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Leather is a high quality natural and sustainable alternative to the animal leather resulted in the creation of pinatex fabric, and the AnanasAnam Company. This natural leather was created in the Philippines, rescuing traditional knowledge of the population that in the past produced clothes using fibres from the leaves of the pineapple plant. Pina-tex is a high quality natural and sustainable material which can be used as an alternative to existing leathers. This innovative leather is strong, versatile, breathable, soft, light, flexible textile that can be used for the production of shoes, bags, clothes and hats. Piñatex™ has been tested according to ISO international standards for: Seam rupture; Tear & tensile strength; Light & colour fastness; Water spotting; Flexing endurance; Abrasion resistance; Resistance to ignition by cigarettes. It can also be used in interiors, furnishings and the car and aeronautic industries. The Leather production process is environmental friendly and sustainable: besides taking advantage of crop wastes, it does not require the use of more water or fertilizers pesticides to produce fibers from pineapple leaves. This natural fabric and the methods of its production have significant environmental, economic and social advantages

KEYWORDS: Pineapple leaf fiber (PALF), decorticator machine, Composite, Leather, Eco-friendly

1. INTRODUCTION

Pineapple is a native plant of America, first seen by Columbus and his companion in 4th November 1493, at a island of West Indies. When the new world was discovered, pineapple has been spread all over South America coastal region as well as in tropical regions. A Spanish government officer, De Oviedo, came to America in 1513; he handed over first written documents of some varieties of pineapple, and he added some Indies varieties also.(1)

The plant is called pineapple because of its fruit which look like pine cone. The native Tupi word for the fruit was *anana*, meaning excellent fruit; this is the source for words like *ananas*, common in many languages. The pineapple is an old emblem of welcome and can often be seen in stamped decorations. In 17th century Americans imported pineapple from Caribbean because of its apparently exotic features and rareness; pineapple began to be considered as an icon of wealthy people in America.(1, 2)

The Portuguese contributed their important role in introducing the fruit throughout the whole tropical regions and major parts of world like south and east Coast of Africa, Madagascar, south India, China, Java, and Philippines. Nowadays, varieties of pineapple plants are available which are used in various applications such as edible, medicinal, and industrial applications. For example, bromelain is an enzyme extracted from its leaves and helps in respiratory ailments. A mixture of pineapple juice and sand is powerful cleaner for boat decks. Dehydrated waste material of pineapple is used as bran feed for cattle, chicken, pigs, and so forth (2) Industries are widely using plant fibres for numerous application from many resources. In the middle of 20th century, synthetic fibres rose found annual growth rate of 3.3%, it is estimated to cross over 3.3 billion pounds only 1.43million tonnes. In 2001the production of Costa Rica, Coted'Ivoire, and Philippines were 322,000 tonnes, 188,000 tonnes, and 135000 tonnes, respectively.(1)

The most important property of natural fibre is biodegradability and no carcinogenic which bring Scientists

and engineers are having great interest to find out new sources of raw materials that possess comparable physical and mechanical properties to synthetic fibres. Various other parameters to be considered while selecting raw materials are being cheap, being eco-friendly, absence of health hazards, high degree of flexibility [8], lower plant's a easy collection, and regional availability which directly influence the suitability of natural fibres

Above all the natural fibres are renewable resource, thus providing a better solution of sustainable supply, like it has low cost, low density, least processing expenditure, no health hazards, and better mechanical and physical properties .

The main drawback of natural fibre is moisture absorption, so it is bound to change its surface property by using chemicals .Synthetic fibre reinforced polymers were costly and have an impact on environment fibre can reduce the pressure on forest and agriculture. The usage of diverse raw materials will help to keep a ecological balance in nature. Generally agriculture materials and forest product produce 30-40% wastematerials, which can also be used in value added processing.

1.1 Pineapple Leaf Fibre

Every year tonnes of pineapple leaf fibres are being produced, though very small portions are being used in the field of feedstock and energy production. The expansion of bio composites has amplified industrial usage that would release the possibilities to minimize the wastage of renewable materials. It promotes a non-food based market for agricultural industry.(2)

It is white in colour, smooth, and glossy as silk, medium length fibre with high tensile strength. It has a softer surface than other natural fibres and it absorbs and maintains a good colour [10].6 International Journal of Polymer Science However, PALF has high specific strength and stiffness ;it is hydrophilic in nature due to high cellulose content .

