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BANANA WASTES USEFULNESS IN MANUFACTURING OF BIOPRODUCTS —A REVIEW

Anil Paswan[1*], C.S. Azad[2] and R.D. Ranjan[3]

[1]Deptt. of Extension Education, [2]Deptt. of Plant Pathology, [3]Deptt. of Plant Breeding and Genetics
Bihar Agricultural College, Sabour, Bhagalpur-813210, Bihar, India
***Corresponding Author** (Anil Paswan) **Email :** anilbausabour@gmail.com*

ABSTRACT

Banana (*Musa paradisiaca*) is one of the most important gigantic and oldest cultivated fruit crops grown almost everywhere in India. Presently, the banana pseudostem is hazardous waste in India whilst it has been used in several countries to develop important bio-products such as fibre to make yarn, fabric, apparel as well as fertilizer, fish feed, bio-chemicals, paper, handicrafts, pickles, candy, etc. Looking at this perspective, entrepreneurs of India should take this golden opportunity and do the needful for such kind of business. The land of our country is suitable for banana production. Its fruit is a healthy diet and demandable in local markets as well as the free waste could be utilized to produce such bio-products which will contribute directly in our national economy. Thus, farmers or entrepreneurs should cultivate more banana trees in unproductive lands of coastal and hilly areas for extra income from the useless wastes and ensure eco-friendly environment. Women can also be employed in production of different bio-products from banana wastes and thus, they can contribute to their livelihood improvement. In conclusion, this review on banana waste utilization will be of help to the farmers, entrepreneurs, planners, scientists as well as Bihar government to take proper initiatives in socioeconomic improvement of Bihar.

Key words : *Pseudostem, bio-products, employment, eco-friendly, health care.*

Banana (*Musa paradisiaca*, family Musaceae) is a central fruit crop of the tropical and subtropical regions of the world grown on about 8.8 million hectares (Mohapatra *et al.,* 2006). It is possibly the world's oldest cultivated crop (Kumar *et al.,* 2004). As a diet, banana is an affluent source of carbohydrate with calorific value of 67 calories per 100g fruit and is one of the most well-liked and widely traded fruits across the world (Emaga *et al.,* 2008; Kumar *et al.,* 2004). It is one of the tallest herbaceous plants with a pseudostem. Its tough treelike pliable stem is composed of the sheathing twisting leaf bases, which contains fibres of sufficient strengths to keep the tree upright. In different countries, about 300 varieties of bananas are grown, of which a vast majority are grown in tropical Asia (Simmonds, 1962). Banana grows almost everywhere in India round the year. In the state Bihar, it is also the second most important fruit crop after mango and is mostly grown in two regions *viz.* Vaishali and the north eastern (Khoshi) region. In the tract around the Ganga basin of Bhagalpur district banana cultivation is specialized type of farming giving more remunerative income to the growers in comparison to cereals and other plantation crops. In spite of these various use of the banana plant, it is seen that huge portion of banana plants are just dumped as waste causing environment hazards and making ecosystem imbalance. Currently, millions of tones of banana pseudostem are dumped in our country as waste and most of the farmers are facing huge troubles in disposing the accumulated banana pseudostem. Therefore, an effective economic means of reducing this environmental problem by extraction of fibre and production of many essential food products, fertilizer, bio-chemicals, papers, etc. from banana waste (pseudostem) can be proposed.

Characteristics of banana fibre :

The chemical composition of banana fibre is cellulose (50-60%), hemicelluloses (25- 30%), pectin (3-5%), lignin (12-18%), water soluble materials (2-3%), fat and wax (3- 5%) and ash (1-1.5%) (http://www.li-fei.com/products/4/e2.htm) (Mukhopadhay *et al.,* 2008).

Its appearance is similar to that of bamboo and ramie fibre; however banana fibre has better fineness and spin ability. It has shiny appearance depending upon the extraction and spinning process (Rao and Mohana, 2007).

It has very strong fibre with 3% elongation and light weight.

Its average fineness is 2386 Nm, average strength is 3.93 cN/dtex and average length is 50 ~ 60 mm (or 38mm) (http://www.li-fei.com/banana.htm).

It absorbs and releases moisture easily.

It can be spun by different methods like ring spinning, open-end spinning, bast fibre spinning, and semi-worsted spinning.

It is bio-degradable and has no negative effect on environment and thus can be categorized as eco-friend fibre (Mukhopadhay *et al.,* 2008).

Business Idea : Banana wastes are being used in different countries like India, Nepal and Philippines as an excellent business idea. These countries have been developing interesting products for last two decades and have been trying to replace cotton that is more expensive at market value. As a developing country, India should begin such kind of business since the land of our country is suitable for banana production. Besides, farmers will be interested to cultivate banana for extra income from useless waste. We have huge barren land that can be productive due to the demand of raw materials of this business through the plantation of banana. If the pseudostem can be utilized for fibre extraction, it will create lots of employment opportunities and make rural woman and school dropouts empowered and improve their socio-economic level and standard of living.

In this paper, attempt has been taken to build up a combination among research and trade system suitable for our country and sector-wise product manufacturing as well as business idea using banana pseudostem derived products in India.

