Plant Fibres in the Development of Ecologically Sustainable Sanitary Napkins for the Green Economy

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Abstract: The issue of biodegradability must be addressed when considering the protection of our environment. Plastic materials are used in commercially accessible sanitary napkins. One of the primary issues with sanitary napkins is that they are non-biodegradable and can be found in landfills for up to 800 years. Increased menstrual waste has sparked calls for a revolution and the development of innovative techniques for addressing the global issue of commercial sanitary pads' non-biodegradability. Plant fibres are a more environmentally friendly alternative to commercially supplied pads. Plant fibres are lignocellulosic fibres composed primarily of cellulose, hemicelluloses, lignin, pectin, and other polymers. In terms of abundance, biodegradability, non-irritant and chemical-free, easily renewable and environmental friendliness, plant fibres represent a suitable alternative to commercial sanitary napkins. The current review focuses on plant fibres such as jute, bamboo, bananas, and kenaf as an alternative raw material in the manufacture of sanitary napkins.

Key words: Sanitary pads, plant fibers, eco-friendly, biodegradable, renewable.

1. Introduction

A sanitary napkin is an absorbent material worn by women during menstruation time. Good menstrual hygiene practices need to be followed during the menstruation period to improve the health status of women. The functional requirements of sanitary napkins are to absorb and retain blood without leakage, breathability, comfort, wetting behaviour and wicking, sterilization stability, mechanical properties, and antimicrobial properties without skin irritants and allergic tendencies [1]. According to an AC Nielsen report titled "Sanitary Protection: Every Woman's Health Right," only 12% of India's female population uses sanitary napkins, while the remaining 88 percent prefer un-sanitized linen or rugs, ashes, and husk sand. Reproductive tract infection (RTI) is 70% more common among those women following unhygienic practices during their menstruation time [2]. The increase in menstrual waste is a major problem and the removal of this menstrual waste is a challenging one across the world. Menstrual waste accumulation, if not cleared, will pollute the land, seas, and human health. Every year, single women generate 150kg of non-biodegradable garbage. Every year, 113,000 tonnes of menstrual waste is produced in India, resulting in a waste load of 113,000 tonnes [3]

*Srikavi Anbalagan

2. Problems associated with commercial sanitary pads

The materials used in commercial sanitary napkins are generally petroleum-based and can not be reused. The globe is dealing with a significant problem caused by the carbon footprint of sanitary pads, which emit gases into the atmosphere [4]. Due to the availability and abundance of wood pulp, it is the major raw material used in feminine hygiene products. Over exploitation of trees will lead to deforestation and have an adverse effect on the environment [5]. Cellulose bleached pulp, super absorbent polymer, rayon, dioxin, artificial fragrances and petrochemicals used in sanitary napkins cause skin irritation, allergies, toxic shock syndrome and ovarian cancer. Synthetic materials used in pads block dampness and heat, increasing the risk of yeast and bacterial infection. Sanitary pads are made of non-biodegradable plastic materials, which increase menstrual waste and pollute the environment. Furthermore, it creates an occupational hazard because the workers pick up this garbage with their bare hands [6].

3. General design of commercial sanitary pads

Sanitary pads comprise a three-layered structure with a specific function to perform. The three layers of sanitary napkins include the top sheet, middle layer and bottom sheet. The top sheet is designed in such a way to absorb the fluid and transfer it quickly to the absorbent layer. Commercially available feminine hygiene products are made up of polypropylene fibers. The middle layer also known as the absorbent core, functions to absorb and retain the fluid. Wood pulp or Super absorbent polymer (SAP) is used for the absorbent core which absorbs the fluid and retains it in a jelly state. The function of the bottom layer, also called a barrier sheet, is to prevent menstrual fluid from leaking out. But the main problem with the general design is the uses of plastic layers which are not easily broken down by microorganisms and do not degrade easily. Hence, an alternative and suitable material must be employed in the designing of feminine hygiene products [4]. After the revolution in plant fibers, they have developed a considerable interest in various products, including medical textiles and the design of sanitary napkins.

