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Natural Eco-Friendly Alternatives to the Existing Wool Scouring

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Abstract—*The conventional detergent oriented raw wool scouring is the most pollution causing process in the mills contributing to 75% of the total BOD load in effluent. The work done by using Cow Urine (Gomutra), a natural ecofriendly scouring, has changed the concept of scouring from chemical and pollution oriented one, to a chemical free, eco friendly process with other advantages. Also chemical scouring process for the wool fibers use alkali and detergents which create degradation in mechanical properties and yellowing of wool fibers, along with environment problems. Therefore our work can be an alternative process to replace chemical scouring process by ecofriendly scouring. In our research cow urine was used as alkali medium with an optimized value of 150gpl along with natural detergent Sapindus Saponaria (reetha) of 20 gpl, in five bowl system.*

It was observed that using this optimize recipe effluent load was reduced by 40% as compared to chemical scouring, without hampering the other desired mechanical properties of Wool. The other benefits of this scouring were to reduce the processing temperature and better grease removal.

Keywords: *cow urine, eco-friendly, reetha, wool scouring*

1. INTRODUCTION

Wool scouring is the process of washing wool in hot water and detergent to remove the non-wool contaminants and then drying it. It has always been an important step in the wool processing. A growing concern for the environment has led to increased demands on the scouring process as reduction in pollution has become increasingly important as the pollution load associated with conventional emulsion scouring of greasy wool is extremely high[1,2]

The Emulsification of grease on the surface of fiber in aqueous scouring is the most important movement of scouring liquor act to remove contaminates from wool. Aqueous scouring is usually carried out under conditions of high temperature 55± 3^0C and high detergent concentrations [3, 4].

The use of high amount of chemicals and detergents in the conventional methods of wool scouring generates serious consequences both for the environment and the industry while effluent treatment and disposal. Moreover, conventional mechanical scouring can result in poor whiteness and a higher level of residual dirt [5, 6].

Natural Cow urine and ritha scouring of wool has the potential to save water and energy, improves product quality and reduces the time and use of chemicals. Cow urine works as an alkaline medium for wool scouring while the Ritha work as detergent. The Cow urine mainly contain the Urea [7,8] that help the wool fiber to swell and the ammonia present in the urine help to maintain the pH of 8-9, along with the enzyme present in the urine help to break the bonding between the wool fiber surface and grease. Ritha work as detergent and take out the loosen grease along with.

In this work the effect of cow urine and ritha solution was studied in terms of scouring efficiency i.e. residual grease content along with effect on effluent load of scoured liquor.

2. MATERIAL AND METHODS

Material

The raw greasy merino wool was procured from Raymond Pvt. Ltd, Vapi, India, and was used for all scouring experiments. The natural chemicals used were Cow Urine and ritha solution. While conventional chemical sodium carbonate and sodium oleate were used for scouring of merino wool. Ethanol (LR grade) was used for soxhlet extraction. The scouring bath ratio of 1: 30 was used for all the treatment.

Methods

Current process of wool scouring is an aqueous process which uses five bowls for washing wool. Combination of detergent and alkali like sodium carbonate 3gm/L and sodium oleate 1 gm/L at 55-600C for 3-5 min are the standard process for scouring as per IWTO method. In order to study the efficacy of cow urine and ritha solution, the wool scouring recipe was optimized with different trials as shown in Table 1. Different experimental combinations were used for process optimization.

Cow Urine

Fresh cow urine was used for treatment and the urine obtained was from the same cow.

Ritha Solution

A 100 gm ritha powder mixed in 1000ml water and this was boiled for 1 hr under closed vessel. The solution was filtered and the final volume of solution was adjusted to 1000 ml by addition of water. This ritha solution was used in different concentration from 10 to 30 gpl for further experiments

Residual Grease Content Analysis

The grease content of wool and residual grease content of scoured wool were analyzed as per the standard method IWTO-19-03. The soxhlet extractor of capacity 250 ml assembled with ground glass joints to 250 ml distillation flask and reflux condenser was used for accurate measurement of residual grease content.

Whiteness & yellowness Measurement

The ASTM whiteness Index (WI) and yellowness Index (YI)-E313 of samples, before and after scouring were determined by using spectrophotometer colour I –Match (version 7) according to IWTO- 35-03 standard test method. The Improvement in whiteness and reduction in yellowness are expressed as the percentage change relatively to the original whiteness and yellowness respectively.

Moisture Content Measurement

The entire samples were preconditioned in a stability chamber for 24hr at 65 ± 2 % RH and 27 ± 2^0 C. The moisture content was determined after obtaining the weight of wool dried at 105^0C for 3 hr. The oven dry mass was determined according to standard IWTO-34-85-E method.

Single Fiber Strength Test

The single fiber strength of raw and sample scoured wool was measured on Shimadzu tensile strength tester according to ASTM D 3822 standard test method. The instrument was based on constant rate of elongation (CRE) principle. The distance between jaws was 10mm and the travel rate was 6 mm/min.

