ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

ECOLOGICAL METHOD OF WOOL WASHING

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Abstract: *The textile industry is considered a polluting industry due to the use of chemicals in production and excessive use of energy and water, plus the generation of toxic waste. In present, the significance of environmental pollution and related problems in the world had led to development and application of environmental friendly production methods that less polluted environment.Wool fibers are subjected to a number of water-based treatments that pollutes the environment. In a desire to make the wool industry to become more sustainable, this paper reports an ecological wool washing method by using three alkaline solutions based on ash obtained from burning wood type beech/oak/hornbeam and water. The mixture solutions used for manually wool washing has different concentration of lye (10% to 30%) and pH, respectively. The higher the pH of the alkaline solution, the more impurities are removed.The optical images of washed wool fibers presented in the paper show no damage on surface structure. Wastewater collected after wool washing was used as natural fertiliser for watering seeds of grass. Some measurements on blades of grass were done to see the effect of wastewater. The number of grass blades/unit area, average lenght and the uniformity regarding the lenght increased when watering was done with wastewater.*

Key words: *wool, alkaline solution, ash, pH, washing, blades of grass*

1. INTRODUCTION

The sheep farming for wool, meat, milk and skins dates back many years and form an important component of rural economy. For the rural population, wool, a valuable natural fiber has been the raw material for textile purposes. Also, the sheep provided a dependable source of income to the shepherds through sale of wool and animal.

The textile industry is the one of environmental polluting agents as a result of the large chemicals amounts employed for its production and the excessive use of energy and water.

Wool fibers are subjected to a number of water-based treatments, such as scouring, bleaching, carbonizationand functional finishing [1,2]. Therefore, wool production has been constrained not only by its poor environmental performance related to sheep grazing but also the polluting fiber industrial processing [3,4].

In the world, the significance of environmental pollution led the industrial companies and scientific enterprises to research alternative wool clean production methods. Thus, these methods should involve low energy consumption that pollute the environment less by releasing less wastewater and by using less chemical materials and water.

In recent times, wool production in Romania has declined considerably and shepherds have mainly limited themselves to breeding the Turcana breed, characterized by rusticity, mobility and resistance to environmental conditions.

Between 2017-2020, in Romania, has been collected over 15000 tonnes/year (80% wool from Turcana breed) by some collection centers at a low price [5]. But a large wool quantity is unused and polluting the environment by landfill or burned At present, wool can be regarded as renewable resource with various engineering/technical applications like thermal and acoustic insulation material, as reinforcement fiber in polymer-fiber composites, adsorbents for heavy metals [6], short-term geotextile for steep slopes protection [7] or as fertiliser [8].

Turcana body conformation is dolicomorphic, mixed wool, thin and thick, conical strand, having different distribution on the body (see Fig. 1).

Fig. 1.Sheep Turcana breed

During the growth, the wool coat it becomes coated with grease (lanolin wax), sweat salts and contaminated with dirt, dust, dung and vegetable matter (burrs, seeds, twigs and straw) [9,10]. These impurities, which may be up to 40% (or more) by weight, must be washed off before the wool can be used as a textile fibre and therefore wool scouring is an important process that is carried out on a large scale [11].

Plant and mineral impurities are products that, if recovered, could be used as an agricultural bio-fertiliser: as fertilisers (mineral ones) and the vegetal ones can be dry naturally and the briquette for own use, at the sheepfold.

The main purpose of raw wool scouring is to remove the wool contaminants at maximum efficiency, with efficient energy utilisation and with minimum impact on the environment. Therefore, in this paper, we report a wool ecological washing method by using an alkaline solution based on water and ash. Finally, the potential of resulting solution after wool washing as grass fertilizer has been reported.

2. MATERIALS AND METHODS

2.1 Materials

Raw wool of Turcana breed and contamined with impurities (suit &dirt, vegetable matter, lanolin wax) has been subjected washing (see Fig. 2).

The components of alkaline washing solution were (i) ash obtained from burning wood type beech/oak/hornbeam (see Fig. 3) and (ii) tap water. Ash is composed of non-combustible inorganic substances such as mineral salts.

Fig. 2. Unwashed Turcana wool

Fig. 3. Ash

2.2 Methods

In order to obtain lye/alkaline solution, ash and tap water (pH 7.5, Voltcraft PHT-01 ATC pH Meter) were boiled for 3 hours and then allowed to cool for 24 hours. The pH of the resulting solution was 12.35.

The wool mass before and after washing was measured in grams using a Kern weighing scale.

Three mixtures solutions having different concentration of lye (10% to 30% lye) have been used for raw wool washing. Addidionaly, tap water up to 100% has been used to obtain final washing alkaline solution. The washing alkaline solution temperature was 21^0C. The details of composition and pH of mixtures coded as A1, A2 and A3 are shown in Table 1.