4. Alternative raw materials for commercial sanitary napkin

Organic cotton could be used as a sheet because of its skin-friendly, non-irritant and superior absorption properties. The cotton layer is soft and easily breathable, allowing comfort and dryness. Bio-based plastic from starch can be used as a barrier sheet as it is fully biodegradable. Plant fibers could be an alternative raw material for the absorbent core in sanitary napkins. The major requirement of feminine hygiene products is absorbency, and plant fibers, due to their excellent hydrophilic property, can be used as an absorbent core in sanitary napkins. [7]

5. Plant fibers

*Srikavi Anbalagan

Plant fibres are bio-based fibres that have gained popularity due to their numerous features, such as biodegradability, environmental friendliness, renewable, and abundance in nature. Fiber-producing plants are commercially important, ranking second after food-producing plants. These plant fibers are used in the textile industry, for baskets, paper, mats, woven clothes, ropes, hats, and cordage materials. Classification of plant fibers is done mainly on the basis of morphology, origin, structure, and uses [8, 9]. Plant fibres are composed mainly of cellulose and hemicelluloses combined with lignin, pectin, oil and wax [10]. The main component of plant fibres is cellulose, a linear polymer of D-glucopyranose units linked together by-1, 4-glycosidic links [11]. Many plant fibres, including jute, kenaf, bamboo, and banana, have attracted the curiosity of researchers working on biodegradable sanitary pads.

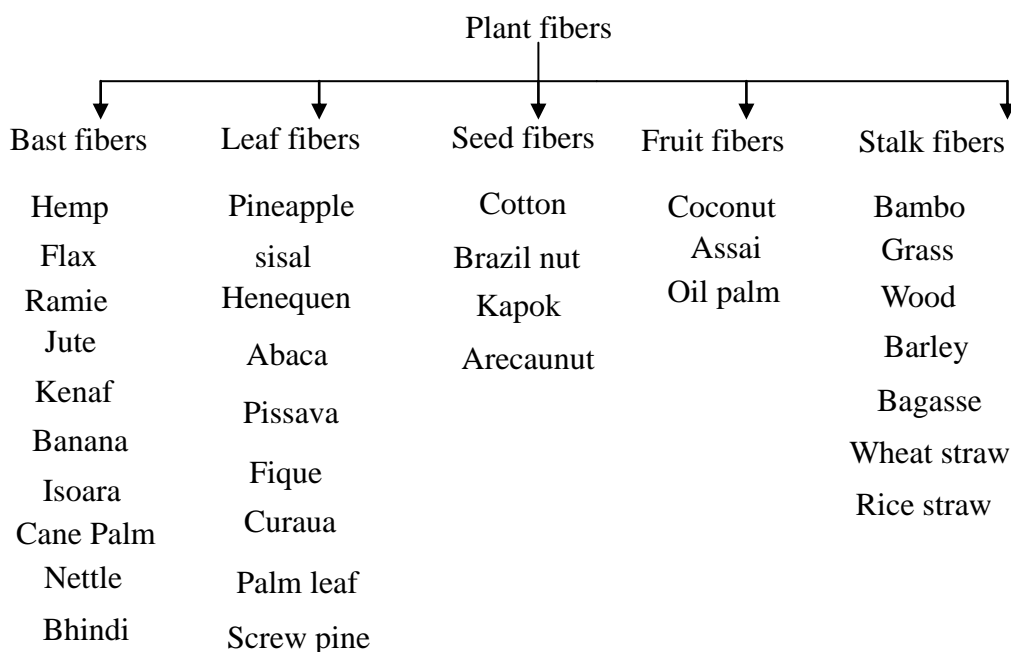


Table 1 Showing Chemical composition of plant fibers [12]

Fibre type	Botanical name	Plant origin	Cellulose	Hemi cellulose	Lignin	Pectin	Moistue regain(%)
Bamboo	Gigantochloa scortechinii Dendrocalamus apus	Stem	26-43	15-26	21-31		-
Banana	Musa ulugurensis Warb	Leaf	60-65	6-19	5-10	3-5	-
Abaca	Musa textilis	Leaf	61-64	21	12	0.8	14%

