Faculty of Engineering

MECHANICAL PROPERTIES OF BANANA FIBER REINFORCED COMPOSITE

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DEDICATION

This research and study of mechanical properties of banana fiber reinforced composite is dedicated to the Faculty of Engineering, University Malaysia Sarawak for further investigation of potential application of natural fiber reinforced composite.

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ABSTRAK

Banyak penyelidikan telah dijalankan terhadap serat semulajadi dan didapati bahawa ianya sesuai untuk mengantikan serat sintesis. Dalam eksperimen ini, serat pisang telah dipilih untuk mempelajari kemungkinan bahan ini sebagai bahan peneguh dalam komposit. Dengan menjadikan serat pisang sebagai bahan peneguh dalam komposit, kita boleh memaksimakan penggunaannya daripada dibiarkan atau dilupuskan. Komposit disediakan dengan menggunakan poliester tulen dengan 1%, 2% dan 3% berat pemuatan serat. Dua ujian dijalankan, iaitu ujian lenturan tiga titik dan tegasan tegangan. Di dalam eksperimen ini, tegasan kelenturan dan tegasan tegangan untuk gabungan komposisi serat pisang dan poliester menurun apabila berat bebanan serat bertambah. Tegasan kelenturan untuk poliester tulen adalah 55.625MPa dan berkurang kepada 34.805MPa apabila 3% berat pemuatan serat digunakan. Sementara itu, tegasan tegangan untuk poliester tulen adalah 19.86MPa. dan apabila 3% berat pemuatan serat digunakan untuk meneguhkan poliester komposit, nilai tegasan tegangan berkurang kepada 11.602MPa. Biarpun keputusan ditunjukan didalam eksperimen ini tidak menggalakkan, tetapi penyelidikan dan pembelajaran yang lain telah membuktikan bahan ini mempunyai potensi untuk diaplikasikan di industri. Sebab-sebab yang menyumbang kepada masalah ini telah dibincangkan dalam bab 4 laporan ini.

ABSTRACT

Many researches have been conducted on natural fibers and results show that it is suitable to replace synthetic fiber. In this experiment, banana fiber has been selected to study the possibility of this material as reinforcement material in composite. By using banana fiber as a material to reinforced composite, we can fully utilize the waste rather than being abandoned and dispose. The composite are prepared by using pure polyester with 1% wt fiber loading, 2% wt fiber loading and 3% wt fiber loading reinforced polyester. Two tests were conducted, which is 3 point bending and tensile test. From this experiment, flexural stress and tensile stress of banana fiber reinforced composite are decreased as fiber loading increased. The flexural stress of pure polyester is 55.625MPa and decreased to 34.805MPa when 3% wt fiber loading used. Meanwhile, tensile stress of pure polyester is 19.86MPa and when 3% fiber loading used to reinforce polyester composite, the value of tensile stress reduce to 11.602MPa. Although the results showed in this experiment are not encouraging, but other research and study have proved that this material has a potential to apply in industry. The reasons that lead to these problems are discussed in chapter 4 in this report.

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CHAPTER 1

INTRODUCTION

During the last few years there has been an increasing environmental consciousness, which has increased the interest to use natural fibers instead of man-made fibers in composite materials. A combination of desirable properties, such as low cost, low density, non-toxicity, high specific properties, no abrasion during processing, and recyclability, contribute to a rising interest from the manufacturing industry of low cost and light composites. Further more, the natural fibers are recyclable, biodegradable and carbon dioxide neutral and can be energy recovered in an environmentally acceptable way [1].

Attempts have been made to use natural fiber composites in place of glass mostly in non-structural applications. Glass fibers are the most widely used to reinforce plastics due to their low cost (compared to aramid and carbon) and good mechanical properties. However this type of fiber has serious drawbacks. Researches have been done and clearly show that natural fiber has distinct advantages over glass fiber. Carbon dioxide neutrality of natural fibers is particularly attractive which can indirectly contribute to the prevention of the greenhouse effect and by extension the world's climatic changes [2]. This phenomenon is believed to be the root cause of the greenhouse effect and by extension the world's climatic changes [2]. So far, a good number of automotive components previously made with glass fiber composites are now being manufactured using environmentally friendly composites. They also now dominate the aerospace, leisure, construction and sporting industries.