Table 1: Components of alkaline solution

Solution code	Composition of washing solution, lye/water (%)	pH of alkaline washing solution
A1	10/90	9.8
A2	20/80	9.9
A3	30/70	10.0

Wool washing was done manually through agitation in containers full with alkaline solution heated to a temperature of 55^0C (added water from final alkaline solutioniswas heated to above the melting point of wool grease, which is about 40°C). After 24 hours, the wool was manually squeezed (mechanical damage of wool fiber to be minimal) and dryed. The wool drying has been performed naturally, on upright supports exposed to sun.

The efficiency of the scouring/washing process can be determined by different analyses [12]. In this study, the effect of washing on the surface morphology of wool fibers was done via Optika microscope with optical camera B5 to a 50x and 20x, respectively magnification degree.

Wastewater was collected for reuse as natural fertilizer for watering grass seeds.

In order to observe the effect of wastewater on grass seeds, two seedling boxes having a surface area of 290 cm^2 each has been used. Sowing was done manually using the same type of soil and amount of seeds, respectively.

The seeds in one box coded S1 were watered with wastewater while the seeds from the other box coded S2 watering have been done with tap water.

The orientation of the boxes was north-south, with south at window. The watering conditions and period were the same for both cases studied.

3. RESULTS AND DISCUSSION

The efficiency of washing (R) was calculated acording to the relation:

$$R = \frac{Q_{ww}}{Qrw} \times 100(\%) \quad \textbf{(1)}$$

where Qww – washed wool quantity/mass in g, Qrw – raw wool quantity/mass in g.

Table 2 shows the experimental average values of quantity of raw wool and washed wool, respectively and also the washing efficiency for three expriments of washed wool in conjunction with alkaline washing solutions.

Table 2: Experimental average values

Experiment	pH of alkaline washing solution	Qrw (g)	Qww (g)	R (%)
I	9.8	50	46	92
II	9.9	50	45	90
III	10.0	50	41	82

The values from Table 2 reveals that as the pH of the alkaline solution increases the mass of washed wool decreases compared to raw wool mass. This means that more impurities (dirt, greases) have been removed from the raw wool which leads to cleaner wool even if R (%) value decrease.

Particles of dirt were removed from the fibre by: (i) agitation of the solution and (ii) being washed away with the grease droplets.

Wool is a relatively weak fibre, compared to other staple fibres. During washing, wool experiences various adverse conditions which can lead to fibre damage. One possible source of fibre damage could be pH of washing solution. A value of pH>9.5 will cause yellowing and damage to the fibre [9].

Microscopic images of wool fibers before and after washing are indicated in Fig. 3 and Fig. 4.

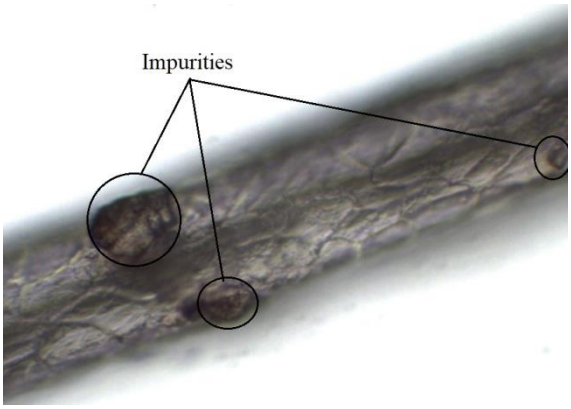

Fig.3. Microscopic image of unwashed wool fiber (50x magnification degree)

Fig.4. Microscopic image of washed wool fiber (30% lye/ 20x magnification degree)

The image in Figures 4 shows the effect of washing, evidencing the fact that washed fibers are not damage by the alkaline solution, have less grease droplets and brighter (slightly whitening of fibers) then raw fibers.

At 7 days after sowing in those two seedling boxes, measurements were done on the number, average length at ground level as well as the density/cm^2 of grass blades which are given in Table 3.

Table 3: Experimental data regarding blades of grass

Characteristic/ Box code	S1	S2
Surface (cm^2)	290	290
Blades of grass number/unit surface	381	331
Density (blades of grass/cm^2)	1.32	1.13
Average length (cm)	13.33	12.88
Length coefficient of variation (%)	21.3	24.9

Table 3 shows an increasing of 13.1% regarding blades of grass number in the experiment coded S1 compared to S2. Also, blades of grass average length and uniformity increased by 3.4% and 14.5%, respectively, when watering with wastewater compared to watering with clean water.

4. CONCLUSIONS

Wool washing can be done ecologically, without large investments, by using the ash resulting from the burning of the wood and water.Three final alkaline solutions with different percentage of lye and pH, respectively has been used to wash raw wool contamined with impurities.

The higher the pH alkaline solution, the more impurities were removed.

Microscopic images of washed wool fibers revealed the fact that fibers are not damage during washing regarding surface structure and are cleaner then raw wool.

In order to protect the environment, the wastewater resulting from the wool washing can be reused in the agricultural or household field for watering the pastures and lawn, respectively. In addition, the soil (sludge) in the washing solution and dried naturally can be used as a mineral fertilizer.

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