Utilization of Limed Flesh Through Fat Extraction and Soap Preparation

Estehad Pathan, Sobur Ahmed, and Md. Saidur Rahman Shakil

Abstract—Leather industry is an export oriented industry in Bangladesh and earn significant amount of foreign currency by exporting leather, leather products, and footwear. It is a matter of great concern leather industry also produces lots of pollution and has dreadful impacts on our environment immensely. Leather processing (tanning) is a complex procedure comprising of several technological steps to shield the raw hide/skin against microbiological degradation as well as to stabilize collagen with defined tanning agents which produce a significant amount of waste. Wastes originate from all stages of leather manufacturing, such as tiny particles, residues from various tanning stages and reagents from different waste liquors comprising of cuttings of raw hides and skins, trimmings and shavings, fleshing residues, solid hair debris. This work is intended to fat extraction from the limed flashings for soap production. In leather processing, just after washing, following the liming process, swollen pelts (lime treated hide/skin) have to pass through an operation to remove the remaining fat and flesh from the flesh side in order to improve the diffusion of chemicals into pelt is known as fleshing. The process could be optimized for large scale production, which would be allowed to produce a new product for the commercial use. The approach could also contribute a significant reduction in the environmental impact of inevitable solid waste and decrease the costs associated with disposal.

***Index Terms*—Liming, Fleshings, Fat Extraction, Saponification, Deliming.**

I. Introduction

Cleaner production has become a critical issue for the industrial sectors, especially the leather sector to regulate environmental obligations. Therefore, tanneries are faced with dual obligations: a) using fewer chemicals more effectively, and b) improving the treatment technologies of all the forms of process residues. The leather sector is one of the most export-oriented sectors of Bangladesh, which plays an important role in the national economy and Bangladesh meets the demand for about 0.034% of the world's total leather market which is remarkable [1]. But due to generating the vigorous amount of environmental pollutants, the tannery has been categorized as 'red' category industry [2]. Tannery waste generation, disposal, and management are causing serious problems to survive tannery, especially in Bangladesh. Tannery produces a huge amount of environmental pollutants in the form of solid, liquid and gaseous besides it consumes substantial amounts of energy. There are 220 tanneries in Bangladesh and daily approximately 150 tons' solid waste is produced from the tannery in the form of trimmings of finished leather, shaving dust, hairs, trimmed animal flesh skin/hide which contaminate the soil and water [3]. Most of the tannery solid wastes are generated from pre-tanning operations, especially in fleshing operation. In tannery, firstly raw hide/skin undergoes the operation so-called unhairing and liming commonly known as liming [4]. In conventional liming operation sodium sulfide and lime are used to remove keratinous substances like hair, wool, epidermis etc. and interfibrillary proteins like albumins, globulins etc. After liming, pelt (lime treated hide/skin) has to pass through an operation known as Fleshing [5]. Fleshing is one of the most indispensable mechanical operations in leather processing where substantial amounts of solid waste (termed as fleshings) are produced. The 'fleshing operation' involves cutting or removing the unwanted part from the flesh side of pelt to improve the diffusion of tanning agents and chemical uptake into pelt from the flesh side. It is reported that fleshings are the 50–60 % of total solid wastes generated in the tanning industry [6]. Fleshings contain protein substances that are hydrolyzed to amino acids through proteolytic bacteria, amino acids are further hydrolyzed by bacteria, which liberate gaseous ammonia (NH_3), hydrogen (H_2), carbon dioxide (CO_2), volatile fatty acids (VFAs) etc. that are directly merged to the air. The VFAs help to generate toxic hydrogen sulfide (H_2S) gas from the fleshings. Individuals of the tannery area are frequently inhaled the liberated gaseous substances and suffering in difficulties [7]. Fleshings also have an adverse effect on water and soil. Fleshing's are composed of various constituents, e.g. subcutaneous tissue, fat and flesh among them fat content is 6- 15 % although the fat content varies according to the type of animal, feeding, climate and flaying method. The objective of this work was to optimize fat extraction process from the fleshings of cowhide and to utilize the extracted fat in new products e.g. soap, glycerin etc. production [8]. The initiative could reduce the pollution load generated by the tannery and also produce more commercially useful products. The following figures show the typical tanning process and cross section of wet blue leather.

