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Short Term Preservation of Goatskin with Antioxidant Containing Banana Peel Paste

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ABSTRACT
The main raw material for the leather business is unprocessed hide and skin, which is leftover in the slaughterhouses. To stop bacterial action after flaying, the raw hide and skin must be preserved right away. Commonly sodium chloride is used to preserve the hides and skins, which has a significant influence on the increment of the total dissolved solids (TDS) and salinity in the groundwater and surface water as well. Therefore, the wet salting method is detrimental to humans, plants, and animals. To lower the pollutant load in a soaking operation, this research focuses on antioxidant-containing short-term preservation of goatskin using *Musa acuminata* (banana peel) paste. Freshly flayed goatskins were preserved by using banana peel paste on a laboratory scale for 12 days and monitoring the hydrothermal stability, moisture content, odour, physical feel, and hair slip regularly. After the 12^{th} day of preservation, chloride, total dissolved solids (TDS), biological oxygen demand (BOD), and chemical oxygen demand (COD) were used to assess the physicochemical properties of soaking wastewater. Compare to the conventional method, total dissolved solids, chloride, biochemical oxygen demand, and chemical oxygen demand are the pollutants that are reduced by the suggested technique by 23.3%, 50.02%, 57.14%, and 33.33% respectively. The findings of this study recommend that salt-free utilizing *Musa acuminata* paste could be an alternative way to preserve goatskin by reducing the pollution load in the soaking wastewater.

Keywords: Banana peel paste, Preservation, Goatskin, Salinity, Pollution load

1. Introduction

Nowadays the performance of the leather industry is thoroughly noteworthy to the economy of the world. The fundamental material is raw hide and skin in the leather industry which is considered a by-product from the meat industries [1]. Water and protein make up roughly 60–70% & 25-30% respectively of the hide and skin, making them vulnerable to microbial attack [2]. Deterioration of hide and skin occurs 5–6 hours after an animal dies. The protein and lipid in the hide and skin are hydrolyzed by saprophytic bacteria that already exist there as well as bacteria from the environment. This results in protein denaturation and lipolysis, which lead to the degradation of the hide and skin [3]. In 8 to 12 hours, bacteria on the flesh side of raw hide and skin can enter via the corium, and in 15 to 18 hours, they can seriously cause grain peeling and voids in the hide and skin [4]. Hair slip, fibre destruction, looseness, and odour of leather are different types of microbiological defects of final leather and for these types of defect, microorganisms are responsible [5].

The quality of leather represents by intact protein material of raw hide and skin [6]. To achieve the best quality leather, the protein must be in intact condition and this can be happening by starting tanning instantly or by preserving the raw hide and skin properly. Due to the dearth of tanneries in regions in which the highest quantity of animals are butchered, it is challenging to begin the tanning process right away. Additionally, it is impossible to tan a sizable amount of raw skins and hides that are gathered all at once for the auspicious occasion of Eid-Ul-Azha (Muslim festival). Preserving the hide and skin till it is sent to the tanneries is thus the most efficient strategy. Preserving the hide and skin before it is sent to the tanneries is thus the most efficient strategy. For producing high-quality leather preservation of raw hide and skin should be done properly.