Fiber Mean Diameter Test

Fiber diameter measurement was carried out using OFDA 100 as per the standard IWTO-47-2011. The fiber samples were cut into 2 mm snippets and spread on a 70mm square glass slide. The whole slide was scanned with a minimum of 6000 fibers measurement in each measurement. For each sample, three measurements were taken. The mean diameter and standard deviation of the sample were then calculated.

COD Measurement

Chemical oxygen demand (COD) was tested using standard test method ISO-15705: 2002, also called as sealed tube method. Total coliform count was tested using standards method IS1622: 1981, RA 2009.

Table 1: Sample Preparation Description

Sample no	Cow Urine Uses (gpl)	Ritha Solution (gpl)
Commercial Way	-	-
S-1	50	10
S-2	50	20
S-3	50	30
S-4	100	10
S-5	100	20
S-6	100	30
S-7	150	10
S-8	150	20
S-9	150	30
S-10	200	10
S-11	200	20
S-12	200	30

3. RESULT AND DISCUSSION

Effect of Cow urine (CU) and Ritha(R) solution on Residual Grease content

For easy processing on the worsted system the residual grease content of wool fiber need to be below 2%. The residual grease content (RGC) obtained by different combination of Cow Urine and Ritha solution is shown in Table -2. It was observed that RGC is superior when 150 gpl CU and 30 gpl R used and is comparable with conventional process. It shows that desired RGC can be obtained by using natural chemicals. This is due to swell of wool fiber and loosening out the bond between wool and grease by enzyme and ritha, where ritha act as a detergent and take out the grease.

Table 2: Residual Grease Content and COD Values

Sample no	Residual grease content (%)	COD, (ppm)
Commercial Way	0.98	5170
S-1	2.20	4621
S-2	2.05	4590
S-3	1.76	4410
S-4	1.88	4201
S-5	1.76	3989
S-6	1.56	3789
S-7	1.48	3548
S-8	1.01	3145
S-9	1.25	3248
S-10	1.42	3201
S-11	1.54	3180
S-12	1.24	3199

Effect on Cow Urine on COD

It was observed that the use of cow urine and Ritha reduces the COD value of effluent. This newly developed natural eco friendly scouring process is not using the any addition chemical like conventional scouring process. So COD load was reduced. This load was reduced up to 40% of original value; it can be seen from the Table 2

Effect on Whiteness and yellowness

The whiteness and yellowness indices of wool before and after scouring are shown in Table 3.

The improvement in whiteness percentage after scouring ranging from 160% to 223 % is attributed to negative whiteness values because of grease present in raw wool and effective scouring. Increase in cow urine concentration was found to increase yellowness; this is because of presence of ammonia. Increase in ritha concentration increases whiteness as ritha acts as detergent and increases the emulsion for grease and other impurities.

Table 3: Whiteness and yellowness

Sample no	Whiteness Index*	Yellowness Index
Commercial Way	1.765	24.464
S-1	14.195	17.373
S-2	16.296	14.965
S-3	21.291	13.564
S-4	13.595	16.213
S-5	15.219	14.274
S-6	20.194	12.764
S-7	18.231	17.555
S-8	12.184	14.616
S-9	11.221	18.777
S-10	10.349	19.862
S-11	13.274	21.161
S-12	12.568	24.223

*Measured using American Standards test method E313.

Effect on Physical properties

The mechanical properties of wool fibers have no significant effect. Little difference in the tenacity and elongation of wool fibers is attributing of high degree of variability in fiber dimension and non uniformity in wool.

It has also been found that there is no difference in fiber diameter of all the samples as shown in Table 4. The fiber diameter ranges is in between 21-22.5 micron.

4. CONCLUSION

With the use of natural resources like Cow Urine & Ritha scouring efficiency was found to increase. The desired residual grease content can be achieved without using any chemicals and the processing temperature by 50C. Use of Cow Urine & Ritha was found to reduce effluent load by 40 percentages, as both the ingredients are natural and are easily bio-degradable

Table 4: Physical Properties

Sample no	Strength (gf)	Strain%	Diameter Micron (μ)	MR%
Commercial Way	4.30 (1.27*)	44.70 (12.16)	21.32	11.25
S-1	4.90 (1.00)	36.50 (14.29)	21.78	10.95
S-2	4.20 (1.10)	49.70 (14.82)	22.05	10.89
S-3	4.60 (1.37)	44.20 (12.88)	22.47	11.02
S-4	4.00 (1.65)	44.70 (7.82)	22.04	11.30
S-5	4.10 (0.87)	40.70 (10.44)	21.01	11.04
S-6	4.10 (0.76)	41.80 (11.49)	21.7	10.45
S-7	3.80 (0.82)	51.00 (10.25)	22.05	11.49
S-8	4.30 (1.29)	49.50 (13.57)	21.06	11.8
S-9	4.15 (1.56)	52.30 (8.65)	21.69	11.42
S-10	4.80 (1.35)	46.60 (11.22)	21.78	11.36
S-11	3.80 (1.13)	47.40 (11.17)	22.48	10.96
S-12	3.98 (1.40)	49.40 (9.42)	23.01	11.82

** values in brackets standard deviations*

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