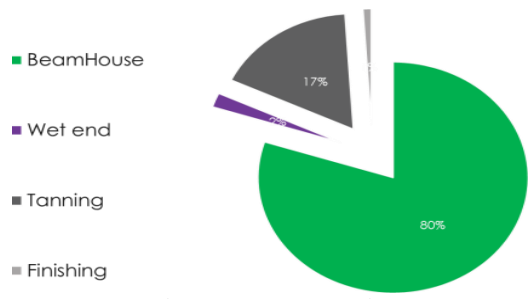

Fig 1. Percentage of solid waste generated from leather industry

Published on October 31, 2019.

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Fig 2. Flesh side of typical wet blue


Fig .3. Lime flesh

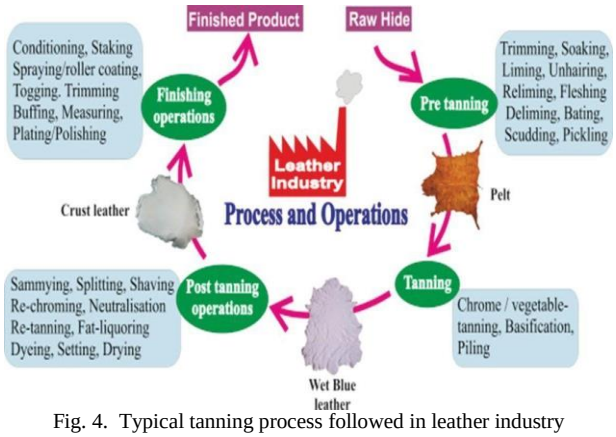

Fig. 4. Typical tanning process followed in leather industry

II. Materials and Methods:

For this study fleshs were collected from savar tannery site Dhaka, Bangladesh. For various chemicals reaction standard laboratory chemicals were used. For acid value, iodine value, saponification number following reagents were used:

Potassium Iodide, Standardized 0.1 N Sodium thiosulphate, 1% Starch indicator solution, distilled water, Hydrochloric acid, Sulphuric acid, Sodium Chloride, Alcohol, Potassium hydroxide, Phenolphthalein, 10% aqueous solution of potassium iodide.

A. Extraction of fat from cow hides and goat skins.

Deliming and Fleshings:

The collected fleshings were washed with water to remove unbound or free lime. Fleshings were chopped with knife into small size to facilitate the next operation. The fleshings were delimed with 1 % (w/w) boric acid for about 4–5 h to remove chemically bound lime. It is necessary to remove lime because this lime can precipitate other chemicals. The pH of delimed fleshings were adjusted to 5–6 by treating with dilute hydrochloric acid and further washed with water. [9]

B. Fat extraction:

Fat was extracted from the samples using Soxhlet apparatus with diethyl ether as the extracting solvent [10].The delimed fleshings were heated in a water bath to separate fat from its structure. The delimed fleshings were subjected to heating with water (water: fleshing =1:1) in a beaker in a water bath for 1–4hours. After distinct separation of the fat from the fleshings, the mixture was transferred to a separating funnel and finally the fat was separated from the residual water in fat was then distilled off.

The dry weight of total fat was calibrated by the following equation.

Extracted fat % = (W-M)/P

Where, W = weight of the conical flask with extracted fat after drying.

M = weight of the blank conical flask.

P = weight of the fleshings after drying.

Flowchart of soap preparation from limed fleshings.