Using a bactericidal agent or inducing a bacteriostatic state are two strategies to convey the preservation process [7]. The classic method of preservation involves sprinkling 40–50% of sodium chloride (common salt) on the whole surface of the flesh side of raw hide and skin. [8]. Wet salting methods hold a strong and mostly top position among so many methods of preservation raw hide and skin the main reason is low cost, availability, and ease of application. During the preservation process, NaCl plays dual functions. Because it significantly reduces the amount of moisture of raw hide and skin while simultaneously creating a bacteriostatic environment. For this dual activities of NaCl-based curing of raw hide and skin is practiced worldwide [9]. The major downside of salting preservation is that it generates 40% chloride (Cl-) and 55% total dissolved solids (TDS) in the entire tannery effluent [10]. Static data revealed that during the preparation of 6.5 million tons of hide and skin that had already been preserved by the wet salting procedure, the wastewater from the soaking process included 2.6 million tons of salt [11]. The soil's and water's quality changes for many factors and this discharging Cl^- from beam house process is also responsible for this. The origination of seed and plant outgrowth is directly or indirectly affected by these ions from sodium chloride (Na^+, Cl^-) [12]. The high salt content of wastewater increases surface salinity and lowers soil fertility, which results in poor crop yields [13]. High salt concentrations can promote halophilic bacteria and produce red heat damage in the final leather by causing areas of redness on the flesh side of cured hide/skin [14]. The primary requirement for reducing environmental pollution is to control chlorine (Cl-) [15].

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To minimize pollution load, particularly during the soaking process, researchers have taken on the issue of creating environmentally friendly preservation methods for hide and skin.

Numerous researchers have developed various physical and chemical preservation techniques during the past few decades to lower pollutant loads, particularly during the soaking operation [16–23]. These aren't employed in commerce because they are costly and complicated. Additionally, natural plants and trees extract paste with less salt and were tested for goatskin preservation [24].

For the conservation of goatskin, the current study uses Musa acuminate peel paste in combination with less amount of common salt. Hydrothermal stability, moisture content, hair slip, and hydroxyproline were all monitored to gauge the Musa acuminate peel paste's potency as a curing agent. The outcomes of the experiment were compared with the traditional preservation procedure.

2. Materials & Methodology

2.1 Goatskin

For this study, a local butcher in Khulna, Bangladesh, provided roughly 3.5 kg of freshly flayed goatskin.

2.2 Curing Agent

In this work, banana peel paste has been used as a curing agent and its effectiveness in the traditional technique has been evaluated. *Musa acuminata* is a banana species belonging to Southern Asia, including the Indian Subcontinent and South Asia. This species is anywhere available nowadays. For the research work, to make the paste, banana peels were collected from the local market area of Fulbari gate, Khulna, Bangladesh.

2.3 Reagents

Biochemical and environmental parameters were determined using analytical-grade reagents. For the preservation trials, commercial sodium chloride was applied, and industrial auxiliaries were used during pre-tanning. Commercial grade common salt purchased from the local scientific store, Khulna, Bangladesh reagents used in beamhouse tanning processes-wetting agent, sodium ash (Na_2CO_3), Busan 40L, sodium sulfide (Na_2S), lime, ammonium sulfate, $(NH_4)_2SO_4$, ammonium chloride (NH_4Cl), sodium metabisulfite ($Na_2S_2O_5$), bating agent, sodium chloride (NaCl), sodium chlorite ($NaClO_2$), formic acid, sulfuric acid (H_2SO_4), basic chromium sulfate, magnesium oxide (MgO), etc.

2.4 Methodology

2.4.1 Preparation of banana peel paste

The waste fresh banana peel was picked from the nearby campus of Khulna University of Engineering & Technology, Khulna, Bangladesh. The banana peels were cut into small pieces. About 20 mL of water was added with 451g of banana peel. The banana peel paste was made using a laboratory-blending machine.

Fig.1 Raw chopped banana peel (a) and banana peel paste (b)

2.4.2 Preservation test

Table 1 Peel paste optimization study (7 days)

No.	% of curing agents	Hair slip	Odour	Physical feel
1	5% paste+ 10% salt	No	No	Soft
2	10% paste+ 10% salt	No	No	Soft
3	15% paste+ 10% salt	No	No	Soft & flexible
4	20% paste+ 10% salt	No	No	Moderate soft

After collecting the freshly flayed goatskin, they were brought to the leather manufacturing workshop for investigation. From them, five samples measuring roughly 30 cm × 30 cm were cut. The skins were cleaned with water to separate adhered blood, grime, etc. After that, the cleaned skins were hung for 30 min to remove extra water.

