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Dyeing of Angora Rabbit Fibers

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Abstract Angora rabbit fibers are exceptionally soft and lustrous fibers. The Angora rabbit is a very old breed of rabbit, believed to have originated in Turkey in the town of Angora. As these fibers are also protein based, dyeing characteristics are similar to wool. All recipes for dyeing sheep wool can be used for angora, too. But angora should be dyed at lower temperatures and it should not be boiled. In this review article, knowledge about the dyeing properties of Angora rabbit fibers are given and recent studies on angora dyeing are summarized.

Keywords: *Angora, rabbit, fiber, dyeing*

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1. Introduction

Angora fibers are exceptionally soft and lustrous fibers. They are found in limited regions around the world. The fibers are also produced in small quantities. The combination of these factors makes the finished products very expensive. These fibers provide high status to people having them in their clothes. Since synthetic fibers do not have the same potential, angora fibers are called "Luxury Fibers" [1].

The Angora rabbit (*Oryctolagus cuniculus*) is raised solely for its fine and soft hair, unlike other breeds which are produced for their meat and fur [2]. The Angora rabbit is a very old breed of rabbit, believed to have originated in Turkey in the town of Angora. Angora production is truly an international industry. Until 1965, France was the leading producer, with the world market now being dominated by Chinese produced fiber. China now provides in excess of 90% of the trade Angora fiber. The other producers are France, Chile, Argentina, Hungary, Germany, Finland and India [3]. Angora fiber production is the third largest animal fiber industry in the world after wool and mohair. China dominates the world Angora fiber trade by producing approximately 90% of the world Angora fiber [4].

Angora rabbit fiber is considered one of the world's finest luxury fibers with the values of 10 to 12 micron in diameter and 40 to 70 mm in length. Despite this fineness, the angora fiber possesses cavities in which air is occluded. It is these air occlusions that give angora its characteristic properties, namely its high thermal insulation and its extreme lightness in weight [4]. These fibers are used in the production of inner and outer garments (hats, sweaters, blankets, etc.) either alone, as well as by blending with other fibers (particularly with fine wool), due to being quite light and having high heat retention capacity [5].

2. Dyeing of Angora Rabbit Fibers

As these fibers are also protein based, dyeing characteristics are similar to wool. In general, except from the dyes used for special and aesthetic purposes, acid, 1:2 metal complex and partially reactive dyes are of great importance in angora dyeing [6].

Atav and Yurdakul compared the dyeing properties of angora fibers (16.82 micron) with sheep wool (28.04 micron). It was found that angora absorbed dye more slowly compared to sheep wool especially at the beginning stage of dyeing especially for levelling and half-milling acid dyes. Furthermore, it was observed that angora fibers had uptaken more dye then wool at equilibrium. However, when the color yield values were examined it was determined that its color was lighter. The reason for this was that the angora fibers used in the experiments were finer compared to wool. Consequently, the reason that angora uptakes higher amounts of dye is not that the fiber has higher potential of dye up-take, but that it has a higher total surface area. In the study, also washing and light fastness values of dyed samples were compared. It was stated that for washing fastness values there weren't important difference, but light fastness values of angora were a little bit lower due to its lighter color [7].

Yurdakul et al. investigated the equalizing effect of β-cyclodextrins in dyeing of wool and luxury fibers (mohair and angora) with acid dyes. In the study, firstly the interactions between β-CD and acid dyes were investigated spectrophotometrically. Although there were changes in the spectrums of C.I. Acid Blue 120 in the presence of β-CD, the spectrum of C.I. Acid Red 42 did not change. From the experimental results it was determined that the β-cyclodextrin showed a retarding and equalizing effect in dyeing carried out with the dyes that show interaction with β-CD. Furthermore, it was seen that

retarding effect of β-CD was increased as the usage amount increased from 2% to 10%. According to these results it was concluded that β-CD can be used as an equalizing agent in the dyeing processes performed with acid dyes [8].

Chemical structure of angora fibers has some similarities with the other animal fibers, but because of their more sensitive structure, during the processes like washing, bleaching and dyeing, these fibers must be proceeded cautiously [5]. All recipes for dyeing sheep wool with can be used for angora, too. But angora should be dyed at lower temperatures and it should not be boiled. It is important that the yarn is processed gently - no squeezing, no wringing and no temperature shock [9]. For this reason, it is very important to dye angora fibers at lower temperatures below the boil and to limit the time of dyeing at high temperatures, so as to curtail any adverse effects on fiber properties, but in the case of low temperature dyeing, dye-uptake and color yield of samples will decrease and also effluent load will increase as a result of increasing the amount of dye remaining in the liquor. It is not a desired situation in dyeing [6].