*Srikavi Anbalagan

Cotton	Gossypium spp	Seed	46	0.3	45	4	13%
Agave	Agave Americana	Leaf	68.42	4.85	4.85	-	7.69%
Jute	Corchorus capsularis, Corchorus olitorius	Stem	72	13	13	0.2	12.6%
Bagasse	Saccharum officinarum L	Stem	32-48	21	19.9-24	10	-
Veld grape	Cissus quadrangularis	Stem	82.73	7.96	11.27	-	6.6
Coir	Cocos nucifera L.	Fruit	46	0.3	45	4	13%
Flax	Linum usitatissimum	stem	60-81	14-19	2-3	0.9	12%
Hemp	Cannabis sativa L.	Stem	70-92	18-22	3-5	0.9	12%
Veld grape	Cissus Quadrangularis	Root	77.17	11.02	10.45	-	7.3%
Kenaf	Hibiscus cannabinus	Stem	44-57	21	15-19	2	17%
Kapok	Ceiba pentandra	Seed	13.16	-	-	-	10.90%
Ramie	Boehmeria nivea Gaud	Stem	68-76	13-15	0.6-1	1.9-2	8.50%
Sisal	Agave sisilana	Leaf	43-78	10-13	4-12	0.8-2	14%
Phormium	Phormium tenax	Leaf	67	30	11	-	-

The water absorption behavior of plant fibers is influenced by their composition and specific structure. The presence of polar groups in compounds such as cellulose, hemicelluloses, lignin, and pectin are responsible for the hydrophilic property of plant fibers [13, 14]. When relative humidity is high, the water concentration surpasses the threshold value, causing void structure relaxation and fibre swelling. Hemicellulose also absorbs moisture in a considerable amount [15]. Pectin has polar carboxyl groups and forms hydrogen bonds with water molecules. Fibers have a porous structure, which allows water to enter and be stored readily [16]. The current review discusses several plant fibres that have been employed in the development of sanitary napkins.

5.1 Bamboo fiber:

The bamboo plant, commonly known as *Bambusa vulgaris*, is a perennial fast-growing woody grass of the Poaceae grass family [17]. Bamboo fibre can be harvested from the plant using either a water retting process or by machine. A study by Tomalang et al. (1980) found that bamboo culms were made up of holocellulose (60-70%), pentosans (20-25%), hemicelluloses, and lignin (20-30%). Bamboo contains 40-50% -cellulose, which is equal to the -cellulose content of hardwoods (38-56%) and softwoods (40-52%). [18]. Because of the presence of 'Bamboo Kun,' a natural antimicrobial agent, they have natural antibacterial,

*Srikavi Anbalagan

antifungal, and antistatic qualities. The absorption capacity of bamboo fiber is 3-4 times better than cotton due to the presence of numerous micro gaps and micro holes. Because of these properties, sanitary pads made from bamboo fiber absorb more blood and they are softer and irritant-free [19]. Bamboo fibers absorb moisture at a rate of 13%, which is more than that of lyocell, viscose rayon, cotton, modal and soybean [20]. They are biodegradable, elastic, environmentally friendly, antifungal, bacteriostatic, antibacterial, hygroscopic, hypoallergenic and natural deodorizers. It has natural antibiosis function and, hence, the finished product needs not be coated with any antimicrobial agent and the product will not cause skin allergy. Bamboo fiber clothing is suitable for summer due to its anti-ultraviolet nature, offering protection to children and pregnant ladies from the harmful effects of UV radiation [21]. Bamboo fibre is strong and flexible, and because it is softer than silk, it may be spun into yarn. They are commonly used in clothes, textiles such as medical textiles, non-woven fabrics (hygiene materials), and home furnishings [9]. Bamboo fibres are employed in biofuel production, construction materials, food and feedstock, musical instruments, the paper industry, the pharmaceutical business, the textile industry, the cosmetic industry, and the sports industry due to their versatile features [22]. Natural bamboo fibers are widely used in the pulp and paper industry for construction purposes and for natural fiber reinforced composites. They have been widely used for various applications due to their excellent properties, such as high hygroscopicity and moisture absorption, anti-odor, ultraviolet resistance, and good electrostatic. Bamboo is biodegradable, environmentally friendly, and sustainable and has a short harvesting cycle (2 to 3 years); its growth and harvesting do not require deforestation. Because of bamboo's antibacterial properties, it is widely used in hygienic products such as masks, sanitary napkins, mattresses, and food packing bags, bandages, nurses' uniforms, surgical gowns, antibiotics, ultraviolet proof, bacteriostatic curtains, and so on [19,20, 2,25]. Ann Mburu et al have designed a biodegradable, cost-effective pad from bamboo for school girls [19]. O L Shanmugasundaram et al. have developed baby diapers by blending organic cotton and bamboo fibers. Bamboo fibers are effective against bacteria such as *E.coli*, *Staphylococcus aureus*, and *Bacillus* sp. and fungi such as *Candida albicans* [23].

