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Eco-benign skin preservation through salt substitution—a low salt approach

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ABSTRACT

For each kilogram of skin almost an equal quantity of salt is being employed for preservation. This large quantity of salt employed is discharged in waste streams of slaughterhouses and tanneries. Given the quantity of skins and hides processed at the rate of 25,000 tonnes or more per day globally, the amounts of salt to be disposed off pose serious environmental concern. Only in few select regions fresh hide/skin processing or alternative preservation methodologies are being resorted to, over a limited quantity of raw material resource. Salting still remains the major preservation methodology as it satisfies the major technological and commercial requirements. Many successful research efforts carried out on salt free/low salt preservation have not gained commercial acceptance for not meeting one or combination of requirements mentioned above. A low salt—MgO substituted skin preservation methodology has been developed meeting the requirements of preservation. The methodology employs less than 25% of salt on the weight of the skin used and is suitable for all conventional raw material resources. This paper deals with the approach made, evaluation of preserved skins and assessment of leathers made from such preserved skins.

Keywords: Skin and hide; Preservation; Curing; Sodium chloride; MgO

1. Introduction

Raw hides and skins are highly putrescible material due to presence of about 30–35% protein along with 60–65% moisture [1]. For reasons of availability and cost effectivity, salt is being employed as preservative for hides and skins. The other major salient features of an ideal preservation system for application even in unorganized, remote collection centers are

1. It should not entail use of any sophisticated infrastructure skill or chemicals,
2. It should be harmless,
3. It should be amenable for easy transportation of preserved hides and skins,
4. It should allow easy wetting back of preserved material so as to allow processing of the hides and skins into quality leather.

Though the actual requirement of salt for preservation is much lower, conventionally very large quantities of salt as much as 70–85% on the weight of the hides and skins are employed in practice [2]. Such large quantities of salt present in hide or skin are let out in effluents during initial stages of leather processing. Discharge levels of 60000–65000 ppm of chlorides in tanning effluent sectional streams are not very uncommon [3].

Removal of this neutral salt is not easy and economically not viable and hence the need for alternate methods such as salt-less or less salt curing methods has assumed importance recently [4]. There are several curing methods reported in the literature such as use of benzalkonium chloride [5], formaldehyde [6] hypo [7], boric acid [8], potassium chloride [9], soda ash [10] and silica gel [11].

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Possibilities of antibiotics such as aureomycin, terramycin [12], radiation curing by using gamma rays (photon emission from radioactive materials) and electron beams for preserving the skin/hide have been explored [13]. Use of formaldehyde as the curing agent [14] and preservation of hides/skins by hypo are also reported in the literature [15].

In the present work, an attempt has been made to replace salt completely or partially with very small quantities of MgO. Based on the preliminary experiments it has been found that 20% salt and 2% MgO on the weight of hide/skin could effectively function as preservative chemicals. Hence detailed investigations have been carried out using the above system along with conventional salt curing.

2. Experimental

2.1. Materials

2.1.1. Skins

Freshly flayed goatskins of average weight 1 kg and average area of 5 sq. ft per skin were used for the study.

2.1.2. Chemicals

Sodium chloride and magnesium oxide (Industrial grade).

2.2. Method

Four freshly flayed goatskins obtained from local slaughterhouse were cut into two halves. 20% salt and 2% MgO premixed preservative mixture was applied on the flesh side of left half skins (all percentages based upon the weight of the skin). For control experiments 50% salt was applied on the flesh side of the right half of skin. The skins were folded and stored at the ambient temperature of 32–35°C. The skins were monitored periodically for physical changes like smell and hair slip, which are indications for putrefaction [16]. Only skins, which were preserved well, were further processed into crust and finally taken for analysis.

The efficacy of the preservation system was assessed based on bacterial count. The shrinkage temperature of the tanned leather and physical properties of finished leather processed from the skins preserved by the new systems were also determined and compared with the results of conventionally preserved skins.

2.3. Determination of bacterial count

Preserved skin pieces weighing 1 g per piece were taken and each piece was soaked in the 10 ml sterile water and the skin extract was prepared by shaking in a shaker at 100 rpm for 10 min. The same procedure was repeated for four times with 10 ml sterile water, to extract all the bacteria. Then this liquor measuring 1 ml was added to 9 ml of sterile water and shaken well to get uniform suspension of the bacteria. A volume of 0.1 ml of the respective dilute solution was taken in a sterile petridish and molten nutrient agar at 40°C was poured and shaken gently to get uniform distribution of the bacteria. The plates were incubated at 37°C for 24 h [17]. The number of colonies on the agar medium was counted.

