AZARDIRACHTA INDICA: A GREEN MATERIAL FOR CURING OF HIDES AND SKINS IN LEATHER PROCESSING

by

VASUDEVAN PREETHI[#], VEERAPPAN RATHINASAMY[+], NARASIMHAN KANNAN, CHANDRA BABU[+], AND PRAVEEN KUMAR SEHGAL[#*]

[#] *Bio-products Laboratory*

[+] *Tannery Division*

Central Leather Research Institute

ADYAR, CHENNAI 600 020

TAMIL NADU, INDIA

ABSTRACT

Common salt (Sodium chloride) in solid form is extensively used in preservation of raw hides and skins. A large quantity of this material is discharged in the liquid effluent as Total Dissolved Solids (TDS) during soaking operation in leather processing. In Central Leather Research Institute (CLRI), Chennai, we have attempted to replace common salt with an herbal-based formulation prepared using *Azardirachta indica* (common Indian name – Neem) in preservation of raw goatskins. After successful trials in CLRI, the material has been successfully field tested at a rural location in India where large quantity of goatskins is collected by local people for trading. The physical, chemical and subjective assessment of wet blues and crust leathers from the skins prepared with this material compare favorably with salt preserved skins. Use of *Azardirachta indica* in preservation also offers considerable reduction of TDS in liquid tannery effluent and material after the usage can be scrapped off from the skins and composted to get garden manure, thereby offering a better solution for its disposal.

ABSTRACTO

Sal común (cloruro de sodio) en forma sólida es extensivamente utilizada en la conservación de pieles crudas. Una gran cantidad de este material es descargado en los efluentes como Sólidos Totales Disueltos (TDS*) durante la operación de remojo en el procesamiento del cuero. En el Instituto Central de Investigaciones Sobre el Cuero (CLRI*), en Chennai, hemos tratado de reemplazar la sal común con una preparación herbácea basada en la utilización de *Azardirachta índica* (comúnmente denominada en India-Neem) para la preservación de pieles caprinas verdes. Luego del éxito en ensayos en el CLRI, el material se utilizó en ensayos de campo en una localidad rural en India donde se recolectan grandes cantidades de pieles caprinas comercializadas por la gente local. La evaluación física, química y sujetiva del material curtido y recurtido se comparó favorablemente con los resultados en pieles preservadas con sal. El empleo de *Azardirachta índica* en la preservación también ofrece considerable reducción en TDS en los efluentes de la curtiembre y el material ya utilizado se puede remover por raspado de la piel y compostado para obtener un producto para jardinería, así ofreciendo una mejor solución para su disposición final.
(*Siglas derivadas del Inglés)

INTRODUCTION

Leather processing is subjected to lots of compliance to environmental norms and regulatory responsibilities. Indications are that leather processing industry will need to meet external pressures and in additional costs of meeting environmental perspectives.[1,2] Remarkable decrease in waste discharges and emissions are needed in leather processing to exit it from the red category of polluting industries. Tannery effluent exhibits high values of the environmental pollution parameters i.e., Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended solids and Total Dissolved Solids (TDS). Common Effluent Treatment Plants (CETPs), which have been established to treat the effluent discharged by tanneries, have effectively removed suspended solids and also brought down COD and BOD within safe limits[3,4], but measures are yet to be taken to treat TDS which remains high in the effluent. The major portion of TDS is mainly contributed by common salt (Sodium Chloride) used in preservation of hides and skins and to some extent in pickling process[5]. The electrolytes discharged in the form of chloride and sulphates form the largest component of tannery effluent and are the most difficult to treat at the end of the pipe. The source of electrolytes is mainly from salt curing method currently followed[6]. Chlorides being highly soluble and stable are not affected by effluent treatment and thus remain a burden

* Corresponding author: Tel: + 91-044-4420709, Fax: + 91-044-4911589. Email: pk_sehgal@hotmail.com
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to the environment. Nearly 40,000 litres of effluent is being generated per tonne of leather processing, contributing to about 350 – 450 Kg of salt as TDS[7]. The high amount of salt contained in the effluent when used for irrigation purpose after treatment will increase surface salinity, thus reducing the fertility of soil resulting in the poor yield of crops[8].