The bamboo fiber has natural antibacterial, sterilization, and anti-ultraviolet, deodorization, and bacteriostatic properties. According to the 'Japan Textile Inspection Association (JTIA)' and 'China Textile Industrial Testing Center (CTITC)' Quantitative Antibacterial test conducted in July 2003, 100 percent bamboo fabric demonstrated a 99.8 percent antibacterial kill rate [24]. It has an antibiosis function and, hence, sanitary pads made from bamboo do not produce any bad odor. The 'Sparkle' pads are made up of biodegradable bamboo fiber, banana fiber, and corn starch, which offer protection from skin allergies, infection, and irritation. 'Carmesi' are biodegradable pads made of corn starch and bamboo fiber. These pads are soft and don't cause any allergies or avoid rashes and infections. 'Pee Safe' is a popular brand that offers intimate hygiene to women. The absorbent layers of these pads are made up of natural bamboo fiber and are plastic free and are hence known for their natural antibacterial properties.

5.2 Banana fiber

The banana plant's stem is a biodegradable agro waste that is reusable, monocarpic, and replantable. Banana fibres contain natural qualities such as UV protection, moisture absorption, anti-oxidant, weather resistance, and biodegradability [26]. Due to these properties, banana fiber pads are one of the sustainable raw materials that can be used for the manufacture of feminine hygiene pads [27]. The amount of CO₂ emitted from one disposable

*Srikavi Anbalagan

sanitary pad is approximately 0.041 kg CO₂, while the amount of CO₂ liberated from BFP is estimated to be less than 0.01 kg CO₂ [27] [28]. One of the important parameters for sanitary pads is pH. The pH of BFP is found to be between the range of 6-8.5, which is optimum, and within this range, microbial growth is not observed, making banana fiber pads safe for women to use [27,29]. Banana fiber also finds use in ship towing ropes, currency paper, packing cloth for agricultural products and drilling cables. They are used in various products, such as baskets, wall hangings, home furnishings, floor mats, etc. Blended fabric can be easily produced by blending banana fiber with cotton or other synthetic fibers. Banana fiber also finds use in ship towing ropes, currency paper, packing cloth for agricultural products and drilling cables.

The elegant and highly versatile nature of banana fibers makes them an excellent raw material for natural bio absorbent agents, bioremediation agents for water purification, tea bags, and handicrafts, for mushroom production, quality paper cards and fabric material. Banana fiber is natural, abundant, antibacterial, antioxidant, offers UV protection and is completely biodegradable. They are considered an eco-friendly fiber and have no side effects on the environment or on women [9, 30]. SHE (Sustainable Health Enterprises) is a non-profitable NGO which makes affordable, quality, and eco-friendly sanitary pads from banana fibre for girls and women in developing countries [4]. 'Saathi' is an organization that produces cost-effective, environmentally friendly banana pads for rural ladies. These banana pads are completely biodegradable and decompose completely within one year [31-32]. Banana fibers are an excellent alternative to synthetic fibers used in sanitary napkins. The use of banana fiber in sanitary pads is completely safe, offers antimicrobial protection, comfort and retentiveness.

