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Generation of fleshings at beamhouse in tannery and its environmental impact assessment: Bangladesh perspective

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Abstract

Leather processing involves the conversion of putrescible hide/skin into imputrescible leather and consequently huge amount of solid waste generated in tanning process. In tannery at beamhouse, fleshing is one of the most indispensable mechanical operations in leather processing where significant amount of solid waste (termed as fleshings) is produced. A work was carried out to estimate the generated fleshing and to assess its environmental impact. In Bangladesh yearly 20.1×10^3 MT fleshings was generated only from cow hide and goat skin where 10.3×10^3 MT for cow hide and 9.8×10^3 MT for goat skin. The generated fleshings are usually kept indiscriminately inside or outside the industrial area as green. In rainy season, all fleshings including other solid wastes are washed away and finally fall in to the river, Buriganga. Fleshings contained alkaline pH (12.3 ± 0.2), fat, proteins, lime and sulphide. Improper management of fleshings has negative effect on human health, air, water, land and plant.

Keywords: Solid waste; Fleshings; Proteinaceous; Fats; Volatile Fatty Acids

Introduction

In Bangladesh, tannery plays a vital role regarding gross output, value addition, export earnings and employment. Export Promotion Bureau (EPB) reported that Bangladesh earned US\$1.29 billion in the fiscal year of 2013-2014 from the leather sector (EPB, 2014). It is a matter of distress that tanneries of Bangladesh are discharging solid and liquid wastes directly as green to the low-lying areas and residential area without any treatment (Zahid *et al.* 2006). Due to environmental pollution, Department of Environment (DoE), Bangladesh has been categorized the tannery as 'red' category industry. Tanning converts putrescible raw hide/skin into imputrescible leather (Covington, 2009). Tanning is a complex procedure comprising of several technological steps; each and every step in leather processing generates significant amounts of solid and liquid wastes as well as gaseous air pollutants. The generated solid and liquid wastes are mostly discharged without treatment from the tanneries at Hazaribagh, Dhaka is the main reason to pollute the river, Buriganga (Azom *et al.* 2012).

At different stages in leather processing tanneries generate a significant amount of solid wastes. The solid wastes consist of curing salt, raw trimmings, keratins (hair, wool, nail etc.), fleshings, shavings and buffing dust etc. It is obvious that quality and quantity of solid waste generation depend on

many features such as animal species, breeding conditions, slaughterhouse practices, conservation conditions, leather process stages, mechanical operations, qualification of the personnel, and chemicals used in processes (Ozgunay *et al.* 2007). In leather processing, from every 1000 kg raw hide/skin only 150 kg of the raw material is converted into leather and nearly 850 kg is generated as solid wastes (Kanagaraj *et al.* 2006). Most of the solid wastes are generated in beamhouse operations, especially in fleshing operation. In beamhouse, solid waste is generated during fleshing operation termed as 'fleshings' (Fig. 1). The operation involves cutting or removing the offal from the flesh side of hide/skin. In the conventional leather processing, fleshing is done just after liming. In this stage hide/skin is easier to handle due to swollen condition. The fleshing operation could be done manually or mechanically; whatever the method is applied, it produces a huge amount of inevitable solid waste. Fleshings contain sub-cutaneous tissue, fat and flesh. It contains protein 5–7%, fat 4–18%, lime 2–6%, sulphide 2–4% etc. (Lupo, 2006). In leather processing, fleshing is one of the most essential operations; skipping of fleshing operation would inhibit diffusion of tanning agents and other chemicals into hide/skin from the flesh side. As a result, chemicals will be wasted and quality leather will not be produced.

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In this study, an investigation has been carried out to estimate the generated solid waste in fleshing operation from the wet salted cow hide and goat skin as well as to assess its environmental effect.

Materials and methods

Study area

Tannery area at Hazaribagh, the western part of Dhaka city was selected to carry out the study, where 85% tanneries of Bangladesh are located (Bangladesh INSPIRED, 2013). One of the largest tanneries was selected to carry out the research work. The study area is shown in Fig. 2.

Materials

Wet salted cow hide and goat skin were collected from the local raw hide market of Postogola, Dhaka, Bangladesh. The conventional tannery machineries and chemicals were used for raw hide/skin processing. Wetting agent (Eusapon OC, BASF, Germany), fungicide (BUSAN 40L, Buckman, USA), sodium carbonate (Hainan Huarong, China), sodium sulphide (Hainan Huarong, China) and lime (CaO, Awal & Brothers Ltd. Bangladesh) were used to obtain desired effects. Digital balance (CAMRY, China) was used for weighing of hide/skin and chemicals.