The salt, in spite of its inherent impact on the environment, is the most widely used material in preservation of hides and skins. The only major change in practice is using brine curing instead of salt packs and that occurred less than half a century ago. Tanners prefer to get salt cured hides/skins even though its presents environmental challenges to them and the packers[5]. A great deal of research had been done in the area of less-salt curing systems. Use of boric acid (approximately 4.5%) solely in conjunction with saturated sodium chloride solution for curing has been investigated[9]. Similarly for short-term preservation of skin, use of benzalkonium chloride in conjunction with salt was explored[10]. Attempts have been made to replace salt curing by chemical preservation (formaldehyde, potassium chloride), freeze drying, super chilling with dry ice, electron beam irradiation etc., but they are either cost intensive or interfere with the final quality of leather. At present none of these techniques has been put to practice in the tanneries in India.

Today our main focus is on significant reduction of total dissolved solids in treated tannery wastewater. Replacement of common salt through salt-less or less salt preservation of hides/skin is one approach which has been receiving much attention all over the world where large-scale processing of raw hides/skins are undertaken.

In this paper, an attempt has been made to replace salt with an herbal preservation called *Azardirachta indica* (common name: Neem tree). The formulation after the preservation can be scrapped off, composted and used as manure thus solving its disposal problem. The details of the experiments are reported in this paper.

EXPERIMENTAL

Materials

Skins

Fresh flayed goatskins of average weight 1 kg and average area 5 sq.ft. were collected from local slaughterhouse located at Perambur, Chennai, India were taken for the study. Skins were cut into equal halves with knife and designated as (1L,1R), (2L,2R),....Goatskins processed at Rajgarh (M.P) were not cut into halves and were processed directly after preservation.

Salt

Commercial grade Sodium chloride of 60% purity

Isopropyl alcohol

LR grade isopropyl alcohol of 98% purity

Liquid extract of Cucumber

Liquid extract was prepared using cucumber by grinding it in the laboratory mixture (Remi Anupam Mixie Ltd, Mumbai, India). The ground paste was filtered to get the liquid filtrate and used for the preparation of *Azardirachta indica* formulation.

Preparation of *Azardirachta indica* formulation and application

The crude paste was prepared in the laboratory from the fresh leaves of *Azardirachta indica* (common name: Neem) tree. This herbal tree is cosmopolitan in nature. Fresh leaves of this tree have been used to prepare this formulation. The weight of fresh leaves is taken before grinding. Grinding is done in the laboratory mixer (Remi Anupam Mixie Ltd, Mumbai, India) in isopropyl alcohol. For each goatskin, 450 grams of crude *Azardirachta indica* paste was used. The average area and weight of the goatskin are 5 sq. ft. and 1Kg respectively. For 100 grams (wet weight) of ground *Azardirachta indica* leaves, 50 ml isopropyl alcohol was used to form a crude paste.

In second batch isopropyl alcohol is replaced with the crude liquid extract of cucumber. For 100g (wet weight) of ground *Azardirachta indica* leaves, 50ml of liquid extract was used to form a crude paste.

Both the formulations were applied on the flesh side of experimental skin in the left side halves of goatskins (Experiment 1 - 1L, 2L, 3L, 4L, 5L; Experiment 2 – 6L, 7L, 8L, 9L, 10L) and the corresponding right halves (Control – 1R, 2R...10R) were preserved using 40% common salt in solid form.

Skins (left side halves) in each experiment were piled separately in the tannery yard having sufficient aeration and cross ventilation. Control (right side halves) batch were kept along with experimental batches in the same yard. The temperature in the tannery yard ranged between 26° and 32°C and humidity prevailing at the time of experiment ranged between 40 and 75%. Skins were shuffled everyday in the mornings and evenings to change the order in which they were piled. Skins were piled in reset by changing the sequence in which the skins were piled 1 to 5 was changed so that inner skin come towards the top portion at least twice during the piling and preservation. Salt preserved skins were also piled and shuffled in the similar manner. Two weeks later, the adhering material was scrapped off, skins were taken for soaking and processed into wet blues and crust leathers as described later in this paper.