5.3 Jute fibers

Jute (*Corchorous capsularis*) is a long, shiny plant belonging to the tiliaceae family [9]. Jute is one of the most versatile, natural, durable, and cheapest fibers that can be spun into long, strong, and coarse threads because of its soft and shiny texture [33-34]. Jute is an easy crop to grow, with a high yield per hectare and a low requirement for fertilizers and pesticides. Jute fibres have a silky lustre, are 1 to 4 metres long, lustrous, and golden brown in color, hence the name "golden fibre" [35]. Jute fibers are recyclable, 100% biodegradable, and environmentally friendly and are hence used in packaging, construction, non-textiles and textiles, and the agricultural sector [36]. Jute fiber is a bast fiber which is obtained from two varieties of jute species, such as tossa and white jute. It has high specific properties, less abrasive behavior, low density, harmlessness, and good dimensional stability. Jute fabrics are easy to transport with high moisture retention properties [36] [37]. Jute is the cheapest, lowest cost, breathable and environmentally friendly fiber like cotton and causes no skin irritation. The fibers have antistatic properties, insulating properties and moisture regain of around 13.75%. Jute fiber can absorb up to 23% of water under high humidity [38]. Jute fiber contains 61-71% cellulose, 14-20% hemicelluloses and 12-13% lignin [39]. They are used in a wide range of products, such as medicine, cosmetics, paints, and other products. The presence of lignin in jute serves as a protective shield and it is resistant to microorganisms. Jute fiber is generally used in sacks and packing cloth, backing cloth for carpets, food processing, curtains and furnishing fabrics, and geotextiles [36]. The jute fiber extracted from the plant is used to make hessian or gunny cloth. Burlap can be spun into strong threads. Jute fiber, also called golden fiber, is the second most widely used fiber after cotton. Jute fabrics are biodegradable, decompose in nature, and neutralize carbon dioxide. They can be recycled

*Srikavi Anbalagan

easily and are considered an environmentally friendly fiber which can be utilized in feminine hygiene products such as sanitary napkins [9]. 'Magnas' is a sanitary pad produced from the combination of jute and cotton that is available on the market [32]. Students from IIT Kharagpur have developed a sanitary pad from jute as a substitute for cotton. Jute has a high cellulose content of 65-70% and has a high water absorption capacity. The fiber length of cotton fiber is much shorter than jute fiber, hence easing the preparation of cellulose pulp. These properties can be harnessed into making sanitary pads from jute [40] [41].

5.4 Kenaf fibers

Kenaf fibers are obtained from the stems of *Hibiscus cannabinus*. The fibers are 2-6 mm long and are present as individual fibers in filaments. They are predominantly made up of cellulose (45-57%), hemicelluloses (21.5%), lignin (8-13%) and pectin (3-5%). There are two types of kenaf fibers, such as long fiber and short fiber. Kenaf fibres are brittle, coarse, and difficult to process. They find application in paper products, composites, textiles, building materials, and absorbents etc. [42] [43]. Kenaf fibres are brittle, coarse, and difficult to process; they are used in paper goods, composites, textiles, building materials, and absorbents. [42] [43]. Kenaf is a biodegradable and environmentally beneficial crop grown in tropical and subtropical countries. They grow quicker in 6 months and are regarded as commercial fibres due to their rapid growth and high fibre quality. Kenaf fibers are used in pulp and paper products. Kenaf fibers are inexpensive, renewable and can be grown in areas with less water supply and low fertilizer. [44]. Kenaf has been used to make rope, twine, and sackcloth, and it has a variety of applications, such as building materials, animal feed, absorbents, and paper goods. Kenaf plants can be harvested after 150 days since they grow rapidly, reaching a height of 4 to 5 m. Kenaf fibers are used to make items similar to those created from wood, reducing the need for wood and thus preventing the need for deforestation. The kenaf fiber is hydrophilic due to its cellulosic content and swells when exposed to moisture. The hydrophilic characteristics of the fiber resulted in increased water penetration into the micro gaps, thus resulting in swelling. The hydrophilic property of fibers is important for recognizing plant fibers as suitable for sanitary pad manufacturing [45]. Experimental studies revealed that the kenaf core of 106-425 microns absorbs water 12 times its weight, while that of a core ranging from 425-840 microns absorbs water 10 times its weight. The moisture content is at 75% and the pH of the kenaf fiber is 5.5, which is optimum for feminine hygiene products. Kenaf-based sanitary pads are a biodegradable, cost-effective, and environmentally friendly alternative to commercial pads on the market [46]. Recognizing their enormous potential, these fibres have the potential to be a sustainable raw material in the production of sanitary napkins. Two students at Kumaraguru College of Engineering have created 100 percent biodegradable sanitary pads using kenaf fibres under the trade name "Bliss".

