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ALTERNATIVE FIBERS I: FEATHER FIBERS AND PEANUT HULL FIBERS

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***Abstract**: Even though various fibers are used today in textile production, researchers have started to search out alternative resources for natural fibers. Air, water and land pollution occurring because of overconsumption of fibers such as polyester, nylon, acrylic, polypropylene that are pretty much used in textile has created quite negative effects on the environment. For this reason, alternative environment-friendly fibers have been gaining importance in recent years.*

Alternative fibers are less known fiber types that exist in the forms of animal and cellulose fibers in nature. With some of their properties such as keeping warm, lightness etc., these fibers can be an alternative to the fibers used today. As these fibers decrease the burden of waste load thanks to their reuse, it is also possible to consider them significant for the protection of the environment. In this study, feather fibers and peanut hull fibers have been investigated and presents some information about obtaining, production and usage areas of these fibers by the method of literature review. At the end of the study, it has been concluded that the usage areas and production of these fibers should be increased.

***Key words:** Feather, Down fibers, Peanut Hull, Environment.*

1. INTRODUCTION

Even though there exist a lot of fibers in the form of textile fibers, the researchers have been working on plant or animal fibers that already exist in the natural environment. These fibers are composed of products found in nature and used in industries such as feed industry or those disposed directly. The reuse of these waste materials as fiber is also important in terms of less environment pollution. This study examines some fibers that are not commercially used by means of literature review method. In the first part of the study, the feather fibers obtained from the poultry have been examined. In the second section, the fibers obtained from peanut hull fibers and in the third section, the fibers obtained from the banana tree have been analyzed.

2. FEATHER FIBERS

Poultry processing industry produces approximately 2268 million tons feathers per year. The chicken feathers obtained in the processing plants can generally be reused by the feed industry. The sales value of the feathers obtained after processing amount to approximately 0.25 dollar per pound for the factories. As a fiber, on the other hand, this value can be between 0.5-2 dollars [1], [2].

Feather fibers, particularly goose down, are used as a filling material. As far as the structure of feather fibers is considered, it is possible to mention their potential usage areas include isolation, filtration and absorbent structures [3].

Though there exists a lot of fiber types in nature, all of them consist of β-keratinous [4]. What differentiates feathers from each other is the way they are formed. The feather types can be in seven different forms according to bird type or the position of the feather (Figure 1).

Fig. 1*: Feather types according to body structure of birds and the position of feather [5].*

Feathers are generally divided into two parts. One of the parts is pennaceous section that is more flat, stiff and thick while the other is plumulaceous section that is softer and thinner. Also, barb that branches from the main body as well as the feather and barbules that are linked to these barbs are the other parts that compose the feather (Figure 2) [1], [5]. Table 1 shows the physical features of pennaceous and plumulaceous sections.

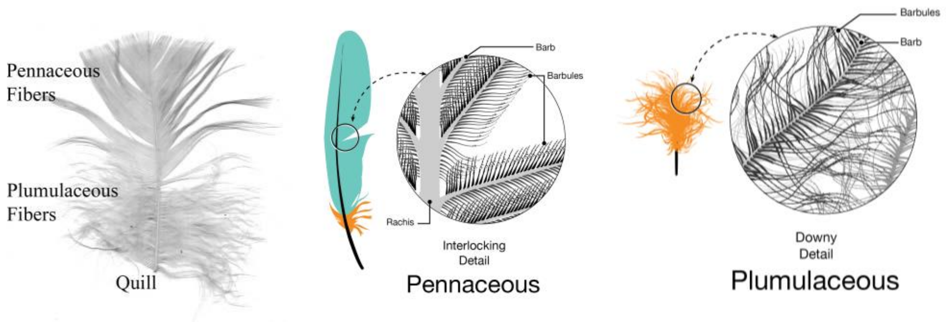

Fig 2: *Schematic display of pennaceous and plumulaceous sections, barb and barbules [1], [5].*

Table 1: *Linear density and mechanical properties of pennaceous and plumulaceous sections [1].*

Feather fiber	Maximum length (cm)	Average denier (g/9000m)	Average tenacity (g/den)	Average strain (%)	Average modules (g/den)
Plumulaceous	4.1	55.2	0.36	16.43	4.47
Pennaceous	5.2	142.0	0.83	7.96	15.55

In the studies, it was found out that the feather fibers were quite absorbent, flexible and light. They also have the property of increasing volume. These properties enable the fiber to become a valuable material for air filters. In addition, that the fibers are of 6-micron thinness makes their usage charming [1], [2], [6].

