Banana Pseudo-Stem Fibre: Processing and Applications

P. Karthika[1], A. Varalakshimi[1] and S. Babu[2]

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[1]*Undergraduate Students, VIT School of Agricultural Innovations and Advanced Learning, Vellore Institute of Technology, Vellore 632014.*

[2]*Professor and Dean, VIT School of Agricultural Innovations and Advanced Learning, Vellore Institute of Technology, Vellore 632014.*

Corresponding Author: babu.s@vit.ac.in

Introduction

Banana is basically a fruit crop cultivated in all the tropical and sub-tropical countries. The fruits are consumed in almost all the countries of the world. Banana plants are known for the usage of all plant parts–ripe and unripe fruits, flowers, pith are edible; leaves, sap, pseudo-stem fibre are used either as such for non-edible purposes or as value added products for other applications. The fibres obtained from pseudo-stem contain cellulose, hemicellulose, lignin and ash, the composition of which varies with different species. Compared to the pseudo-stem fibres, hemicellulose content is high in leaf fibres. Depending on the plant part used (leaves or leaf sheaths of pseudo-stem) and the extraction methods followed the physical and chemical properties of the banana fibres vary. The market value of banana fibres is several folds higher than the fibres obtained from flax and hemp. Hence, at the end of crop season, after harvest of banana fruits, the pseudo-stem which is considered to be an agricultural waste can provide additional income to the farmers, if the pre-processing of fibres are done at the farm level.

Banana Pseudo-Stem Fibre

For every ton of banana fruit produced, four tons of biomass waste (leaves, pseudo-stem, rotten fruit, peel, rhizome etc.) is produced, of which the bulky waste is pseudo-stem. Pseudo-stem is the trunk part of the plant which consists of a central core (pith) wrapped by leaf sheaths. The central core contributes to 10-15% of the pseudo-stem. Out of the remaining 85-90%, fibre is 1.5-2% and the rest is non-fibrous material. About 30-40% of the non-fibrous material is sap and 60-70% is scutcher. The central pith is directly used as vegetable or indirectly used to prepare value added food products like pickle, soft drink and candy. The sap is used to make organic liquid fertilizer and to prepare mordant for the paint industry. Scutcher material is useful as manure after composting or as raw material for the preparation of vermicompost. A normal banana plant has 15-18 leaf sheaths making the pseudo-stem. The outer sheaths are composed of course fibres and the soft fibres are obtained from inner sheath. Each leaf sheath in cross section has three layers – the outer epidermis, water conducting tissue and inner soft layer of cells.

Extraction of Banana Fibres

Manual extraction process involves separation of leaf sheaths, rolling them to remove excess moisture, making of crude fibres by combing which also removes impurities and pigments. The fibre shreds are then cleaned and dried. For industrial applications, specialized machines are available and the banana fibres can be extracted automatically. The machine consists of horizontal beams, a carriage and comb like structure. Banana sheaths are fed through a fixed platform and the resulting fibres are dried at 200°C for three hours. There are various types of banana fibre extraction machines that are custom designed. In some places, the fibre is extracted by separating the ribbon like layers of pulp. These are called tuxies which are then used to remove residual pulp with the help of a knife. The fibres are then spun into twines. A decorticator machine containing a drum mounted on a shaft was designed and found to be successful (Subagyo and Chafidz, 2018). The blades mounted on the circumference of the drum create a beating action on the drum when rotated. The pseudo-stem of banana is fed into the drum by a feeding roller. Due to crushing, beating and pulling, the pulpy material is removed. This machine can handle two tons of dry fibre per day. Fibreboards prepared from banana fibres use steam explosion at high temperature and pressure which rearranges the lignin to give the strength. Extracted long fibres are also cut into small pieces and treated with enzymes like pectinase for six hours to produce textile grade fibres (Ortega et al., 2016). These fibres are found to be suitable for production of yarns. Polygalacturonase producing bacteria such as *Streptomyces lydicus* are also used to process textile purpose fibres from the raw material.

Applications of Banana Pseudo-Stem Fibre

With increasing demand on eco-friendly materials, banana fibres are now used to make garments, ropes, mats, carpets, cushions, cushion covers, bags, baskets, table cloths, curtains, rugs, matresses, pillows, wallets, wallets, yoga mats, sausage casings, tea bags, vacuum bags, cigarette papers, fishing nets, packaging sheets, base material for growing of mushrooms, cardboards, string threads, socks etc. It is used to make currency papers, bond papers, envelopes, tissue papers, filter papers, decorative papers and writing papers. Banana fibre is an alternative for wood pulp in paper industry due to its high cellulose content. In composite materials, banana fibres can be used as alternative to fibre glass and thus it finds application in automobile industry. Due to the high resistance to salt water, banana fibres are the most preferred ones in making marine ropes that are used in boats and ships (Vigneswaran et al., 2015).

Fibre industries have been exploring alternate materials that can replace the synthetic fibres and the demand for usage of wooden trees. Synthetic fibres are toxic, non-degradable and energy consuming during the manufacturing process. Among the biodegradable natural fibres such as coir, jute and palm, banana fibres exhibit better tensile strength. Banana fibres can be blended easily with other natural fibres like cotton or synthetic fibres in textile industries. Due to the high absorbent properties, banana fibres are useful in absorbing oil spills in the oil refineries and also to remove the dye in textile industry effluents. Cellulosic banana fibres are eco-friendly reinforcing materials for the production of green polymers.

Use of cloths based on banana fibres originated in Japan during 13th century. Since water is absorbed and released quickly, fabrics made from banana fibres are considered as comfortable summer wear. Banana fabrics are beautiful and similar to silk. Although the raw fibres are not as soft as silk, it is possible to create silk like fabric from these fibres. Use of non-woody raw materials for paper production will reduce the need for timbers and thus the environmental issues like deforestation can be reduced. Pseudo-stem of Cavendish varieties of banana is useful for paper making. Papers made from banana fibres are known to have resistance to water and also stronger than the wood pulp-based paper (Jacob and Prema, 2008).

Conclusions

In many agricultural farms, the pseudo-stem of banana plants after harvest are disposed as landfill waste or burnt after drying. There exists a high potential for converting this waste into wealth. One metric ton of the pseudo-stem (contributed by 50 plants approximately) can yield about 15-20 kg of banana fibres. Compared to other natural fibres, production of banana fibres is less expensive since the raw material is cheap and abundantly available in banana growing regions. Although many products based on banana fibres are available in the market, banana fibres are not yet explored completely. Cellulose nano-crystals obtained from banana fibres is an emerging field which has a greater potential to find additional applications for banana fibres. Low cost fibre extraction machines established at the village level can not only help in recycling this banana biomass into fibres but also provide employment opportunities to the rural poor and additional income to the farmers.

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