Currently, plenty of research materials are being generated due to the potential of cellulose based fibers as reinforcement for plastics. However, all researchers who have worked in the area of natural fibers and their composites have agreed that these renewable (unlike traditional sources of energy, i.e., coal, oil and gas that are limited), abundantly available materials have several bottlenecks: poor wettability, incompatibility with some polymeric matrices and high moisture absorption by the fibers.

In this research, banana fibers which are abundant in Sarawak have been selected. The high cellulose contains (64%) and low microfibrillar angle (11^{o}) of banana fiber indicates that it has potential as a reinforcing material [3]. Composite made out of banana/ cotton hybrid fabric has been found to be useful in preparation of low strength material. It has been reported that addiction of banana fiber to polymeric matrices can make composite products adequate for building application. The objectives of this project is to study the potential of banana fibers to replace synthetic fiber as composite reinforcement material and to study the effects of untreated and different banana fiber loadings reinforced polyester to its flexural and tensile strength.

CHAPTER 2

LITERATURE REVIEW

2.1 Classification of natural fiber

Natural fiber is categorized into vegetable fibers, animal fibers and mineral. Vegetable fiber can be divided into seed fiber, leaf fiber, bast or skin fiber, fruit fiber and stalk fiber. Animal fibers divided into animal hair, silk and avian fiber. Mineral fiber that can be categorized as natural fiber is only asbestos. Figure 2.1 show types of natural fiber.