In the middle of 20th century, synthetic fibers are drastically used, and natural fibers industries collapse its market shares. For promoting natural fiber as material, year 2009 is

considered as international year of natural fiber (IYNF), which is highly supportive to farmers, agriculture, environment and market demand. The most important property of natural fiber is biodegradability and non-carcinogenic which bring it back into fashion, with an advantage of being cost-effective. The versatile nature of it makes it suitable for automobiles, railway coach, building construction, partition wall cabinets, furniture for machinery uses and packaging.

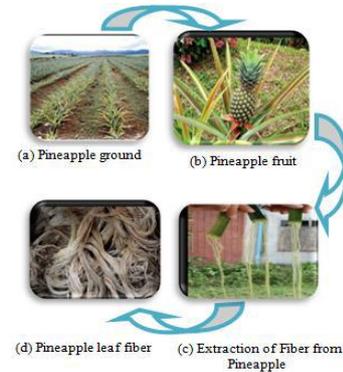
Natural fibers are important agricultural biomass contributing to Indian economy. The huge and wide range availability of natural fibre can reduce the pressure on forest and agriculture. The usage of diverse raw materials will help to keep an ecological balance in nature. Generally agriculture materials and forest product produce 30-40% waste materials, which can also be used in value added processing. The low density natural fibers can also be utilized as per the aim of utility. For example, a grass fiber can be a good alternative for low load bearing products. It has cumulative advantage of light weight (low density), cheaper source, low wages, being non-carcinogenic, and biodegradability(1).

Pineapple is perennial herbaceous plant with 1-2m for height and width belongs to family Bromeliaceae. It is chiefly cultivated in coastal and tropical regions, mainly for its fruits purpose. In India, it is cultivated on about 95 million hectares of land and is continuously increasing its production; it is a short stem with dark green colour. First sprout of leaf looks decorative; later it converts into 3 ft. long, 2 to 3 inch wide sword shaped and numerous spirally arranged fibrous leaves edges as well as curved towards the cross section to maintain the stiffness of the leaf. Each pineapple fruit has equal number of hexagonal sections on outer shell and does not depend on the size or shape. India is a large country to produce pineapple plant in Asia. It produces a huge amount of waste material, currently; India produces 1.53million Tones of pineapple with productivity of 15.3 tones/hectare in 2013(1,2).

1.2Pineapple Leaf Fiber Leather

This natural leather was created in the Philippines, rescuing traditional knowledge of the population that in the past produced clothes using fibres from the leaves of the pineapple plant. The textile expert Carmen Hijosa with Spanish origins, consultant in both the design and manufacture of leather goods in the Philippines, realized that from the fibres of the pineapple leaves a big quantity of pulp could be extracted to be transformed by physical and chemical processes into a flexible and resistant textile, very similar to the leather. Also she found that the conditions of constant humidity and temperature of this tropical country facilitate the removal of all pulp from pineapple leaves without these become unplayable. The pineapple wastes are extracted following a process called decortications, cut into layers and processed as a textile.

Philippine farmers are responsible for scraping the fibres from the pineapple leaves at the plantation, whilst the transformation process and the Pinatex production take place in other headquarters of the company, based in Spain and the UK. This natural fabric and the methods of its production have significant environmental, economic and social advantages. Her work and research of a natural and sustainable alternative to the animal leather resulted in the creation of Piñatex fabric, and the Ananas Anam Company (3).



2. METHOD OF EXTRACTION

Scrapping machine is the machine used for scrapping the pineapple leaf fibre. The machine is the combination of three rollers: (a) feed roller, (b) leaf scratching roller, and (c) serrated roller. Feed roller is used for the feeding of leaves into the machine; then leaves go through the second roller that is called scratching role.