In previous studies it was observed that reducing dyeing temperature causes an important decrease in exhaustion of dyes having big molecules, while it approximately does not affect the exhaustion of dyes having small molecules such as leveling acid dyes. Leveling acid dyes have small molecules and they do not need high energy for diffusion, for this reason they can be exhausted by fiber also in lower temperatures than boiling point. As a result, it can be suggested that acid dyes with low molecular weight should be preferred for preventing color yield losses at low temperature dyeing process, but it will not be a good solution when high wet fastness values are desired as these dyes have fairly low wet fastness properties [6]. If it would be possible to increase wet fastness properties of leveling acid dyes after dyeing angora fibers with them below boiling temperature without taking any precaution, the low temperature dyeing of angora fibers could easily be achieved. For this aim ***Atav and Yurdakul*** investigated the effects of fixing agents on wet fastness properties of samples dyed with leveling acid dyes at low temperatures. Angora fibers were dyed with leveling acid dye (C.I. Acid Blue 204) at 70°C and then treated with anionic and cationic fixing agents in different concentrations. According to the experimental results, it was determined that it is not possible to improve wet fastness values of angora fibers dyed with leveling acid dyes by using fixing agents [10]. So it is possible to say that if low temperature dyeing can be achieved with dyes having big molecules (such as milling acid dye, 1:2 metal complex dyes etc.) without causing any decrease in color yield, it would result in improved dyeing characteristics, such as wet fastness, of the final product [6].

Due to the leveling capabilities of milling acid dyes having large molecules are low; pH of the dyeing liquor should be set to weak acidic condition in order to ensure the dye-uptake of fibers during the dyeing process to be slowly. However, when dyeing process is carried out at low temperature, the kinetic energy of dye molecules will already be reduced, the risk of dye molecules to be up-taken fast and unevenly will decrease. With the idea of adjusting pH to strong acidic medium, which is normally risky, will not cause major problems in dyeing of angora fibers carried out at low temperature, ***Atav and Yurdakul*** examined the effect of decreased pH for lowering the dyeing temperature without causing any decrease in color yield of dyed samples. From experimental results it can be concluded that it is possible to dye angora fibers at pH 3 and 90°C without causing any decrease in color yield compared to the dyeing carried out at pH 6 and boiling temperature [11].

Akçakoca et al. investigated the effects of proteases on dyeing properties of four different protein based textile materials (sheep, goat and Angora rabbit wools and silk). According to the experimental results, it was observed that these protein based fibers could be dyed evenly with high light and washing fastnesses by using sumac as a natural dye. Furthermore it was found that the enzymatic treatment before dyeing did not have an important effect on the dyeing results of sheep wool, goat wool and silk, but for angora wool the color yield of dyed samples increased approximately 20-30% according to the enzyme type. Moreover in this study, in the light of these results angora fibers, treated and untreated with enzymes, were dyed with tannin based plants like myrabolan fruit, oak bark and gall nut, and it was found that the enzymatic treatment has increased the dye-uptake significantly [12].

Atav and Yurdakul aimed to improve the dyeability of mohair and angora fibers via dendrimer application. According to the experimental results, it was found that dendrimer applied mohair and angora fibers could be dyed darker than the un-treated fibers and optimum conditions of dendrimer application was found to be pH 4, 2% conc., 30 min. and 50°C [13].

Perincek et al. investigated the effect of ozonation process on whiteness and dyeability of Angora rabbit fiber. The results showed that the ozonation process produced a significant increase in the cysteic acid signal at 1040 cm^{-1} in the FT-IR spectra of the ozonated angora. The ozonation modified the angora surface as indicated by the increase in cysteic acid signal intensities. This was attributed to the reduction in the disulphide bonds. Furthermore it was determined that ozonation treatment increased the color yields during dyeing with milling acid dye (C.I. Acid Blue 120). With SEM analysis it was shown that the epicuticule layer became thinner compared to the untreated one, and so the dye uptake became easier [14].

Atav and Yurdakul in their study focused on the use of ozonation in order to achieve dyeability of the angora fibers at lower temperatures without causing any decrease in dye exhaustion by modifying the fiber surfaces. The study was carried out with known concentration of ozone, involving process parameters such as wet pick-up (WP), pH and treatment time. The effect of fiber ozonation was assessed in terms of color and test samples were also evaluated using scanning electron microscopy (SEM). The optimum conditions of ozonation process were determined as WP 60%, pH 7 and 40 min. According to the experimental results it can be concluded that, ozonated angora fibers can be dyed at 90°C both with acid and reactive dye classes without causing any decrease in color yield [15].

Atav and Yurdakul searched the effect of the use of fiber protecting agent on preserving angora fiber during dyeing treatments carried out at boiling point. Furthermore the effect of dye class on fiber damage during dyeing was

also determined. Alkali solubility results of samples dyed with different dye classes (milling acid dye (C.I. Acid Blue 120), monofunctional reactive dye (C.I. Reactive Red 66) and bifunctional reactive dye (C.I. Reactive Black 5)) at 80 and 100°C in the presence and absence of fiber protecting agent was investigated. According to the experimental results, in dyeing process at 100°C by adding fiber protecting agent into the liquor, degree of fiber damage decreased and reached to the damage value of fiber dyed at 80ºC. Furthermore, it can be concluded that bifunctional reactive dye usage is advantageous for the aim of fiber protecting during dyeing [16].

3. Conclusions

Angora fiber is considered one of the world's finest luxury fibers having prices approx. 30 $/kg. When the costs of these fibers are compared with wool, it can be understood that these fibers are quite more expensive. For that reason angora is a valuable fiber. The most important step which increases the added value of textile product is the finishing process. In finishing processes of angora fibers, there are some problems especially in dyeing step. During dyeing process carried out at boiling temperature, some properties of these fibers (softness, strength etc.) can be damaged. For that reason they should be dyed at lower temperatures, but in order to achieve this without causing any decrease in dyeing efficiency, some precautions should be taken.

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