The above experiment was repeated in actual field conditions in a rural location in Rajgarh, Madhya Pradesh, India. In Rajgarh district flayers preserve goatskins with common salt (solid). Flayers after 3-4 weeks or when they have sufficient numbers take the preserved skins to a weekly village market place for trading. Here the skins are sold to the middleman (a trader who collects skins from flayers and later sells them to either wet blues processing units or to another trader who in turn supply them to large tanneries located in Kanpur, (U.P) or other

regions. The neem formulation (neem + isopropanol) prepared by us was given to flayers and they were requested to apply the formulation on goatskins. The skins (15 nos) were kept along with salt preserved skins but in a separate pile and they were asked to shuffle the pile everyday in the mornings and evenings at ambient temperature and humidity (temperature 18-24°C and humidity 30-50%). The skins were collected from them after thirty days and processed at CLRI tannery into wet blues and crust leathers as described later in this paper.

METHODS

Subjective assessment of goatskin after preservation

Goatskins were assessed subjectively in the mornings and evenings on daily basis by a panel of three technicians/scientists from CLRI. They gave their subjective assessment for odor, hair slip, preservation and condition of skins after wetback in soaking. Total solids, Suspended solids, Chemical Oxygen Demand (COD), Total dissolved solids (TDS) and Chlorides were estimated by standard methods from the soak liquor obtained from soaking operation in each batch[11].

Determination of moisture content

Goatskin samples from each set of experiments (bit measuring 3cm x 3cm) were cut, weighed and unhaired using a sharp one-edge blade. The moisture content of each was determined using Dean and Stark method[12].

Determination of hydrothermal stability of goatskin

Collagen stability against bacterial attack is an important property to assess preserved goatskins. The thermal stability of preserved skins was assessed by hydrothermal shrinkage temperature using shrinkage meter[12].

Histopathology Analysis

The histological analyses at different durations of preservation of the goatskins in both experiments and control goatskins were carried out. The skin samples (1cm x 1cm) from each experiment after two weeks preservation were transferred to 10% neutral buffered formalin (NBF) for a period of 24 hours at 4°C. The formalin fixed skin samples were taken out and allowed to dehydrate in a series of alcohol of different grade (40 – 90%) and then cleared in xylene. They were finally embedded in paraffin wax (58-60°mp) into molds. The molds were labeled and stored until use. The skin samples were sectioned at a thickness of 10_m and deparaffinized. They were initially stained with hematoxylin and again counterstained with eosine.

SDS PAGE

The stability of the collagen extracted from preserved (experimental and control) goatskin samples (after different periods of preservation) were analysed according to the procedure of Laemmli[13] in 10% SDS PAGE. Skin samples of size measuring 3cmx 3cm were taken and washed thoroughly with water. The samples were placed in 0.5M acetic acid and allowed to swell overnight. The sample was then homogenised in a homogeniser and filtered through a muslin cloth. The filtrate was then treated with dilute sodium hydroxide solution (10% w/v) to precipitate collagen. The precipitate was added to 50µl sample buffer (1.25 ml separating gel buffer (pH 6.8), 1 ml Glycerol, 0.50 ml β-mercaptoethanol, 7.25 ml double distilled water, 150 mg SDS and a pinch of Bromophenol Blue) and heated for 2 – 5 minutes in a boiling water bath[14]. 20µl of each sample was loaded on to gel and electrophoresis was carried out at 10 mA/50V.

Measurement of Pollution Load Generated from Soaking Operation

Processing into wet blues and crust leather

After 2 weeks of preservation, the adhering material was scrapped off from the neem-preserved skins and put for soaking in separate drums. After soaking operation, skin samples from each experiment were pooled and processed into wet blues and crust leathers following the standard process practiced in tanneries. In brief, the soaked skins from 15 days preservation and salt preservations were pooled and kept for liming (paste liming), reliming (pit), deliming and batting, pickling, chrome tanning (8% chrome), basification, shaved to required thickness and converted into wet blues. The wet blues were taken for nutralization, rechroming (4% chrome), retanning, dyeing and fat liquoring to get crust leathers. The skins collected from field experiment at Rajgarh, MP were converted into wet blues and crust leathers by the same process as described above.

Wet blue properties

Wet blues made from the experimental stock were tested by a panel of three technicians/scientists from CLRI. They gave their subjective assessment for grain smoothness, flatness, color and fullness.