It scratched supper leaf roof and removes the waxy layer. And at last leaves come to the dense attached blade serrated roller, which crushes leaves and makes several breaks for the entry passage for the retting Microbes.(2)

2.1Retting pineapple leave

In retting process, small bundles of scratched pineapple leaves are immersed in a water tank which contains substrate: liquor in 1 : 20 ratio, urea 0.5%, or diammonium phosphate (DAP) for fast retting reactions. Materials in water tank are regularly checked by using finger to ensure fibre are loosened and can extract many chemical constituents like pentose's, lignin, fat and wax, ash content, are segregated mechanically, through washing in pond water. Extracted fibres are dried in hanging place by air. Both ball mill and disc mill can be used to extract PALF from chopped fresh pineapple leaf. The methods not only are simple but also provide higher fibre yield and smaller fibre than the Conventional methods. Among the two mechanical grinding methods studied, wet ball milling is much slower but provides PALF with a greater of elementary fibre(2).



Table 3.1.1:-Chemical Composition of PALF

Contents	Chemical Composition %
Cellulose	67.12-82
Hemicelluloses	9.45-18.80
Lignin	4.4-15.4
Pectin	1.2-3
Fat and Wax	3.2-4.2
Ash	0.9-2.7

The decorticator machine used for scrapping the pineapple leaf is shown in figure I (a). The machine has three rollers, (i) feed roller (ii) leaf scratching roller and (iii) serrated roller. The leaves were fed through feed roller and then scratched by other roller to remove the waxy layer followed by serrated roller creating space for retting microbes. Figure I (a) shows the scrapping machine operation. using ceramic plate over

the pineapple leaf with pressure and fast movement of it, will give the fiber beneath the leaf shown in figure I (b). The extraction of fiber from long leaves is done easily by this process.

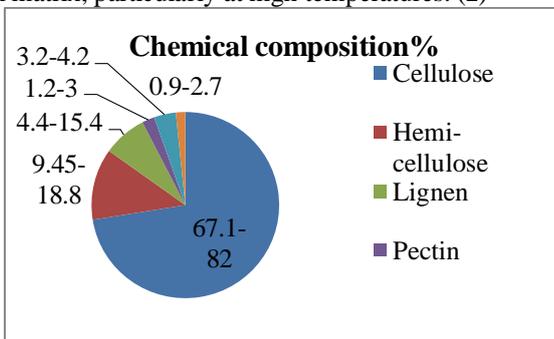
Another process of PALF extraction is nitrogenous matter, and pectin. After retting process, fibres in which the scratched leaves are tied and immersed in a retting tank. Urea or di-ammonium phosphate is added for quickretting. At the end of retting, leaves are taken out and washed mechanically by fresh water(2).

3. CHEMICALS USED IN THIS PROCESS

Alkali treatment or mercerization using sodium hydroxide (NaOH) is the most commonly used treatment for bleaching and cleaning the surface of natural fibers to produce high quality fibers. NaOH reacts with hydroxyl groups of the cementing materials in natural fibers and brings on the destruction of the cellular structure, thereby splitting the fibers into filaments. Hydrogen peroxide (H2O2) bleach improves PALF fineness by 5-6% but reduces the tensile strength by 40-45%(2).

3.1 Chemical Composition

The chemical composition of PALF constitute hemicellulose (70– 82%), lignin (5– 12%), and ash (1.1%). Pineapple (PALF) has tremendous mechanical properties and can be applied in making of reinforced polymer composite, low density polyethylene (LDPE) composites, and biodegradable plastic composites. Physical and mechanical properties of composites like visco elastic behavior processing, tensile strength, flexural strength, and impact are dependent on length of fibre, matrix ratio, and fiber arrangement. The main drawback PALF is hydrophilic nature; it does not make good bunk matrix, particularly at high temperatures. (2)



4. PHYSICAL AND MECHANICAL PROPERTIES OF PALF.

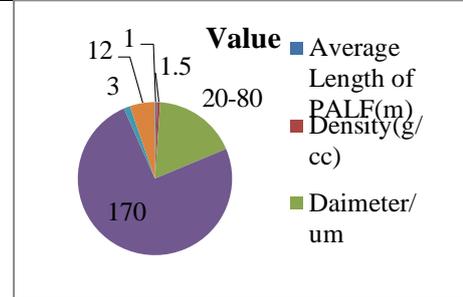
One of the SITRA’s (South India Textile Research) findings under the UNDP/UNIDO assisted projects revealed that PALF could be successfully spun in the cotton spinning system with slight modifications to produce 100% PALF yarn and their blends with other natural and synthetic fibers, especially with cotton. The yarn thus produced was used to make fabrics, fancy carpets, mops, curtains etc. [5].