Fig.2 Application of 5% banana peel paste with 10% salt (a) 10% banana peel paste with 10% salt (b) 15% banana peel paste with 10% salt (c) and 20% banana peel paste with 10% salt (d)

Preliminary tests were carried out to determine the bare minimum of peel paste and salt required for preservation. After applying the preserving materials, the skins were piled up flesh-to-flesh and kept at ambient

temperature (27 ± 2°C) for 12 days. **Table 1** shows the various combinations of curing materials available based on raw skin weight and evaluated regularly (fresh, 1st, 2nd, 3rd, 6th, 9th, and 12th days) to monitor changes such as odour, hair slip, physical feel, fungus growth, and so on. The optimum concentration of peel paste and salt for preservation was found for 15% peel paste and 10% common salt based on preliminary experimental findings.

2.4.3 Moisture content determination

A known weight of about 6 g of samples was taken from each goatskin piece after a different period of preservation and put in a drying oven at 105ºC temperature for 4–5 h. Finally, the loss of unbounded water was calculated according to the Bureau of Indian Standards [25].

2.4.4 Hydrothermal stability

The temperature at which protein cross-links and collagen matrix structure break down is called shrinkage temperature [26]. The SATRA shrinkage meter was used to determine the shrinkage temperature of the preserved goatskins.

2.4.5 Determination of hydroxyproline

Hydroxyproline was determined following the Woessner method. About 1 g of preserved sample was taken in a conical flux with 40 mL of distilled water and shook it for 30 minutes at 35rpm. After completing the shaking period, the solution was filtered and the filtrate was collected in a conical flux. For acid digestion, 1mL of HCl of 6N was added to the filtrate solution. Then the sample was oven dried at 110°C overnight. The next day the sample was taken to 80°C in a water bath for 3-4 hours. Then 1mL of chloramine T, 1 mL of perchloric acid, and 1mL of Para Dimethyl Amino Benzaldehyde (PDAB) were added to oxidize. The solution was rested to clear overnight. Then the sample was tasted in UV-Vis spectroscopy at 557nm.

2.4.6 Total dissolved solids determination

The APHA 2540 D technique was used to determine the TDS of the experiment and control soaking liquors.

2.4.7 Biological oxygen demand determination

BOD was calculated using APHA standard method 5210 B [26]. Phosphate buffer, magnesium sulfate, calcium chloride, and ferric chloride solutions were mixed with water in a bottle to make dilution water. Sulfuric acid or sodium hydroxide solution was used to alter the pH to 6.5 to 7.5. A sample volume of 300 mL was loaded in a BOD container with adequate dilution water to ensure that air is removed before the stopper is inserted, leaving no bubbles. As a rough check on the quality of the diluted water and the cleanliness of the incubation bottle, a blank sample (just diluted water) was also incubated. Titration was used to determine the initial DO. For 5 days, the BOD bottle was incubated at 37°C. After a 5-day incubation period, the final DO was obtained and BOD was estimated.

2.4.8 Chemical oxygen demand determination

The APHA standard technique 5220 C was used to determine COD [27]. A diluted wastewater sample was placed in a culture tube and prewashed with 20 percent sulfuric acid before being introduced to a potassium dichromate-digested solution. Sulfuric acid was carefully poured into the tube, forming an acid layer on top of the sample digestion solution layer. To completely mix the fluid, the culture tube was tightly closed and inverted numerous times. The tube was placed in a 150°C block digester and refluxed for 2 hours with a protective shield.

The tube was placed in the test tube rack after cooling to room temperature. The cap of the culture tube was removed, and a tiny TFE-coated magnetic stirring bar was introduced. While titrating with 0.10 M ferrous ammonium sulfate, 1 to 2 drops of ferroin indicator were introduced and agitated rapidly on the magnetic stirring bar. The endpoint was indicated by blue-green to reddish brown, but the blue-green reappeared after a minute. A blank was refluxed and titrated with distilled water and reagent.