2.4. Determination of hydrothermal stability of the skin

The thermal stability of collagen is an important property for the assessment of quality of skin, as it indirectly indicates the structural stabilization of the skin protein. The thermal stability of the skin is normally assessed by shrinkage temperature. A shrinkage meter was used [18] to determine the shrinkage temperature of the preserved skin. For measuring the shrinkage temperature the test samples of dimension 20 × 3 mm were taken and hooked in the meter. The samples were immersed in a glycerin–water solution (70:30). The temperature at which the specimen starts shrinking was noted as shrinkage temperature of the particular skin. The shrinkage temperature is a measurement of breakdown of stabilizing linkages existing in the collagen matrix. The main aim of this component of the study was to understand whether the new curing system had any effect on the stabilization of collagen matrix.

2.5. Determination of nitrogen content

The preserved skin samples of known weight (5 g) were treated with ten times (by volume) its weight of distilled water, shaken well in a bottle for 3 h at 30–35 rpm. The liquor was then filtered through a filter paper, digested and the amount of nitrogen was determined using Kjeldahl method of extraction [18].

2.6. Physical strength properties of leathers

The preserved skins were converted to crust leather and tested for strength properties. After conditioning the crust leather at 20 ± 2°C and 65 ± 2% relative humidity over a period of 48 h, the properties such as tensile strength, elongation at break tear strength and grain crack were assessed [18] in comparison with conventional salt cured leathers.

3. Results and discussion

Table 1 shows the effect of new skin preservation system in comparison with conventional method of salting. Experimental skins showed no degradation and

odour was absent. Table 2 shows bacterial count of preserved skin for a minimum period of 14 days. The experimental method of preservation has low bacterial count compared to conventionally cured skins. This shows that the experimental skins are well preserved. Table 3 shows the total extractable nitrogen for the skin preserved with less salt and control. The decrease in volatile nitrogen content in the experiment is probably due to the fact that the use of MgO, inhibits the enzyme responsible for putrefaction. Shrinkage temperature of all the leathers processed from conventional and less salt-cured skins are comparable as shown in Table 4. Importantly a substantial decrease (upto 60%) in TDS was observed in the new method of preservation compared to the conventional method of salting as shown in Table 5. Finally the leathers obtained from the skins cured with low amount of salt possesses similar strength properties as that of conventional method of salting (Table 6) is an additional proof that this method of curing has not damaged the skin matrix or quality.

Table 1
Assessment of preservation system.

Method	Days	
	15 days 1 2 3	30 days 1 2 3
20% salt and 2% MgO	Nil	Nil
Control 50% salt	Nil	Nil

1 – Hair slip; 2 – odour; 3 – Signs of putrefaction.

Table 2
Bacterial count in the preserved skins.

Duration of preservation	20% salt and 2% MgO	Control 50% salt
Fresh	2×10^3	2×10^3
1 day	7×10^{10}	9×10^{10}
7 days	6×10^{10}	6×10^{10}
14 days	4×10^{10}	5×10^{10}

Samples drawn from two skins for analysis of each experiment.

Table 3
Total extractable nitrogen (g/kg) of the preserved skins.

Duration of preservation	20% salt and 2% MgO	Control 50% salt
0 h	2.30 ± 0.10	2.20 ± 0.10
12 h	2.65 ± 0.10	2.80 ± 0.10
1 day	2.80 ± 0.10	3.80 ± 0.10
2 days	3.40 ± 0.10	3.90 ± 0.10
4 days	3.70 ± 0.10	4.05 ± 0.10
7 days	4.85 ± 0.10	4.70 ± 0.10
14 days	5.06 ± 0.10	5.80 ± 0.10

Values given are mean value of two determinants.

Table 4
Shrinkage temperature (in °C) of the leathers.

Type of sample	Shrinkage temperature °C
Experiment	105 ± 1°C
Conventional	106 ± 1°C

Values given are mean value of two determinants.

Table 5
Pollution load generated in the soaking process.

Parameters	Pollution load generated (g/kg of raw material)	
	20% salt and 2% MgO	Control 50% salt
BOD	8 ± 1	9.5 ± 1
COD	15 ± 1	26 ± 1
TDS	80 ± 2	264 ± 5
TSS	8 ± 0.5	21 ± 1
Cl	80 ± 5	195 ± 5

Values given are mean value of two determinants.

Table 6
Physical properties of leather.

Parameters	20% salt and 2% MgO	Control 50% salt
Tensile strength (kg/cm^2)	210 ± 5	205 ± 5
Elongation at break (%)	48 ± 3	42 ± 2
Tear strength (N)	28 ± 2	26 ± 2
Lastometer test		
Load grain crack (kg)	18 ± 0.5	17 ± 0.5
Distension at grain crack (mm)	11 ± 0.5	9 ± 0.5

Values given are mean value of two determinants.

4. Conclusion

Salinity reduction is a global priority. The new skin preservation system resulted in more than 60% reduction in chlorides and total dissolved solids in the effluents. The new curing system has been found to be effective in preserving the skin as demonstrated by the preservation parameters and leather properties. The application methodology of the curing agent has been maintained the same as that of the conventional system. Since the new preservation system do not require any sophisticated new skills or instruments, they have a great potential to emerge as viable alternatives for the conventional salt preservation system.

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