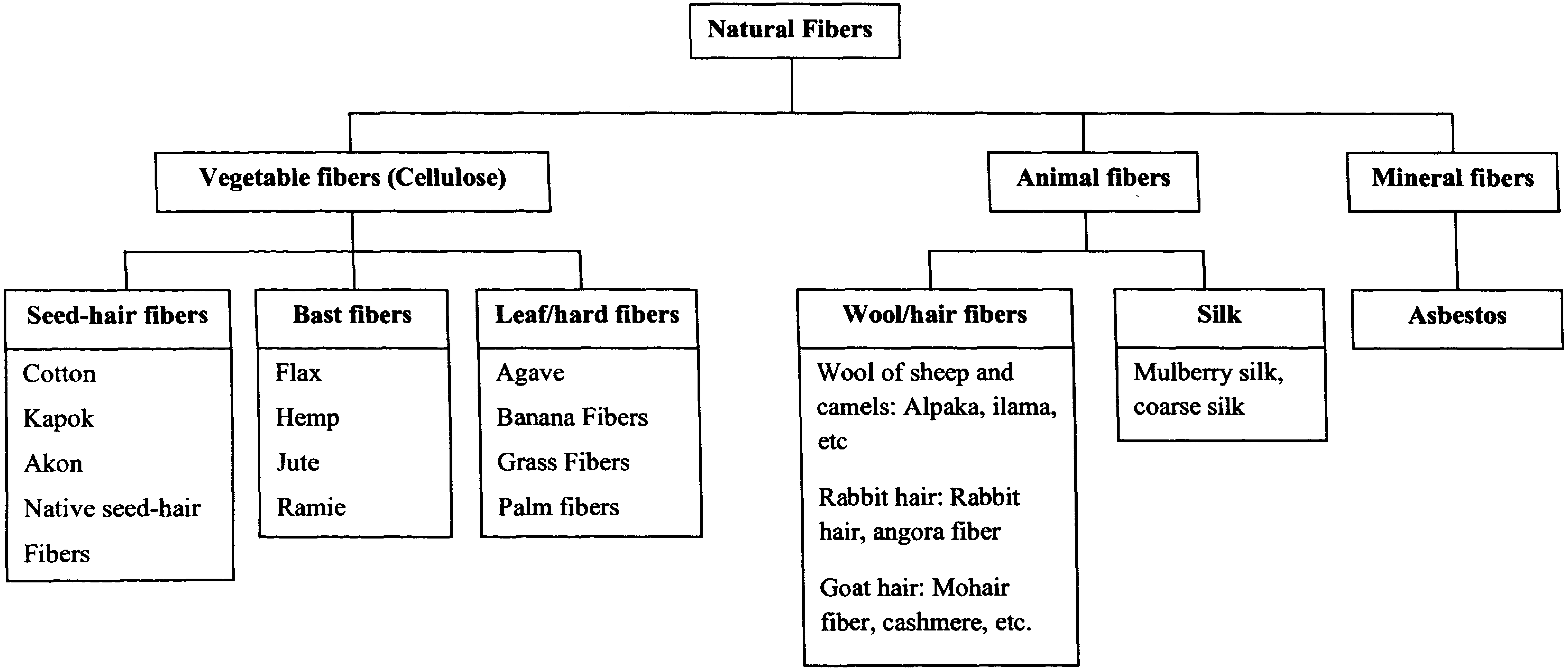

Figure 2.1: Type of natural fiber [4][5]

2.2 Fiber extraction method

Banana fibers are extracted from banana tree. Banana fibers are mostly extracted from banana trunk since it has the main portion of fibers. In order to get good quality of fibers, the extraction must be done properly. There are three methods which are normally used to extracted banana fibers which are mention below.

In the first method, banana trunks are chopped and cooked. After the hands of banana are harvested in the fields, the heavy, moisture laden stems are cut down and peeled into component layer of sheaths. A single sheath was flattened on the ground, a worker pin one end of it under broad, straightedge knife as shown in figure 2.2 and 2.3. Then, the sheath will be draws firmly from under the blade. Finally, banana fibers are clean to remove particulate matter and then soaked overnight [6].