Crust properties

The samples for physical testing were cut from the crust leathers according to the official sample position IUP2. Samples were conditioned at 26±2°C and 65±2% relative humidity for a period of 48 hours, the properties such as tensile strengths[15], elongation at break[16], split tear strength[17] were measured as per the IUP6 and IUP8 respectively. In brief, the physical properties were measured as follows:

$$\text{Tensile strength in N/mm2} = \frac{\text{Breaking load (N)}}{\text{Thickness in mm x width in mm}}$$

Breaking load (N) = Highest load reached at break

$$\text{Elongation at break in \%} = \frac{\text{Length at break (mm) –initial length x 100 (mm)}}{\text{Initial length (mm)}}$$

The split tear strength was measured as the mean value of tearing load in N/mm (force applied to tear the specimen).

TABLE I
Subjective Assessment* of Goatskins after Preservation

Properties	Experiments: Experiment 1	Control	Experiment 2	Control	Field Experiment 3	Control
Odour	No putrid odour	No putrid odour	No putrid odour	No putrid odour	No putrid odour	No putrid odour
Hair slip	< 1	No	< 1	No	< 1	No
Days of Preservation	2 weeks	2 weeks	2 weeks	2 weeks	30 days	2 weeks
Preservation	Normal	Normal	Normal	Normal	Normal	Normal
Wet back after soaking	100%	100%	100%	100%	100%	100%

*Skins were assessed subjectively by a panel of 3 technicians/scientists from CLRI

Experiment 1: *Azardirachta indica* formulation containing isopropyl alcohol
Experiment 2: *Azardirachta indica* formulation containing liquid extract of cucumber
Field Experiment: *Azardirachta indica* formulation containing isopropyl alcohol
Control: Salt

TABLE II
Pollution Load Generated from the Soaking Process

Properties	Experiment 1 (5 Skins)	Experiment 2 (5 Skins)	Field Experiment	Control (Right side skins – 10 nos)
Total solids (mg/l)	9330	9128	9250	32,442
Suspended solids (mg/l)	3128	3128	3236	958
Chemical Oxygen Demand (mg/l)	200	185	210	1075
Total dissolved solids (mg/l)	6202	5856	6105	31,484
Chloride (mg/l)	505	485	510	16,672

Note: Experiment 1, Experiment 2, Field experiment and Control (Right side skins of Experiment 1 & 2) were taken separately for soaking and all the parameters (Total solids, Suspended solids, COD, TDS Chlorides) were calculated from the soak liquor in each case and no mean or standard deviation can be generated from single run.

Experiment 1: *Azardirachta indica* formulation containing isopropyl alcohol
Experiment 2: *Azardirachta indica* formulation containing liquid extract of cucumber
Field Experiment: *Azardirachta indica* formulation containing isopropyl alcohol
Control: Salt

Composting of used *Azardirachta indica* formulation

After 2 weeks of preservation the *Azardirachta indica* paste was scrapped off and taken separately for composting. The whole material was mixed with equal quantity of dung and buried in a pit for a period of 6 weeks. The pit was opened and the composted material gave a good aroma indicating good composting of the material. It is being used as garden manure. Note: The details of the manure on plant usage are not reported in this paper. We shall report the same after detailed investigation.

RESULTS AND DISCUSSION

The subjective assessment carried out on goatskins (experimental and control) showed no sign of putrefaction. The epidermal hair was found intact on skin indicating normal preservation as shown in Table I.

Pollution load generated in leather processing

The Table II shows the pollution load generated during leather soaking operation of goatskins in all experiments and control. Total solids, total dissolved solids, chlorides showed reduction in experiment 1, experiment 2 and field experiment compared

TABLE III
Wet Blue Assessment*

Wet Blue Properties	Experiments: Experiment 1 (L)	Control (R)	Experiment 2 (R)	Control (L)	Field Experiment
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Grain smoothness	8.14±1.04	7.91±1.16	8.24±1.0	8.35±1.02	8.12±1.2
Grain flatness	8.27±1.07	8.02±1.06	8.25±1.25	7.17±0.14	7.25±0.14
Color	6.23±0.78	10.95±1.2	8.35±1.52	8.28±1.48	8.24±1.2
Fullness	7.48±1.45	6.12±0.86	6.12±1.2	7.34±1.24	7.14±1.2