5.5 Hemp fibers

Indian hemp, commonly known as Himalayan hemp (*Cannabis sativa*), is a tall, annual, upright plant that can reach a height of 4 metres. The whole plant yields a variety of items, including oil from the seeds, fibre from the stems, and narcotic medications from the leaves and flowers. The plant is sensitive to light and, hence, longer fibers will be obtained upon early planting. Hemp is one of the oldest plants and its fiber is considered to be environmentally friendly [9]. Hemp fibre is biodegradable, eco-friendly, moisture permeable, anti-static, insulation, warmth retention, anti-UV, anti-mildew, and antibacterial. Hemp fiber is soft with numerous cracks and small holes with more capillary action. It absorbs more

*Srikavi Anbalagan

moisture and has good breathable performance. According to the National Textile Quality Supervision and Inspection Center, wearing hemp clothing will keep your body cool even when the temperature outside is high [47]. Hemp fibres provide excellent rigidity and strength, and can thus be employed in composite products. In recent years, the use of hemp fibers has increased exponentially, accounting for less than 0.5% of natural fiber [48].

Hemp fibers are used in the design of hemp fiber reinforced biodegradable polymers, including thermoplastic starch, polylactides (PLA), polyhydroalkanoates (PHA), soy based resins, and lignin based epoxy, epoxy-idised linseed, and soyabean oil [49]. Hemp fibers are hydrophilic and hence absorb moisture in a considerable amount. The moisture content ranges from 5-10%. At 23°C, the hemp fiber showed 66% saturation water uptake, which further increased to 80% at 80°C [50]. Hemp fibers consist of cellulose (70-74%), hemicelluloses (15-20%), lignin (3.5-5.7%), and pectin (0.8%) and wax (1.2-6.2%) [42]. Industrial hemp finds numerous applications in textiles, composites, automotive, heat-insulating materials, fiberboard, and building construction [48]. Hemp is a sustainable, friendly crop that can be used for a variety of applications. The high quality fiber obtained from hemp has been used for centuries for the production of textiles, ropes, and paper. Long fibres from hemp may be spun into high-quality fabric and used in clothes, and they have anti-mildew and antimicrobial characteristics, making them an environmentally beneficial alternative to fibre glass. Hemp textiles are longer, shinier, mildew-resistant, and more absorbent than cotton textiles [9].

Hemp fiber is used in textiles such as blankets, bed spreads, carpets, clothing, luggage, hats, shoes, shirts, towels. They are also used in the production of non-woven fabrics [9]. The antibacterial activity of hemp plants provides utilization of these plants in textiles (such as t-shirts, nappies, bed linen, medical scrubs), healthcare products and cosmetics (antiseptic ointments, antibacterial skin treatments, mouthwash, toothpaste), food packaging and biomedical applications (wound dressings, implants, and medical devices). It was found out that the hemp fiber showed activity against *Escherichia coli*, *Staphylococcus aureus* and *Candida albicans*. Hemp extracts showed good antimicrobial activity against gram-positive organisms such as *Staphylococcus aureus* [51]. *Staphylococcus aureus* is a gram-positive organism which is a leading cause of infections in humans and survives at human body temperature (37°C). They cause cellulitis, toxic shock syndrome, impetigo, toxic shock syndrome, endocarditis, necrotizing pneumonia, and sepsis. Because of their antibacterial action, hemp fibre sanitary napkins could provide great protection against these organisms [52]. Recognizing their immense potential benefits, these fibres could be used to make sanitary napkins. A washable and reusable sanitary pad known as a "Himalayan hemp sanitary pad" is now available on the market [32].