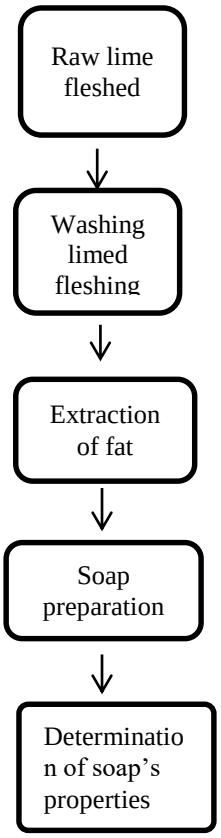

Fig. 5. Flow chart of soap preparation from lime flesh

C. Optimization of Extraction Process:

Trials were carried out to optimize the extraction process by varying the parameters like water bath temperature, agitation, time etc. The experiments performed for optimization of fat extraction are shown in figure-2(a). effect of temperature, figure-2(b) showed that with increased time percentage of fat extraction is rapidly raised up to certain level but if the extraction time is again extended, then percentage of fat extraction does increased sharply because of there is acid value also increased which hinds the percentage of fat extraction. The optimized conditions were established by investigating the percentage and the acid value of the extracted fat from the fleshings. The results obtained from trails to determine the effect of agitation to extract fat from the fleshings are represented in Figure. 2(c) positive result was perceived with agitation. Agitation increased the percentage of extracted fat, but on the contrary increased the acid value, i.e. contributed contamination of free fatty acid which was undesirable. With agitation leads optimum fat extraction thus

significantly acid value was increased. The best extraction of fat was attained with agitation even through there may be free acid developed which has negative effect on overall properties of fat [14]

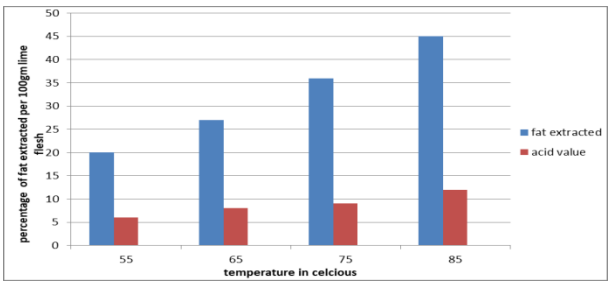

Fig. 5. Effect of temperature on fat extraction.

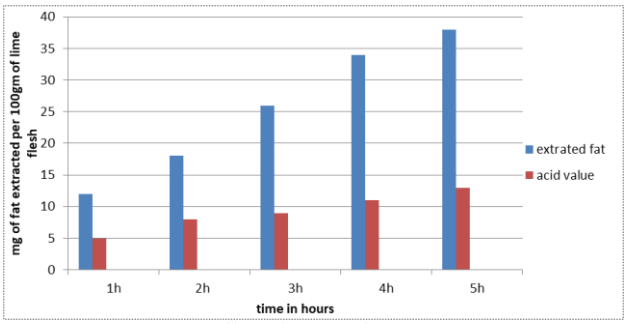

Fig .6. Effect of time on fat extraction.

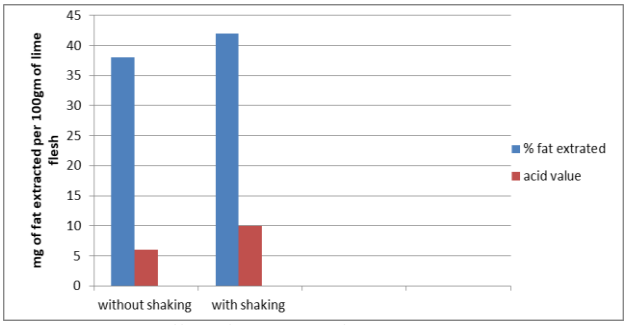

Fig.7. Effect of agitation in fat extraction process.