Maximum rating of wet blues – 10
*Wet blues were assessed subjectively by a panel (3 Nos.) of technicians / scientists from CLRI

Experiment 1: *Azardirachta indica* formulation containing isopropyl alcohol
Experiment 2: *Azardirachta indica* formulation containing liquid extract of cucumber
Field Experiment: *Azardirachta indica* formulation containing isopropyl alcohol
Control: Salt

TABLE IV
Crust Assessment*

Crust Properties	Experiments: Experiment 1 (L)	Control (R)	Experiment 2 (R)	Control (L)	Field Experiment
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Grain smoothness	6.96±0.86	6.12±1.16	6.89±1.45	7.16±0.26	6±1.6
General appearance	7.18±1.06	6.24±0.09	7.05±0.66	6.11±1.36	7.1±0.16
Softness	7.24±1.56	7.2±0.36	7.13±1.12	5.85±1.69	6.82±1.22
Fullness	7.08±1.18	5.98±1.12	8.1±1.04	8.06±0.76	7.8±1.04
Dye intensity	6.82±0.96	7.06±0.86	6.06±0.86	7.14±1.16	6.94±1.2
Grain tightness	5.9±0.26	6.2±0.79	5.88±1.2	6.94±0.14	6.12±1.02

Maximum rating of crust – 10
* Crust assessment was done by a panel (3 Nos.) of technicians / scientists from CLRI

Experiment 1: *Azardirachta indica* formulation containing isopropyl alcohol
Experiment 2: *Azardirachta indica* formulation containing liquid extract of cucumber
Field Experiment: Azardirachta indica formulation containing isopropyl alcohol
Control: Salt

to control. Experiment 1, Experiment 2, Field experiment and Control (Right side skins of Experiment 1 & 2) were taken separately for soaking and all the parameters (Total solids, Suspended solids, COD, TDS Chlorides) were calculated from the soak liquor in each case and no mean or standard deviation can be generated from single run.

Any standard tannery processing 1000skins/day will generate 40,000 liters of effluent contributing approximately 400 kg of salt as TDS in the effluent. If preservation using *Azardirachta indica* formulations is carried out TDS could be cut down to bare minimum, because salt has not been used in curing. The liquid effluent without salt can be easily recycled after suitable treatment thus saving considerable cost on water consumption. Also scrapped off *Azardirachta indica* formulation is composted to get garden manure. The same can be used in the tannery to keep the area green and surrounding clean.

Determination of moisture content

Figure 1&2 shows the moisture content of goat skins preserved with *Azardirachta indica* formulations (experiment 1&2). In both the experiments, the moisture content after 24hrs is lower than the critical moisture content of 50% providing less chance for putrefaction to occur in the experimental stock. After 2 weeks, the moisture content in the experiment 1 & 2 was dropped to be 40% & 43% versus 39% & 37% of

TABLE V
Physical Testing of Crust

Physical Properties	Experiments: Experiment 1 (L)	Control (R)	Experiment 2 (R)	Control (L)	Field Experiment
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Tensile Kg/Cm²	240.7±2.6	252.2±5.2	250.4±3.1	244.2±2.7	255.6±4.2
% Elongation at break	71.4±1.3	65.2±1.7	77.4±2.6	73.2±1.1	78.2±2.1
Tear Kg/Cm	55.5±3.5	52.2±1.4	50.4±1.5	54.2±2.7	53.2±1.9
Lastometer strength	44±2	46±2.2	48±3.1	45±1.2	49±2.5
Load (Kg) distension at grain crack	12.75±1.84	11.27±1	11.77±0.94	12.32±1.6	12.22±1.2

* Crust assessment was done by a panel of 3 technicians/scientists from CLRI

Experiment 1: *Azardirachta indica* formulation containing isopropyl alcohol
Experiment 2: *Azardirachta indica* formulation containing liquid extract of cucumber
Field Experiment: *Azardirachta indica* formulation containing isopropyl alcohol
Control: Salt

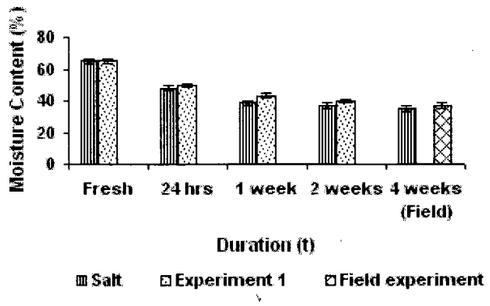

Figure 1. - Moisture content of goatskin preserved with *Azardirachta indica* formulation containing isopropyl alcohol (Control, Experimental 1 and Field experiment).