Raw hide/skin processing at beamhouse

The sequential conventional beamhouse operations were carried out to estimate the generated fleshings. Fig. 3 shows the operational steps for the beamhouse operations. The collected wet salted cow hide and goat skin were taken for chemical and mechanical operations. The operations namely raw trimming, weighing, soaking, unhairing & liming and fleshing were carried out orderly. The details of the operations were shown in Table I.

Estimation of fleshings

Material balance technique was applied *i.e.* weighing the samples before and after operation to determine the generation of the solid waste. A series of cow hide and goat skin were weighed before and after fleshing operation to estimate the generation of fleshings.

Determination of pH of fleshings

To measure the pH of the fleshings, it was squeezed and the liquor was collected. The pH of collected liquor was measured using a calibrated pH meter (UPH-314, UNILAB, USA).

Environmental impact of fleshings

Physical monitoring was carried out with individuals at Hazaribagh tannery area as well as embankment area of river, Buriganga. Also interviews were made with the relevant personnel *i.e.* workers, tannery authorities and resident at Hazaribagh tannery area to assess the environmental effect of fleshings.

Results and discussion

Estimation of fleshings

The amount of fleshings was generated from the wet salted cow hide and wet salted goat skin is shown in Table II and Table III, respectively. It is clear from Table II that 0.31 kg fleshings were generated from every kg of wet salted cow hide in fleshing operation. Similarly, 0.39 kg fleshings were generated from every kg of wet salted goat skin (Table III). Based on the FAO report in 2012, yearly 33.80 thousand tons wet salted cow hide and 24.80 thousand tons of wet salted goat skin were taken for leather production in Bangladesh (FAO, 2013). It was estimated that yearly 10.3×10^3 MT fleshings from the wet salted cow hide and 9.8×10^3 MT fleshings from wet salted goat skin were generated during fleshing operation in tannery of Bangladesh. Annually, the sums of the fleshings both from cow hide and goat skin was estimated 20.1×10^3 MT. Generally, huge amount of generated solid waste is discharged as green directly from the tanneries and dumped nearby road side (Fig. 4).

pH of the fleshings

The pH of the fleshings for both cow hide and goat skin was highly alkaline (pH 12.3 ± 0.2). The highly alkaline pH has adverse effect on environment including aquatic life.

Effect of fleshings on human health

There is no direct effect of fleshings on human health as it contains proteinaceous substances, which are hydrolysed to amino acids by proteolytic bacteria. The amino acids are further hydrolysed by bacteria, which liberate NH_3 , H_2 and CO_2 . The fatty substances in fleshings are hydrolysed by bacteria and produced volatile fatty acids (VFAs) *i.e.* acetic acid, propionic acid and butanoic acid etc. (Shanmugam and Horan, 2009). The liberated gases are directly merged to the air. The produced VFAs help to generate toxic hydrogen sulphide (H_2S) gas from the fleshings. Individuals of the tannery area are frequently inhaled the liberated gases and suffering in difficulties. Hydrogen sulfide can affect the nervous system, and even exposure to high concentrations (> 900 ppm) for one minute can cause instant coma and death

(UNIDO, 2001). NH_3 irritates the eyes, respiratory tract and skin (USDHHS, 2004).

Effect of fleshings in atmosphere



Fig. 1. Generated fleshings in wheelbarrow



Fig. 2. The study area is located at Hazaribagh, Dhaka

Directly fleshings have no effect of in atmosphere. But the secondary substances like gaseous forms of H_2S , NH_3 , CO_2 and VFAs are produced from fleshings are directly merged to atmosphere. The so called volatile fatty acids (VFAs) such as acetic acid, propanoic acid and butanoic acid which are responsible to provide H-atom in the atmosphere (Atkinson, 1989). The fluxes of H_2S led to increase toxicity at atmosphere by atmospheric photochemical reaction. It also destroy ozone shield and increase the greenhouse methane gas (Kump *et al.* 2005). The exposed H_2S burns with blue flame to atmosphere and produces sulphur dioxide (SO_2) (OSHA, 2005). The sulphur dioxide is the major precursors

of acid rain; it reacts with atmospheric oxygen and water vapor to produce sulfuric acid, the so-called acid rain. Acid rain has the negative effect on soils, lakes and streams; it accelerates the corrosion of buildings and monuments and reduces the visibility (Padhan and Kumar, 2013). Ammonia is once emitted to atmosphere it could undergo conversion to NH_4^+ aerosol due to its highly reactive nature and quickly deposited near to the sources of emission (McCulloch *et al.* 1998). The conversion of NH_3 to NH_4^+ in aerosol or in clouds is depending on the concentration of acids in atmosphere.