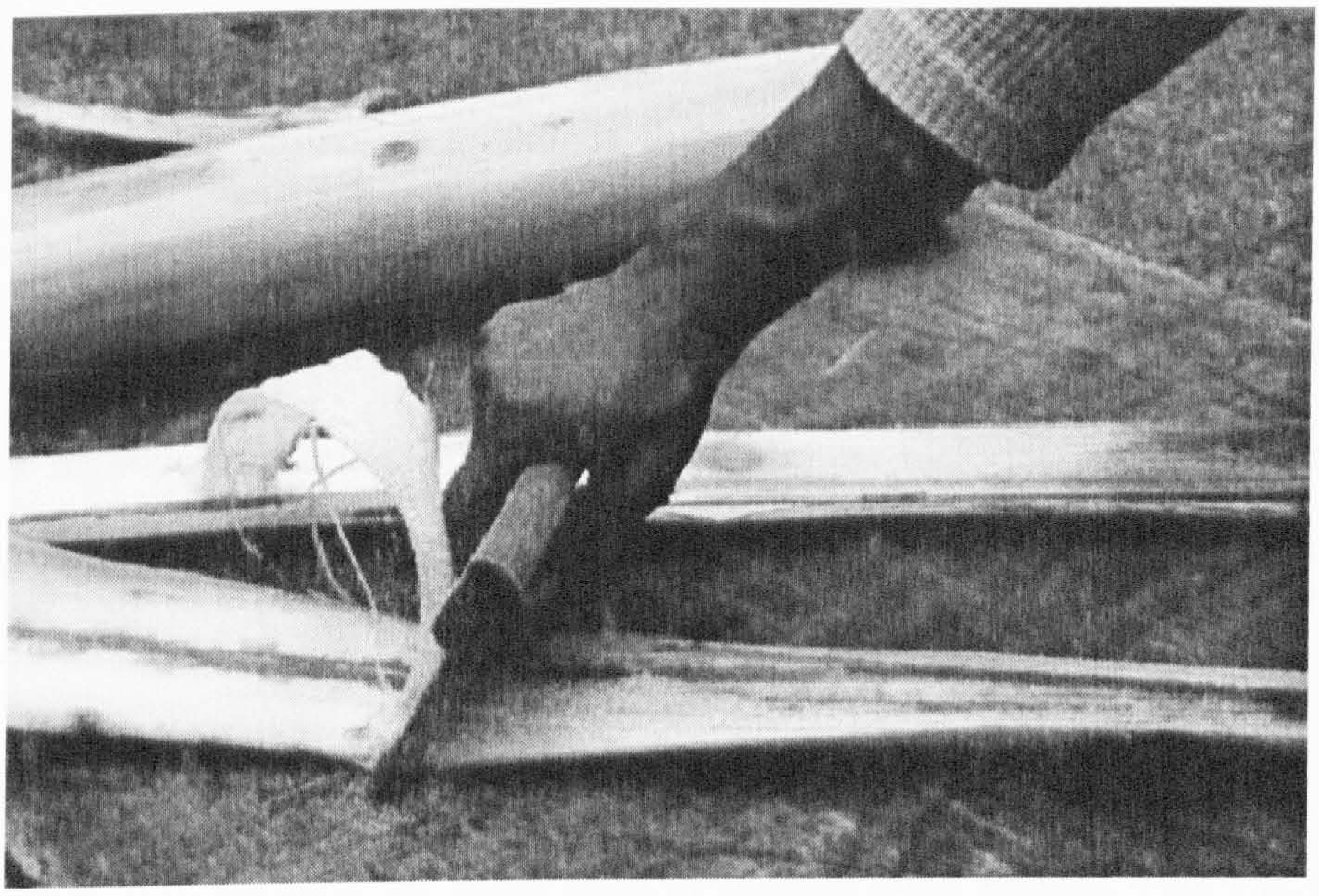

Figure 2.2: Banana stems are peeled into layers, then scraped with a broad, straightedge knife