2.4.9 Chloride content determination

A standard (0.0282N) silver nitrate solution from a burette was used to titrate 20 mL of the sample in a beaker with 4-5 drops of the freshly produced starch indicator, with steady stirring until the first permanent crimson colour showed. The Mohr method was used to determine the chloride content of the needed amount of silver nitrate by comparing it to pure water as a blank.

3. Results and Discussion

3.1 Moisture content

Moisture content (%) of the preserved skin is an essential parameter that can be used to assess the preservation procedure. The moisture content in the experimental (15% peel paste with 10% common salt) preservation methods compared to the conventional (50% salt) preservation methods throughout 12 days is illustrated in Fig.3.

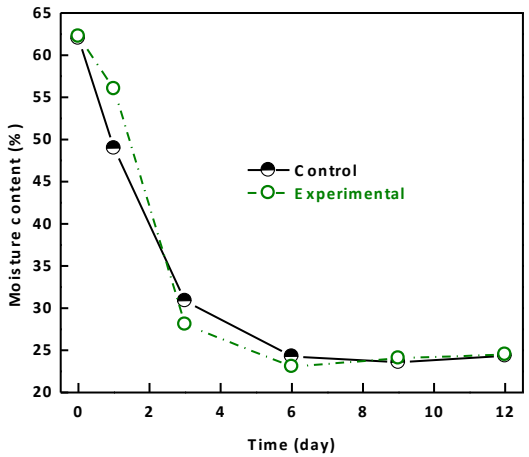

Fig.3 Moisture content in control (50% salt) and experimental (15% peel paste with 10% salt) of the preserved goatskins.

The fresh moisture content in the control preserved goatskin was higher than in the controlled experimental goatskin, as seen in Fig. The moisture content in both cases gradually declined from the initial moisture content to the 12th day, but no signs of putrefaction were found. The banana peel of *Musa acuminata* may possess antioxidant properties. This antioxidant can work against bacteria by disrupting their cell membranes [28]. Moisture content was gradually reduced in both preservation procedures, and it was lower than the critical moisture content (50%). The proportion of moisture content in both approaches was almost the same on the 6th, 9th, and 12th. There was no evidence of skin deterioration e.g. hair slip, odour, etc.

3.2 Hydrothermal stability

Hydrothermal stability (shrinkage temperature) is an important feature for preservation since it signals the structural breakdown of skin protein. From fresh to 12 days, the shrinkage temperature in control (50% salt) versus experimental (15% peel paste with 10% common salt) is illustrated in Fig.4.

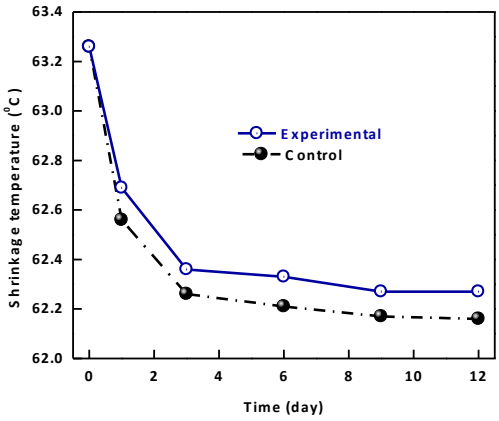

Fig.4 Shrinkage temperature in control (50% salt) and experimental (15% peel paste with 10% salt) of the preserved goatskins

The control and experimental shrinkage temperatures, according to the graph, were nearly identical.
The shrinkage temperature in the experimental (63.3°C, 62.7°C, 62.4°C, 62.3°C, 62.3°C, and 62.3°C) and control (63.3°C, 62.6°C, 62.30°C, 62.2°C, 62.2°C, and 62.2°C) preserved goatskins was 63.3°C, 62.6°C, 62.2°C, and 62.2°C) preserved goatskins was 63.3°C, 62.6°C. It appears that there were few differences in shrinkage temperatures between the experimental and control goatskins. As a result, preserving with *Musa acuminata* peel paste does not alter the hydrothermal stability of the goatskin collagen protein matrix.