The major end use of the pineapple fibre is the Barong Tagalong, wedding dresses and other Philippine formal dresses. Again, table linen, mats, bags, shoes (leather like substance), sports item, baggage, automobiles, cabinets, and other clothing items. Another application is thread and fine casting nets. Pineapple yarn and pineapple–jute-blended yarn are used for fashion fabric development, like fashion bag, curtain and furnishing fabrics and pineapple–acrylic-blended yarns are used to produce fancy apparel products.

Table 02 shows the different physical and mechanical properties of PALF that are collected from the articles of different researches.

Table: Physical and Mechanical Properties of PALF

Properties	Values
Average Length of PALF (m)	1.0
Density (g/cm ³)	1.526
Diameter/μm	20-80
Tensile Strength (MPa)	170
Elongation at break (%)	3
Moisture Regain (%)	12



5. APPLICATION OF PINEAPPLE LEAFFIBRE.

The major end use of the pineapple fiber is the Barong Tagalong, wedding dresses and other Philippine formal dresses. Again, table linen, mats, bags, shoes (leather like substance), sports item, baggage, automobiles, cabinets, and other clothing items. Another application is thread and finer casting nets. Pineapple yarn and pineapple–jute-blended yarn are used for fashion fabric development, like fashion bag, curtain and furnishing fabrics and pineapple–acrylic-blended yarns are used to produce fancy apparel products. Industrial textiles using PALF are V- belt cord, Conveyor belt cord, Light weight duck cloth. Healed shaft lifting cords, Air bag tying cords, Shoe lace, Wicks etc. [4]. PALF can be blended with polyester fibers to replace jute for making needle-punched nonwovens for technical textile.



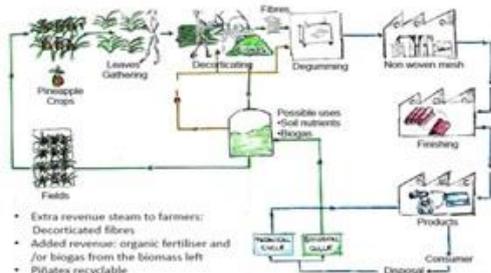
6. MANUFACTURING PROCESS OF SUSTAINABLE AND NATURAL LEATHER WHICH IS MADE FROM PINEAPPLE LEAF FIBRE.

Leather is branded natural and sustainable nonwoven textile material made from pineapple leaf fibres. This product is developed and manufactured by Anans Anam. This can be used as an alternative to what has evolved from seven years of R&D to create a natural textile from waste plant fibres. Meanwhile Pinatex is providing new additional income for farmers while creating a vibrant new pineapple growing countries. The fibres extracted from the pineapple leaves during the process called decortication(3).

Which is done at the plantation by the farming community. Furthermore, the by-product of decortication is bio-mass, which can be further converted into organic fertilizer or biogas. Both the extraction of the fibres and the consequent bio-mass will bring added revenue streams to the farming communities. Then the fibre undergoes an industrial process to become a nonwoven textile which is the base of pinatex. Spina is Spanish for pineapple, the new material created by Carmen Hijosa, who worked as a consultant in the Philippines leather goods industry in the 1990s. She was unimpressed with the standard of goods produced and started to look for

alternatives. It was the strength and fineness of the pineapple leaf fibres used in the Barong Tagalog that first alerted her that there was another option; She was looking for alternative to leather. That was the beginning of her thinking. 'what is going to be in these beautiful bags that is not leather?'