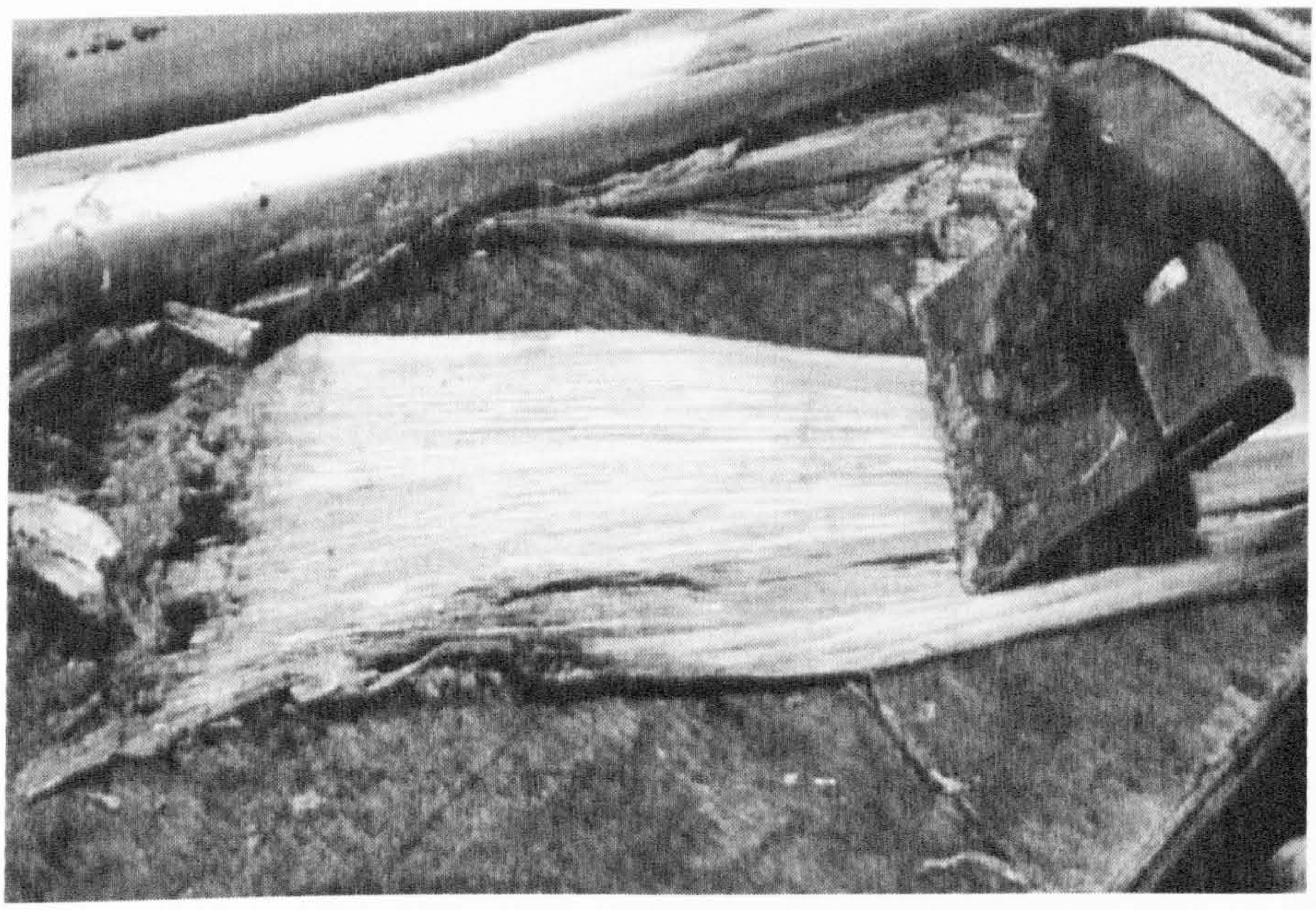

Figure 2.3: The extracted banana fiber is a lustrous raw material for papermaking

For the second method, banana fiber is extracted from banana tree bark. The trunk is peeled and brown-green skin is thrown away retaining the cleaner or white portion. The fibers are extracted through hand extraction machine composed of either serrated or non serrated knives. The peel will be clamped between the wood plank and knife and hand-pulled through, removing the resinous material. Finally the extracted fibers are sun-dried which whitens the fiber [7].

In the third method, the main stem of banana plant section were cut and then rolled lightly to remove the excessive moisture. Then, impurities in the rolled fiber such as pigments, broken fibers, coating of cellulose etc. were removed manually by means of a comb, and then the fibers were cleaned and dried [8].

2.3 Chemical Treatment

Although natural fibers have a number of advantages over glass fibers, the strong polar character of their surface is a limiting factor, as compatibility with strongly apolar thermoplastic matrix is very low. Such problems of incompatibility may be overcome with fiber pretreatments, which can enhance compatibility, albeit having a negative impact on the economics. When the treated fibers were incorporated into an epoxy matrix, mechanical characterization of the laminates revealed the importance of two types of interface: one between fiber bundles and the matrix and the other between the ultimate cells. In general, fiber treatments can significantly improve adhesion at the former interface and also lead to ingress of the matrix resin into the fibers, obstructing pull-out of the cells [9][10]. Two types of chemical treatment that are usually used are alkaline and acetylation.

2.3.1 Alkaline treatment

Banana is immersed in 6% NaOH solution for 2 hour at room temperature. After the alkaline treatment, the fiber then thoroughly washed by immersion in water tank, followed by running water. The material then filtered and dried at 80℃ for 24 hour. Alkali treatment have been proven effectively in removing impurities from the fiber, decreasing moisture sorption, and enabling mechanical bonding, and thereby improving matrix-reinforcement interaction [11].