3.3 Pollution load in soaking operation

Table 3 shows the pollution load of preserved goatskins during the soaking process for both control and experimental samples. When the current preservation method (15% peel paste with 10% common salt) was used instead of the control method (50% conventional salt), the chloride value was significantly reduced.

According to chloride and TDS were reduced by 45% and 50%, respectively. [29], however, the chlorides reduction value in this study was higher (50.02%) than [30], while the TDS reduction value was lower (23.28%) than [31]. TDS levels, on the other hand, should be higher than chloride levels, which was not the case here. This could be due to a TDS measuring machine error or chemical contaminants in the chloride concentration being measured. The BOD was likewise decreased by 57.14% when comparing the experimental soaking wastewater to the control. The organic content of the water used in soaking increases the BOD value, but distilled water was used in this study, resulting in very little organic and inorganic matter and lower BOD values in the soaking process. Chlorides and TDS in experimental soaking wastewater were reduced by 50.02% and 23.28% respectively, when compared to control soaking water, which was substantially better.

Table 3 Pollution load generated in the soaking process

Parameters	Control	This study	Ref. [25]	Unit
Cl^-	1999	999	9980	mg/L
TDS	7730	5930	21215	mg/L
BOD	700	300	1360	mg/L
COD	1920	1280	5644	mg/L

3.4 Hydroxyproline test

The hydroxyproline test is essential for tracing the changes in the collagen content of tissues through time. This necessitates the use of dependable and low-cost approaches for determining it. Here from table 4, it had been shown that with time proline, which is an important part of collagen, had degraded less. So, it proved that putrefaction had not occurred.

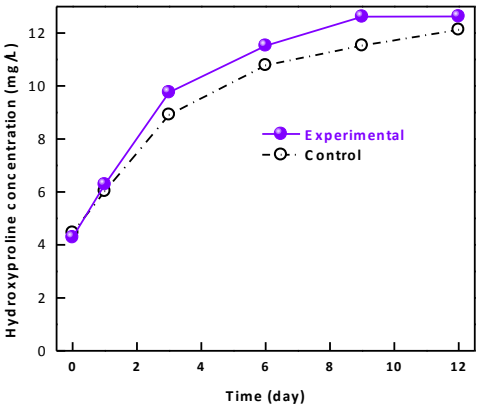

Fig.5 Hydroxyproline in control (50% salt) and experimental (15% peel paste with 10% salt) of the preserved goatskins

The hydroxyproline concentration in fresh goatskin was 4.5 mg/L for the control and 4.3 mg/L for the experimental, respectively. The concentration of hydroxyproline was gradually increased for both the control and experimental groups as the preservation period was increased. On the 6th day, hydroxyproline for

control and experimental was 10.8 mg/L and 11.5 mg/L, respectively. From day 6^{th} to 12^{th}, increasing hydroxyproline concentration was very less and became stable. It can be summarized that goatskin is preserved with the proposed technique.

4. Conclusion

The recently created, lower-salt preservation technique may reduce environmental risk. In comparison to traditional salt preservation, this method is therefore regarded as a cleaner preservation technique. The goatskin could be preserved with the *Musa acuminata* peel paste for up to 12 days without losing its physical or organoleptic qualities. The main issue with salt preservation is salinity, but when a 15% peel paste is combined with 10% regular salt, the salinity is significantly reduced. The new strategy is regarded as environmentally friendly because it reduces all pollution load parameters. The soaking process reduces pollution load parameters such as Cl, TDS, BOD, and COD by 50.02%, 23.28%, 57.14%, and 33.33%, respectively. Goatskin is alternatively preserved using *Musa acuminata* peel paste, and the recently discovered formulation (15% peel paste mixed with 10% table salt) could be a viable and sustainable alternative to traditional salt preservation.

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