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Determination The Density of Various Luxury Fibers From Different Origins in The Presence of Surface Active Agent Instead of Using Organic Solvents

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Abstract – Using pure water in the determination of the fiber density is a well-known technique and a simple method. But, it is known that using water in the determination of textile fibers is not sufficient. Thus, the aim of this study is to produce a simple technique in determination of the textile fibers by adding a wetting agent in the pure water. For this aim, 6 different scoured protein fibers (one from sheep origin, one from goat origin (mohair), one from rabbit origin (angora) and three from camelid origin (camel, Huacaya Alpaca and Suri Alpaca)) were investigated. In order to measure the volumes of the 2 grams of fibers, three different solvents (pure water, a wetting agent added pure water and toluene) were used. The results of the study showed that pure water is not a sufficient solvent in the determination of the protein fiber's density since water only by itself is not enough to wet the fibers and replace the air gaps with water. Adding a wetting agent gave a little bit better results compared to the pure water. However, toluene as expected gave the best results compared to the previous studies.

Keywords –*Protein fibers, density, pure water, wetting agent, toluene.*

I. INTRODUCTION

Density is the measure of the "compactness" of a material. It can be calculated from the ratio of mass to volume [1];

$$d = \frac{m}{V}(g/cm^3) \qquad (1)$$

Mass is usually expressed in grams,

Volume is usually expressed in cm^3 or liters, etc.

On the other hand, density in the textile fibers is defined in two different ways.

• Volumetric Density: The ratio of the mass of an object to the mass of the same volume of water. The volumetric density of the textile fibers is usually greater than 1.

• Linear Density: The weight of unit length of textile fiber is the linear density. The weight of the unit length of the textile fibers and yarns is given with the numbering systems [2].

Fiber density plays a direct part in affecting the weight of fabrics, so that glass fabrics, with a fiber density of 2.56, will tend to be heavy, whereas those of polyethylene, with a density of 0.92 will be light. Fiber density is a useful parameter in fabric identification and occurs incidentally in many parts of textile physics. There are mainly three methods to determine the fiber density [1];

- Simple method: In this method, the mass of the fiber on a balance is firstly measured. Then the Measuring Cylinder is filled with liquid to a known volume and the fiber is put inside. Volume of liquid that is displaced is determined. Displacement of the level of liquid in a measuring cylinder equals the volume of the added fibers. Although this method is the easiest, two fundamental forces of error are immediately obvious in this method [1];

- Firstly, the liquid may not displace all the air particularly from crevices in the fiber surface. This means that the measured volume will be too high and the density too low.

- Secondly, the liquid may be absorbed by the fibers, which results in a smaller displacement of the liquid level. This would give ta very low volume value and a too high density.

It is now generally accepted that the best values of density are obtained with a large number of organic liquids such as nitrobenzene, olive oil, toluene, benzene and carbon tetrachloride (CTC).

- **Floatation method:** This method was developed by Abbott and Goodings. This method is preferred for single fiber or small bundles of fibers. If the chopped-up fibers are placed in a liquid (or a mixture of liquids) of the same density as the fibers, and then are centrifuged in a tube, they remain as a uniform cloud. If the densities are different, they will be accumulated into a single group, which floated if the fiber density is the lower and sank if it is the greater. By a process of trial and error, the correct density can be calculated [1].

- **Density gradient tube method:** In this method a long tube called density gradient tube containing a heavy liquid (e.g. pentacholoethane, 1.7 g/cm^3) at the bottom, a light liquid (e.g. xylol, 0.9 g/cm^3) at the top, and a continuously varying mixture of the two between them is used. If the fibers dropped in, they sink to the point at which the fiber density equals the liquid density and remain suspended there. Calibration of the tube may be provided either by means of pieces of different materials of known densities floating at their appropriate levels or by hollow glass spheres of varying mean density. The fiber density can be found by interpolation between the known densities on either side of the position at which the fibers come to rest [1].

As explained above, in simple method, analysis only with water is far from accuracy in the determination of density of fibers. Since water alone is not enough to remove air from the fibers. It is stated that organic solvents have more successful results. The aim of this study is to determine the effect of adding surfactants to the success of the obtained results in the determination of the density of wool and various luxurious fibers by simple method.