The Spanish designer said. The breakthrough came when Hijos realised that she could make a nonwoven mesh-a fabric which is bonded together without knitting or weaving-from the long fibre in the similar way to felt. The fibers that make up pinatex are extracted from pineapple leaves plantations by farmers before they are cut up and layered. They are then put through an industrial process using needle punch technology, to be converted into a nonwoven textile and the end of which emerges the textile. A byproduct of the process is a biomass which can be converted into fertilizer, giving additional income to the farmers.(3)



6.1. Piñatex(Leather)intended Life Cycle

With a similar appearance to canvas, it can be dyed, printed, and treated to give different type of texture. With treatment, the pinatex can closely resemble while separate thickness are also produced, depending on a use of finished product. For more heavy wearing items, such as bags, a thicker material will be required.

6.2. Undergo Mechanical And Chemical Processes

Completely natural by-product, Pinatex is biodegradable and environment-friendly and has all the characteristic of durable leather that can be use in product like bags, shoes and furniture. So good is the quality that even companies like Puma and Camper have created prototypes with the textile. Dye use without chemical Plant have many u of their oldest being as a source of natural dyes(dyes that don't require chemicals) that provides mankind an exotic range of colorful pigments.

Madder (Rubiatinctorum) is probably the best known natural dye, whose crushed, dried, fermented root gives a deep and brilliant shade of vermilion used as a textile dye by the ancient Egyptians. Other plant that were use natural dye includes weld, or Reseda Luteola, whose tall, daintly, sweetlycented, bee friendly flower spikes colloquially known as mignonette or Dyers rocket, its leaves and flowers yields both a beige and yellow dye. In medieval times wood, or Isatistinctoria, was used as powerful deep- blue dye. Currently have 5 different colours. Charcoal (almost black), Natural, Brown, Gold and Silver. We will be adding extra colours in limited edition.

7. PROPERTIES OF PINEAPPLE LEAF FIBRE LEATHER

- Tensile strength comparable to flax, and greater than jute, hemp, sisal
- Density comparable to jute, sisal, ramie and flax
- Fineness higher than abaca and banana fibres
- High cellulose content Low amount of lignin.

7.1 Table- Tested Properties Of Pineapple Leaf fibre Leather

8.ADVANTAGES

- Can be added with other allied fibers to improve their quality and application.
- Zero waste management.
- Eco friendly and rapid technology.
- Employment opportunity for rural population.

9.APPLICATION OF PINATEX IN TEXTILES:-

Resembling leather in appearance, the new material has caused a buzz in the fashion industry as it can be dyed, printed and treated to produce a variety of textures in different thicknesses. It can then turned in to shoes, wallets, bags and furnishings, footwear, and fashion accessories and can be used in interiors, and the car and aeronautic industries, hand bag from the fabric. Identification of natural fibres from agro-wastes which possess potential textile uses.

Designing and development of technologies to convert agro-waste leaves to useful fibres. To standardize the technical strategies for diversified application pineapple fibre as uses of waste leaves. Less energy and based on renewable raw material.



CONCLUSION

The aim of the Ananas Anam Company is to provide an innovative textile that promotes social, cultural and ecological development, establishing a circular economy by developing a commercially successful business that supports local farming communities. The Ananas Anam Company supports pineapple-farming communities in the Philippines, developing a new industry that will enhance the social network in rural areas as farmers will be able to sell fibers as a commercial and viable proposition. This can be used as an alternative to existing textiles and leathers. To develop new textiles using natural fibres, which are the by-product of pineapple harvest thus no extra land, water, fertilizers or chemicals are utilized in its production.

Tested Property	Pinatex original performance
Tear strength	136N(Warp) 145.3N(Weft)
Tensile strength	380.67N(Warp) 145.5N(Weft)
Seam rupture	299.13N(Warp) 144.17N(Weft)
Flexing endurance	No change after 20000 cycle
Colour fastness to light	Bws 5
Water spotting	4-5 No change

ACKNOWLEDGEMENT

The author are very much thankful to the Head of Department of Textile Engineering Jawaharlal Darda Institute of Engineering India for this encouragement and permission to present this paper.

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