2.1 Goose Down

China is in the first place in the production of goose down with its export rate of 35.2% in the external trade of the world. The USA, on the other hand, is the leading importing country in the world with its import amount of 27.7%. Even though goose down is now known as a material used in clothing industry or as bed materials, it has been used for several purposes for ages. For instance, it was used as a writing tool in the western world from 6th to 16th century, and as a playing tool called “plectra” in string instruments such as qanun and lute [3].

Goose and similar birds have air absorbent fibers in their bodies. These special fibers provide them lightness and high heat absorbing feature [7]. Goose down is quite an interesting material and composed of multi barbs, each of which branches out from a central point. On each of these barbs, there exist thin fibers on which there are barbules (Figure 3). These barbules on the fibers enable thousands of fibers to be linked to each other and create a three-dimensional structure. Because of its magnificent filling performance and perfect insulation ability, goose downs are one of the mostly preferred filling materials in bedclothes, winter clothes, curtains and jackets [3], [4], [8].

When compared to wool, the surface of goose down is more hydrophobic and provides better thermal isolation in humid places. In thermal measurement, it was seen that goose down displayed better isolation than wool, cotton and polyester (PET) [8]. In a study, the young’s modulus was measured as 1.31 GPa for goose down and 2.21 GPa for duck down. On the other hand, their flexibility is not as good as that of wool, they break at approximately 12% extension [4].

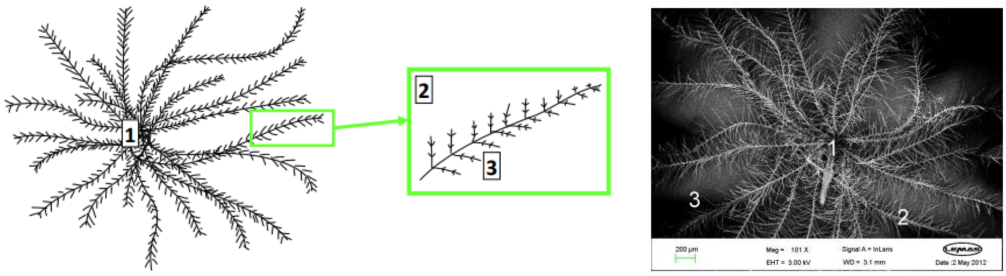

Fig 3: *Parts of goose down and appearance of goose down in electron microscope. 1- goose down core, 2-barb, 3-barbules with prongs [4].*

Feathers obtained from various parts of goose have different values in terms of economy. The feathers obtained from the chest of down are the most valuable one. The feathers collected from its wing and tail parts are shag and have less commercial value [9]. In addition, feathers of down, goose, mallard and swan are divided into two colors: white and grey [8].

2.2. Turkey and Chicken Feather Fibers

Even though chicken feather fibers are more easily found, turkey feathers are more suitable fibers for textile production because they are longer [10]. Chicken and turkey feathers are generally used in yarns, nonwoven and composite structures. While yarns are uses by being blended with synthetic yarns, surfaces are obtained alone or by being blended in nonwoven sector [11-13].

The amount of chicken feathers, which is the by-product of chicken meat production, is approximately 15 million tons each year throughout the world. Chicken feathers have a unique structure and properties that do not exist in natural or synthetic fibers. Because of their complex structure, chicken feathers cannot be processed as wool or silk. However, their barb and barbules sections make them suitable to be used as natural protein fibers. Chicken feathers' low density, perfect compressibility and flexibility, sound reducing ability, heat absorbing and distinguishing morphological structure make them unique. For instance, while the density of the chicken feathers is 0.8 g/cm^3, it is about 1.5 g / cm^3 for cellulose and about 1.3 g / cm^3 for wool. These unique features of chicken feather enable them to be preferred by the automotive industry for many applications such as textile and composites.

In order to obtain chicken feather fibers, it is required to separate barb parts from more rigid and thick parts called rachis. For this separation procedure, Gassner and his friends took patent [15]. Barb length of chicken feathers is approximately 0.3-1.3 cm, but this is not enough to produce a yarn. The chicken feathers can be used in the production of nonwoven and composite surface. They can also be used in such areas as automotive, construction, packaging, filter, isolation material, erosion control, winter outdoors clothing [2, 13-16].