D. *Preparation of soap from extracted fat:*

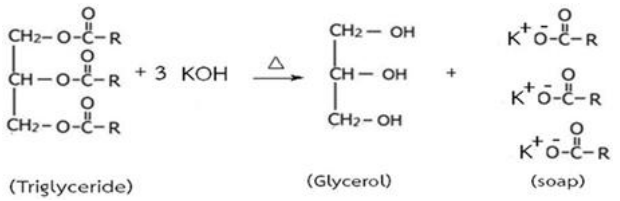

Fig. 8. Typical reaction involved in soap preparation

Soaps are prepared by the alkaline hydrolysis of fats and oils. This process is known as saponification. [12] Soaps are salts of fatty acids whereas fatty acids are saturated monocarboxylic acids that have long carbon chains (at least 10) e.g. CH_3 $(CH_2)_{14}$ COOH. Natural fats are increasingly becoming important in nutrition as well as the manufacturing industry worldwide [13]

A by-product of this reaction is glycerol which is useful as in foods, antifreeze and as moisturizing agent. The manufacturing of soap is a complex process that involves different activities and process. For the soap production, 5gm of solid sodium hydroxide and 15 ml of ethanol with 15ml distilled water were put into a beaker and stirred to dissolve the sodium hydroxide. 5gm of lard was added to short the reaction time. The flask was heated on the hotplate water surface which allows the reaction to reach its final point. This process was carried out for at least 30 minutes. While saponification was proceeding, a salt solution of 25gm of sodium chloride in 150 ml of water and a mixture of about 25ml of ice water was prepared. Sodium silicate is added when the soap is being cooled down. Sodium silicate hardens the soap. It eases removal of dirt and preventers deposition of dirt particles. After 40 minutes, the reaction was mixture into the salt solution followed by the filtering the mixture thoroughly for several mixtures through a funnel containing 2-3 layers of cheesecloth and finally liquid soap prepared. The color of the fat is light brown. The soap obtained was washed with 10 ml of distilled water, filtered using a linen cloth, air-dried, then a small amount of water was added to soften it whist heating [14]. The soap was allowed to dry.

1) *Properties of the soap*

The extracted fat was analyzed for some important physical and chemical properties. Fat yield, color, acid, iodine, saponification and values of the fat were determined using standard American Oil Chemists' Society methods. The knowledge of physical and chemical properties of fat is important. Acid value is often used an indicator for suitability for industrial use [15]

Oils with high acid value are not suitable for the soap making and paint industries. Low acid values indicate stability over long periods of storage and suitability for consumption. The iodine value is also an important characteristic of fat that guides its application in a processing industry [16]. Fat with iodine value of less than 65/100 g are classified as non-drying fat. The iodine value obtained in this study clearly indicates that fat oil is non-drying oil and could therefore be utilized as a raw material in the manufacture of leather as candle lubricants and hydraulic break fluids. The iodine value also indicates the degree of unsaturation of a fat or oil which reflects the susceptibility of the oil to oxidation reported that the lower the iodine value, the lesser the number of unsaturated bonds; thus, the lower the susceptibility of such oil to oxidative rancidity. The saponification value gives a measure of the average molecular weight of the fatty acids present in the fat which also govern the utilization of the fat [17]. The saponification value obtained in this study (170.5 mg/g) indicates the presence of higher molecular weight fatty acids in the fat and thus suitable for soap making. The results of this study show that the fat is potentially good source soap with low iodine and acid value. Physicochemical properties of fat indicate that it is non-drying fat, has low levels of polyunsaturated fatty acids and has low susceptibility to deterioration by oxidation [18]. Liquid soaps which are produced generally use for cleaning hands, and feature skin conditioners. However, there is need for further research on toxicity levels of the oil before its exploitation as edible oil in Malawi [19].

a) *Determination of Solubility:*

Solubility of soap describes inherent properties sodium and potassium based soaps. Every sodium soap has a large range of temperature between fair and high solubility,

whereas the potassium soaps go abruptly into solution, at almost the same temperature and concentration of each soap.