II. Materials and Method

In the experiments, 6 different scoured protein fibers (one from sheep origin, one from goat origin (mohair), one from rabbit origin (angora) and three from camelid origin (camel, Huacaya Alpaca and Suri Alpaca)) were investigated. Merino wool was supplied from YUNSA INC-Turkey. Mohair (originating from Argentina), angora (originating from Turkey) and camel (originating from Mongolia) fibers were provided by processors. Huacaya and Suri alpaca fibers were supplied from Alpacas de la Tierruca-Spain. All fibers used in the experiments were white in color except camel hair which was brown.

All the fibers used in the study were conditioned for 24 hours in order to stabilize the humidity values. After conditioning, 2 grams of each fiber were measured. Then, the volumes of the fibers were determined by using 50 mL's of 3 different solvents. The solvents used in the study were as follows;

a) only pure water
b) pure water containing 2 g/L non-ionic/anionic wetting agent
c) organic solvent (toluene)

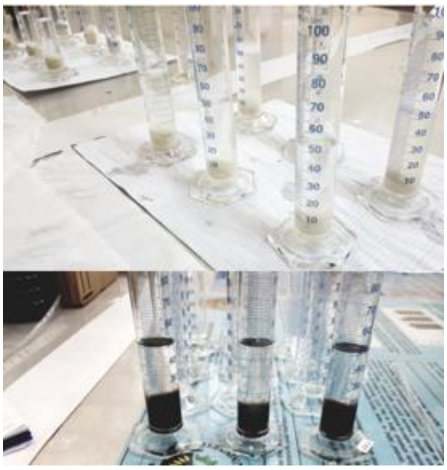

Figure 1: Volume measurements

III. Results and Discussion

The results of the measured density values of the fibers with regard to 3 different solvents were given in Table 1. The experiments were performed with two repetitions and the average values of the densities were given in the third columns of each solvents. In Table 2, the results of the densities of the related fibers measured in other studies were given.

Table 1: Measured density values of the fibers with regard to different solvents

	Pure Water			Wetting Agent			Toluene		
Wool	0,8	1	0,90	1	1,33	1,17	1,33	1,33	1,33
Mohair	0,8	1	0,90	1	1	1,00	1,33	1,33	1,33
Angora	0,8	0,8	0,80	1	1	1,00	1	1,33	1,22
Camel	0,8	1	0,90	1	1	1,00	1	1	1,00
Huacaya	1	1	1,00	1	1,33	1,17	1	1,33	1,17
Suri Alpaka	1	1	1,00	1	1,33	1,17	1	1,33	1,17
Huarizo	1	1	1,00	1	1,33	1,17	1	1,33	1,17

Table 2: Measured density values of the fibers in other studies

Wool	Mohair	Angora	Camel	Alpaca
1,30 (3) 1,30-1,39 (4) 1,31 (5) 1,3-1,31 (6)	1,32 (7) 1,27-1,31 (8)	1,10 (9) 1,15- 1,18 (10)	1,32 (11)	1,309 (12)

As it is seen from Table 1, the measured results of the densities with using pure water was a little bit deviant from the results of the previous studies given in Table 2. By using water, changing the fiber type did not affect the results of the densities. As it is seen, the density results of different fibers by using pure water were almost the same. This is because the liquid may not displace all the air particularly from crevices in the fiber surface. This means that the measured volume will be too high and the density too low. Adding wetting agent to the pure water in measuring the volume of the fibers however increased the measuring performance. When the obtained results were analyzed in detail, adding wetting agent caused water to displace the air particularly from crevices in the fiber surface. Thus, the measured volume would be a little lower than the one measured with pure water and the density calculated was a little bit higher compared to the ones obtained by using pure water. The results obtained by using toluene were almost similar with the ones determined in the previous studies. Toluene, as it was mentioned in the introduction part, is a well-known solvent used in determination of the fiber density, but it is ecologically hazardous.

IV. Conclusion

Using pure water in the determination of the fiber density, unfortunately did not give the desired values as expected. However, the aim of this study is to produce a simple technique in determination of the textile fiber's density. Thus, adding a wetting agent into the pure water is a really simple technique in the determination of the fiber density. As it is well-known, in the simple method unfortunately pure water may not displace all the air particularly from crevices in the fiber surface. As a result, the measured volume would be too high, and the density calculated would be too low. In order to overcome this handicap, wetting agent was added in water to decrease the surface tension of water. Using a lower surface tension of water would wet effectively the fibers. However, the results obtained during the study showed that although adding a wetting agent gave a little bit better results compared to the pure water, the wetting agent was not proper. For this reason, it would be better to use density gradient tube method which gives precise results.

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