5.6 Water hyacinth fibers

The water hyacinth (*Eichhornia crassipes*) is a free-floating perennial weed in the Pontedericeae family. It is seen as a major issue since it reduces the oxygen content in the water, reduces the flow of water, and impedes boating, etc. Because oxygen is essential for living, aquatic creatures are killed when the oxygen content in the water drops [53]. Water hyacinth in aquatic environments clogs irrigation canals, makes fishing difficult, becomes entangled with motorboat rotors, and renders areas inaccessible and uninhabitable to other living species, reducing biodiversity [54]. Water Hyacinth blocks cause enormous damage to hydroelectric turbines. It is a noxious and rapidly spreading weed that out competes all other species in the ecosystem to which it belongs. This water hyacinth plant has been studied for

*Srikavi Anbalagan

its potential use as a natural absorber for water pollution, heavy metals, and other contaminants. The positive qualities of this plant are that they are abundantly available, do not need any land space for growing, no need for sowing, weeding or fertilizing, have rich fiber content, and water absorbency equal to that of cotton [55]. Due to these positive aspects, water hyacinth plants could be a potential source of sustainable raw materials for many applications. The chemical composition of fibers includes cellulose (32%), hemicelluloses (21%), and lignin (14%). Water hyacinth fibers are used in clothing and fabrics. Other applications include wallets, hand bags, fashion accessories, flower pots, and paper products [53] [56]. The fiber is extracted from the stem of the water hyacinth plant. The fibers are used in paper manufacturing, matting, baskets, furniture, and as animal fodder. Water hyacinth has shown considerable promise in the textile and paper industries. It is also utilised for vermicomposting in a number of countries [9]. Furthermore, these plant fibres have the potential to be successfully used in the manufacture of sanitary napkins. Utilizing these plants could help in eradicating weeds from the aquatic environment, reducing water pollution and other related problems. Water hyacinth sanitary pads are being marketed under the trade name "Jani". These pads are cost-effective, biodegradable and environmentally friendly [32]

5.7 Flax fibers

Flax (*Linum usitatissimum* L.), generally known as linseed or common flax, is an annual plant that grows to 1.2 m in height and belongs to the *Linum* genus in the *Linaceae* family [57]. It is an industrial plant grown mainly for its valuable fiber and hence designated as a "fiber plant" or "fiber crop". The chemical composition of flax fiber includes 60-70% cellulose. Hemicelluloses-17% and lignin 2-3%, pectins 10% and waxes 2% [58]. Flax fiber is mainly used in the textile industry for the manufacture of linen and is soft, crisper, stiffer, lustrous, flexible and stronger to handle in comparison to cotton. The moisture absorption is high and releases water quickly, making linen fabric more comfortable in hot weather [9]. Flax fiber finds great application in the high-quality paper industry for designing printed bank notes and as a raw material for rolling paper for cigarettes and tea bags. Linen fabric has the advantage of excellent strength, cool in warm weather, and hydrophilic, which absorbs water and dries very quickly. Linen uses range from home and commercial furnishing items (wallpaper/wall coverings, upholstery, window treatments, etc.), bed and bath fabrics (tablecloths, dish towels, bed sheets, etc.), apparel items (suits, dresses, skirts, shirts, etc.) to industrial products (luggage, canvases, sewing thread, etc.) [59]. Various parts of the plant are used in the manufacture of ropes, twines, fishing nets, fabric, dye, paper, hair gels, and soap [60]. Since flax fibers are renewable, biodegradable, and eco-friendly fibers than synthetic fibers, increasing research is being carried out into utilizing these plant fibers for various applications. Hence, these fibers could be successively employed as a raw material in sanitary pad making for a sustainable green economy.

6. Conclusion

Biodegradable sanitary pads are the best solution to the problem of commercially accessible non-biodegradable sanitary napkins. This article examined various plant fibres that have the potential to be used in the development of sanitary napkins. Lignocellulosic plant fibers are considered as renewable, biodegradable, and environmentally friendly fibers with potential replacement for synthetic and manmade fibers. The use of plant fibers in feminine hygiene products will not only make our environment clean but also help to increase the health and

*Srikavi Anbalagan

lifestyle status of women. Younger generation women must be educated about the benefits of using biodegradable sanitary napkins. The use of indigenous plant fibres is cost-effective and contributes to increased employment in rural regions. Given all of these advantages, plant fibres are a viable raw material for the production of sanitary napkins.

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*Srikavi Anbalagan

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