Usefulness of Banana Waste : Pseudostem processing and fibre extraction the banana fibre can be extracted manually or by machine. Manual fibre extraction is a cumbersome process. In this process, pseudostem is initially cut into pieces of about 60cm length and 7.5cm width. Then the pseudostem is scraped and the fibre is separated by using scraper or a flat blunt blade. In manual process, a skilled labour can produce only 500-600g of dry fibre in 8 hours time. On the other hand, fibre extraction process by machine can be carried out using cutter machine which facilitates speedy splitting of pseudostem into 2 or 4 halves. From these halves, sheaths are separated easily. Such cutter machine is sufficient for providing sheaths required for four raspador machines (Patil and Kolambe, 2005). By this machinery process, pseudostems are isolated from banana tree and divided into pieces. Then the pieces are passed through the extracting machine, known as mechanical decorticator and fibres are automatically extracted faster. The mechanical decorticator contains of a pair of feed rollers and a beater (Mukhopadhay *et al.,* 2008). After extraction by this technique, the fibres are dipped into bio enzymes to clean and improve quality in terms of length and softness, strength and colour which finally make the fibres shiny (Manandhar, 2007). After sun dry, the fibres are ready for knotting. A bunch of fibres are mounted or clamped on a stick to facilitate segregation. Each fibre is separated according to fibre sizes and is grouped accordingly. To knot the fibre, each fibre is separated and knotted to the end of another manually. The separation and knotting is repeated until bunches of un-knotted fibres are finished to form a long continuous strand. This fibre can now be used for making various bio-products.

Products from banana-pseudostem fibre : Banana fibre is extensively used as blending material in textile industry in countries like Philippines, Malaysia, Japan and Korea. It can be easily blended with other fibres such as jute and mesta being natural fibres. Therefore, lots of industrial products like gunny bags, door mats, carpets, yarn, ropes, geo-textiles, trivialities, luggage carriers and interior decorative crafts paper, tissue paper, paper bag, etc. can be made from this fibre, where great strength is required. It has also some industrial uses such as natural sorbent, as a base material for bioremediation and recycling and as a natural water purifier (Mohapatra *et al.,* 2005). Among other uses banana fibre is used in making socks and gloves in European countries.

Yarn : Rope making from extracted banana fibre is called Banana fibre yarn (Fig. 2). Rope making is one of the most basic skills for converting any linear material into a usable stage (Manandhar, 2007). Rope is a length of fibres, twisted or braided together to improve strength, for pulling and connecting. It has tensile strength but is too flexible to provide compressive strength (Maleque *et al*., 2007). There are actually three layers in the decaying bark of the banana tree. The outer layer is the toughest and usually used for weaving items. The middle layer produces rope that is used for thick cloth making and the inner layer which is

Table-1 : Physical and mechanical properties of banana fiber.

Fibers	Width or diameter (m)	Density (kg/m^3)	Cell L/D ratio	Microfibrillar angle (degree)	Initial modulus (GPa)	Tensile strength (MPa)	Elongation (%)
Banana pseudo-stem	80–250	1350	150	10 ± 1	7.7–20.0	54–754	10.35

the silkiest fibres is used for spinning yarns and making fine clothing (Mohapatra *et al*., 2005) such as sharee, three pieces, T- shirt, under garments, etc.

Fabric and apparel : Cloths produced from rope or yarn is called fabric whilst various types of dresses made of cloths are called apparel (Sapuan and Maleque, 2005). The process of fabric and apparel production from banana fibre is as usual as cotton textile. It is also possible to prepare synthetic and laminated fabric by mixing some other fibre like jute or cotton in special ratio

Paper : Banana fibre can be an alternative raw material of paper industries like writing paper, anti grease paper, cheque paper as well as hard board industries (Muraleedharan and Perumal, 2007; Mohapatra *et al.,* 2005 and Cordeiro *et al.,* 2004). At first, raw paper materials are collected from banana plants and fibres are collected afterwards. The collected fibres are soaked in water prior to make pulp. Later, the extracted fibre is bleached by microbial treatment using Trichoderma and Pythium for 3-5 days (Muraleedharan and Perumal, 2007). These fungi acts on cellulose and breaks the bonds between lingo cellulosic complex structures and lignin and hemicelluloses are broken down and leached out (Crouch *et al.,* 1998). It enhances the brightness of the paper and helps to soften the fibre as well as do pulping process easier.

After the microbial treatment, banana fibre has to be washed to clean unwanted materials including microbes and convert to pulp in a process called beating. All of the additives in required amount and actual proportions must add during the beating process. Usually starch, polysaccharide resins, and natural gums (glue) are used to modify or enhance the bonding between the fibres in paper pulp. In the sizing step it is tried to retard the ability of wetting and penetration. Sizing reduces porosity and hence reduces absorption ability. After several steps to be carried out finished paper is made from pulp (Cordeiro *et al.,* 2004). This paper is used to prepare shopping bags, files, visiting card, greeting card, invitation cover, scribing pad, envelops, art paper, printing paper, etc. (Uma *et al.,* 2005; Muraleedharan and Perumal, 2008).

Besides, writing paper is also prepared from banana fibre following as usual industrial process just by replacing banana fibre pulp against bamboo or wooden pulp (Uma *et al.,* 2005 and Mohapatra *et al.,* 2005).

CONCLUSIONS

The products manufacture from banana fibre or other parts of banana tree will survive in market with a high competition. Addition of values to the banana bio-products will improve its quality and hence will enhance its acceptability. Addition of natural composites will reinforce the fibre for better strength and quality. The organic products are becoming increasingly popular worldwide. Therefore, government should take initiative in combination with scientists and technologists to prepare banana bio-products and reach the people in home and abroad, which in turn will contribute of food security. Banana fruits and its plants as a whole are a good source of bio-chemicals. Thus, bio-pharmaceutical industries can collect bio-chemicals from backyard industry and can save foreign remittance of Bihar. It seems that this information will be of immense help to the farmers, entrepreneurs, planners, scientists as well as Bangladesh government to take proper initiatives for the betterment of the nation.

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