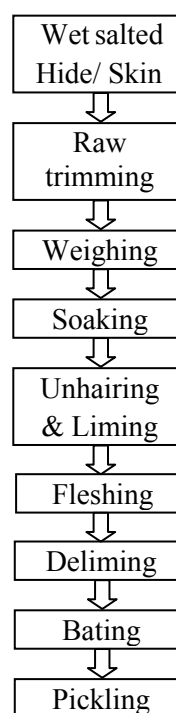


Fig. 3. Flow chart for the conventional beamhouse operation



Fig. 4. Dumped fleshings outside of the tannery

Table I. Processing of raw hide/skin at beamhouse (up to fleshings)

Operation	Chemicals	%	Remarks
Raw trimming			Trim unwanted parts from raw hide/skin
Weighing			All percentage of chemicals was taken based on raw weight.
Soaking	Water	400	Run 60 min, rest 90 min, run 5 min/hr. Duration 14 hrs.
	Wetting agent	0.5	
	Sodium carbonate	0.5	
	Bactericide	0.1	
Unhairing & Liming	Water	200	Drain the float Run 60 min, rest 90 min, run 5 min/hr. Duration 18 hrs. Drain the float
	Sodium sulphide	4.5	
	Lime	5.0	
Fleshing			Removal of flesh, sub-cutaneous tissue and fats from the flesh side

Table II. Generated amount of fleshings from wet salted cow hide

No.	Wt. of wet salted cow hide (kg)	Pelt wt. (kg)		Fleshings wt. (kg)	Fleshings (kg/kg)	Average wt. (kg/kg)
		Before fleshing	After fleshing			
01	22700.00	35716.80	27900.00	7816.80	0.34	
02	17000.00	25900.00	21100.00	4800.00	0.28	
03	20600.00	30894.40	25000.00	5894.40	0.29	0.31 ± 0.02
04	20200.00	31769.60	25700.00	6069.60	0.30	
05	21400.00	33656.00	27100.00	6556.00	0.31	

Effect of fleshings on aquatic life

In rainy season dumped fleshings and other solid wastes are washed away to low lying area and finally fall in to the river, Buriganga. Fleshings cause to increase the pH, biological

oxygen demand (BOD), chemical oxygen demand (COD), total solids (TS) and decrease the dissolved oxygen (DO) of the aquatic body. As a result aquatic balance is influenced by the fleshings.

Table III. Generated amount of fleshings from wet salted goat skin

No.	Wt. of wet salted goat skin (kg)	Pelt wt. (kg)		Fleshings wt. (kg)	Fleshings (kg/kg)	Average wt. (kg/kg)
		Before fleshing	After fleshing			
01	2900.00	3855.00	2700.00	1155.00	0.40	
02	2700.00	3802.05	2800.00	1002.05	0.37	
03	3050.00	4622.65	3300.00	1322.65	0.43	0.39 ± 0.02
04	3850.00	5086.10	3600.00	1486.10	0.39	
05	3550.00	4847.50	3500.00	1347.50	0.38	

Effect of fleshings on plant growth

Fleshings have alkaline pH because of lime which spoils the soil fertility. It contains sulfide which inhibit the growth of plants (Olson, 2012, Lamers *et al.* 2013). Due to its toxic effect on soil many plants are disappeared in the tannery area.

Conclusion

The work reveals that huge amount of fleshings was generated in fleshing operation from the tanneries at Hazaribagh, Bangladesh. Fleshings have the negative effect including human, air, water and land. Tannery authorities and leather engineers have two options: i) proper management of the fleshings *i.e.* collection of fats, proteins for by-product before disposal to the environment and/or ii) omitting the fleshing operation in leather production for the reduction of environmental impact. The second one is not possible because it is an essential operation for manufacturing of good quality leather. Leather engineers, researchers, tannery authorities should optimize the proper management of fleshings for environmental friendly leather production.

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