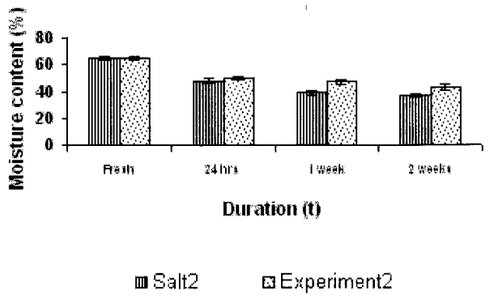

Figure 2. - Moisture content of goatskin preserved with *Azardirachta indica* formulation containing liquid extract of cucumber (Control and Experimental 2).

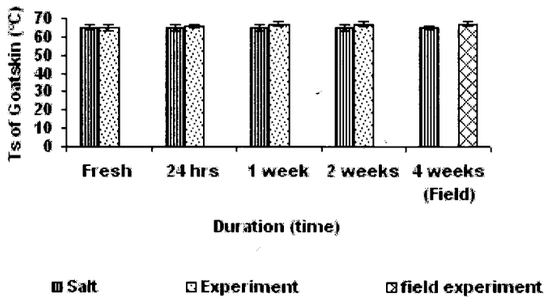

Figure 3. - Shrinkage Temperature of goatskin preserved with *Azardirachta indica* formulation containing isopropyl alcohol (Control, Experimental 1 and Field experiment).

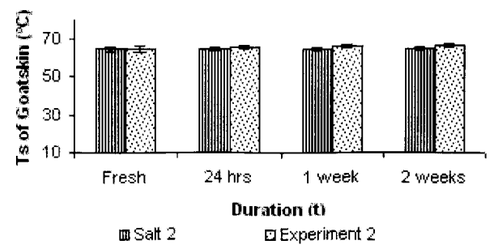

Figure 4. - Shrinkage Temperature of goatskin preserved with *Azardirachta indica* formulation containing liquid extract of cucumber (Control and Experimental 2).

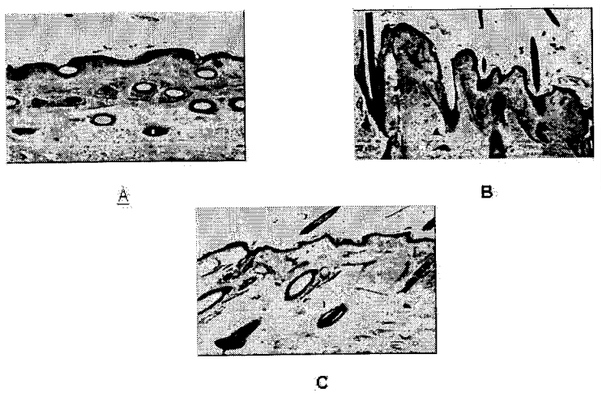

Figure 5. - Histological analysis of preserved goatskins after 2 weeks. A – salt preserved goatskin (Control), B – goatskin preserved with Azardirachta indica formulation containing isopropyl alcohol (Experiment 1) & C - goatskin preserved with Azardirachta indica formulation containing liquid extract of cucumber (Experiment 2).

corresponding salt cured stocks. The rate of decrease in moisture content in the experimental skins was match with salt cured stock. In experiment 1, isopropyl alcohol and neem combination dehydrates the skins to a level, which will not support autolysis and putrefaction. Neem formulation applied skins were dried within 12 hrs and presence of isopropyl alcohol was not seen on goatskins after one day of preservation. In experiment 2 also cucumber extract combination dehydrate the skins in the prevailing temperature and humidity conditions and do not support autolysis. In the case of salt cured stocks, salt dehydrates skin to moisture content insufficient to support autolysis and putrefaction.

Determination of Hydrothermal stability of Goatskin

Figures 3 & 4 show the shrinkage temperature (Ts) of the goatskins preserved with *Azardirachta indica* formulation (experiment 1 & 2). Ts value compare favorably with conventional salt cured stock. The shrinkage data indicates that the formulation of *Azardirachta indica* does not have any detrimental effect on the configuration of the collagen molecule and on the skin matrix.