Ye and Broughton [2] compared the isolation properties of nonwoven fabrics made from chicken feather, down feather and polyester fiber. In the study, chicken feather fiber was turned into nonwoven surface by having been blended with other fibers. At the end of the study, it was found out that chicken feather fiber provide better isolation than polyester and goose down fibers. Bessa et al. [16] examined thermal and acoustic isolation properties of chicken feather supported composites. The composite structure was obtained with chicken feather fibers and thermoset resin like epoxy. Blending the epoxy resin with the chicken feather in three different amounts (80-20, 70-30 and 60-40), composite structures were created. With the increase in the chicken feather amount, thermal resistance increased proportionately. It was also mentioned that these materials could be used in sound isolation for supporting purposes. Experimental results showed that the chicken feather fibers had high potential to be used as supporters in the production of composite materials.

As turkey feathers and the feathers of the plumulaceous section is very light and the feathers at pennaceous part is very stiff, they are not alone suitable for yarn production. It becomes possible to produce yarn by blending them with other types of fibers. In the study carried out by Evazynajad and George [12], turkey feathers were turned into yarns by having been blended with nylon in different amounts. At the end of the study, it was found out that as turkey feather amount of the yarn increases, its tenacity and elongation increase while its young's modulus decreases. It was also concluded that the obtained yarns did not have the required properties to produce clothes, but could be more suitable to be used in technical textile applications such as filtration. In another study carried out by Evazynajad et. al. [11], knit fabric was produced after turning the turkey feathers into yarns. After that, thermal insulation values of this fabric were evaluated, and it was seen that the increase in turkey feather fiber amount affected thermal insulation values positively.

In a study carried out by George et. al. [10], turkey feathers were used to produce erosion preventing nonwoven surface. In this study, an erosion-preventing nonwoven surface was obtained by using the turkey feathers and these surfaces were compared with jute and coir fibers that are commercially sold. Even though the fabrics obtained from the turkey feathers were weaker than other fabrics, they displayed similar results in terms of water and light permeability and erosion prevention. In addition, the turkey feather fabrics increased humidity amount in land.

3. PEANUT HULL FIBERS

Peanut is one of the most important foods produced in the USA. The body of the peanut is composed of cellulosic fiber layer. Most studies on peanut have usually focused on the separation of fiber from the hull and producing erosion preventing nonwoven fabrics [1].

The fibers range in length from 0.64 centimeters (cm) to 6.4 cm (Figure 4). Its average tensile strength is lower than many textile fibers. As the peanut is fairly stiff, it becomes difficult to process them, which subsequently makes it hard to card them effectively or punch them with needle in the production of a nonwoven fabric.

Peanut fibers should be separated from their hulls in the first place. With the machine patented in 1982, the fibers are milled from the plant bodies by the rod mill and thus the fibers are separated. This separation results in two separate fibers from the outer and inner parts of the hull.
Inner fibers are shorter than external ones [1], [17].

Some researchers have made a fiber spun by using the peanut hull. In one of these studies, Merrifield and Pomes [18] obtained regenerated fiber, whose trade name is Serelon, from the peanut hull in 1946. The hand feeling of the obtained fibers and their thermal properties were at desired values. These fibers can be dyed with acid, vat, direct and acetate dyes. As with all synthetic protein fibers, the weak point of these fibers is their low strength.

Imperial Chemical Industries (ICI) made a fiber spun from the peanut hull, whose commercial name was Ardil. This fiber was used in clothing, curtains and carpets. Due to its low wet strength compared to wool and its high price, its production ended in 1957 [19].

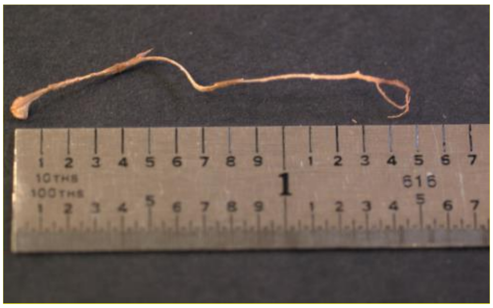

Fig 4: *The average peanut fiber length [17].*

4. CONCLUSIONS

As environmental problems increase day by day, efforts to reduce plastic based production have gained importance. Therefore, the use of alternative fibers will most likely expand. In this literature study, feather and peanut hull fibers were examined. In the light of the obtained data, it can be concluded that these fibers can be an alternative to conventional fibers and can be used commercially. As increasing the usage of these fibers will decrease waste load, they are considered important for the environment.

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