The solubility of the soap in water was examined by taking 5gm soap and 20 mL distilled water into a test tube. Then the soap and water were rinsed well and note was made to determine the solubility level.

b) Determination of pH

Testing the pH of soap is an easy way to be sure whereas the soap is safe to use, and doesn't contain any extra lye. The pH scale shows the strength of an acid or base. Soap with a high pH (above 10) is likely to be too harsh, or lye-heavy, for use. The pH of soap is an important indicator that the soap is safe to use. But it is believed that soaps which are within the normal pH range from 7 to 10 are suitable for used. This indicate that there is no free lye remaining in the soap (lye has a pH of 14). The soap was dissolved in distilled water in a beaker and the pH of the soap solution was measured by using the pH meter.

c) Determination of Lathering Power:

About 2 mL of deionized water added to four large test tubes. Then addition of an equal amount of soap solution to one test tube of water and mixed vigorously by placing a stopper in the tube. This mixing gave a permanent lather that lasts for at least 30sec.

d) Determination of Cleansing Power:

Most of the dirt is oily in nature and oil does not dissolve in water. The molecule of soap constitutes sodium or potassium salts of long-chain carboxylic acids. In the case of soaps, the carbon chain dissolves in oil and the ionic end dissolves in water. Thus the soap molecules form structures called micelles. In micelles, one end is towards the oil droplet and the other end which are the ionic faces outside. Therefore, it forms an emulsion in water and helps in dissolving the dirt when we wash our clothes.

Few drops of used motor bike oil were placed on a separate thin strip of filter paper. It was made sure that the strip of filter paper was fitted in the test tube. Filter paper with oil spot was placed in the tube containing soap in water. The tube was shaken well and made sure that the filter paper was immersed in the solution. After 2 min, the filter paper was removed and rinsed with tap water. The observation was made that whether if the oil of the filter paper strips gets washed out or not.

Physicochemical properties of the extracted fat are presented in below table

TABLE I: CHARACTERIZATION OF EXTRACTED SOAP

Parameter	Properties
1. Solubility of the soap	Moderate
2. pH of the soap	8.5
3. Lathering Power of the soap	Average
4. Cleansing Power of the soap	Average
5. Acid value	12
6. Iodine value	45
7.Saponification number	170.5
8. Free fatty acid	0.8

III. RESULT

Amount of extracted fat from cow hide and goat skin is shown in below table:

TABLE II: FAT GENERATED FROM COW AND GOAT

Cow (delimed flesh 76gm)	Goat (delimed flesh 76gm)
Extracted fat 8.96gm	Extracted fat 15.64gm

Flesh contains as much as 6-15% fat of its total weight it has found that in some cases its range may varies from 10-22% of the skin weight [20]. From the experiment it was found that goat skins contain large amount of natural fat compare to cow hides. So fat extraction process can be used to recover huge amount natural animal fat and convert that fat to produce commercially important product like soap. It was found that efficient temperature for the fat extraction process was 75^{0}C for 3 hours without agitation. If large amount of solid flesh can used to produce soap thus it is expected solid waste pollution is significantly abated.

IV. CONCLUSION:

In this study, main focus was to extract fat from cowhide and goat fleshings and convert fat into soap preparation. fleshings obtained from cow and goat showed that fleshing is a noteworthy source of the fat. It is expected that annually significant amount of fat could be extracted only from cowhide fleshings in Bangladesh. The enormous amount of extracted fat from the fleshings can be a potential source for the production of liquid or commercial soap. The characteristic prominence exhibited by the soap solution point out that the extracted fat is suitable for soap production especially for low leathering soap. The process could be implemented for the large-scale commercial production by rectifying specific parameters of soap production. The attempt could enable the production of valuable products like soap for the commercial use of the inevitable solid waste of tannery and consecutively could reduce the environmental pollution. Various Studies show that tannery solid wastes especially fleshing decreased soil fertility, pH, moisture contain, if these waste can utilize into sailable commercial product thus it is expected to lessen environmental degradation as well as unemployment by creating job opportunities.

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