Histopathological analysis

The histological analysis of skin samples is shown in Figure 5. The histology of goatskin preserved with *Azardirachta indica* formulation (experiment 1 & 2) clearly shows that the epidermis, dermis of skin was completely intact. The glands and hair follicles were also intact comparing favorably with salt cured stock.

SDS PAGE

PAGE method helps to find out the purity and the type of collagen present in the samples of pure collagen. It also tells about the monomeric, dimeric, trimeric and higher polymeric forms (α, β, γ sets) of collagen present in the samples of pure

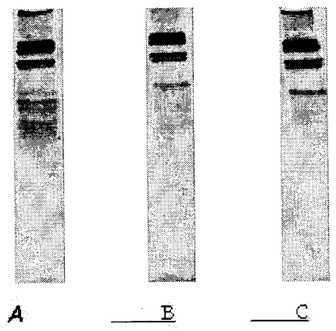

Figure 6. - SDS PAGE analysis of preserved goatskins after 2 weeks. A – salt preserved goatskin (Control), B – goatskin preserved with Azardirachta indica formulation containing isopropyl alcohol (Experiment 1) & C - goatskin preserved with Azardirachta indica formulation containing liquid extract of cucumber (Experiment 2).

collagen and modified collagen. Separation of α, β, γ chains are achieved on the basis of molecular weight of each species of collagen on a stationary phase of polyacrylamide gel. This stationary phase provides a platform for the separation of α, β, γ and higher components of collagen.

PAGE analysis reveals the qualitative assessment of collagen. α, β, γ components are intact in all the preserved stock as shown in Figure 6. The bands shown by the skin sample preserved with *Azardirachta indica* formulation (experiment 1 & 2) are found to be intact an analogous to salt cured stock.

Physical strength properties of leather

The subjective properties of wet blues and crust leathers are shown in Table III & IV. Table V shows physical properties of crust leathers from all experiments. Subjective assessment and physical properties compare favorably with salt cured skins. Also, the used *Azardirachta indica* formulation is scrapped off and composted for using as garden manure. Use of this material as a manure would solve its disposal problem and also generating additional revenue for the tannery.

CONCLUSIONS

We have successfully attempted to replace common salt with *Azardirachta indica* (Neem) in preservation of goatskins. Use of common salt (solid form) in preservation of hides/skins causes environmental pollution by increasing total dissolved solids (TDS) to considerably high value in the soak liquor and ultimately TDS level goes up when soak liquor is mixed with liquid tannery effluents. Use of *Azardirachta indica* offers near zero solid waste discharge in soak liquor and it would considerably reduce TDS in tannery effluents. Moreover use of common salt (solid form) in preservation generate large quantity of used salt mixed with other impurities like hair, sand, dust particles proteinatius matters etc. Disposal of these

materials poses serious problems and present methods for their recovery or disposal are either cost intensive or unsuitable. Near zero solid waste discharge is possible if salt is replaced with neem in preservation of goatskin. The scrapped off neem material can be composted and it has potential to be converted to organic compost with high nutritive value. Our initial experiments are encouraging and we shall be reporting them when we are ready with results. Use of neem in preservation can bring down TDS to less than 2100mg/ l in the tannery wastewater and after suitable treatment both BOD and COD can be brought down to less than (30mg/ l) and (250mg/l) respectively and discharged to the river. If cluster of tanneries processing goatskins switch over to neem preservation then they can effectively bring down BOD, COD and TDS within river discharge standards without investing much on CETP. We have planned to use neem formulation on 100 – 200 goatskins in CLRI and also conduct demonstration outside CLRI in some tanneries. We have a mandate to take it further and are interacting with industry to sponsor our experiment on large scale. A project has been launched by CLRI to gain global technology leadership for India through causing paradigm shift technologies for the manufacture of leather from chemical to bioprocessing. Besides other parameters, the project focuses on significant reduction of total dissolved Solids in treated tannery wastewater by replacing common salt through salt-less and ambient preservation of hide/skin. Biotechnological recourses through these measures will reduce environmental risks in leather processing to near zero values.

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