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# Soil chemical condition in the nearest tannery waste dumping place

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**Abstract**
The study purpose to know the soil chemical condition nearest tannery dumping area in Bangladesh. The existing management system of tannery solid wastes and its consequences were investigated through field survey with structured and unstructured questionnaire; the tannery workers, technologists, officials were interviewed during 2009-2011. The maximum amount of solid wastes generated was measured in the peak season (October-December) in the year 2011 through developed formula and found 443 metric ton solid wastes were generated in a day from tannery at Hazaribagh, Dhaka. It is observed that soil pH level very place to place. It was found that solid wastes impact soil organic matter directly. Chloride is one of the important indicators of soil pollution. Common salt adds to salinity of water. The salts concentration level in soil more than 1.35% is harmful to the plant life. Tannery solid wastes are mainly protein based wastes which are the polymers of amino acids, fatty acids etc.

**Keywords:** soil, chemical, condition, tannery waste, dumping, Bangladesh

## 1. Introduction
Bangladesh is densely populous country. The overall economic development of the country mainly depends on agriculture, industry, and trade and service sectors. The industrial blooms were come together in contributing to the national economy of the country from the mid seventy's when Jute and Leather industries in Bangladesh were developed on a large-scale basis. Previously, the leather industries especially tanneries were owned by Bangladeshi Traders from the Punjabi and Madraji traders after liberation war in 1971 while there were some tanneries owned by Bangladeshi people as well. The 350 numbers of industries were running with new management and tried to renovate across the country

Manufacturing of leather and leather goods produce high amount of wastewater, solid wastes and volatile emission containing different loads of pollutants. As a result, the leather industry as a whole is under critical condition, needs to review by the environmentalists throughout the world. There is no exception for Bangladesh.Toxic gases such as ammonia, acid vapour, hydrogen sulphide, sulphur dioxide, carbon dioxide chlorine etc. are also produced in different steps of leather production. In fact, there is no chemical which is absolutely devoid of any harmful effect to the environment, plant, animal and human health; the variation is in the use of doses and the degree of toxicity and/or harmful effect of the reagents used in the process.

There is no single process for producing leather without generating huge amount of wastes. Some of the wastes will arise from surplus, spent or washed-out chemicals used in the process. Some chemical constituents may be toxic while others are powerful pollutants in water and on soil. The release of volatile sulphides contributes obnoxious and toxic odors. Certain solvent vapors can have adverse health effects after prolonged exposure.

The solid wastes generating from leather processing consists of raw trimmings, hair & wool, flashings, wet blue trimmings, splitting, shaving dusts, buffing dusts, dyed trimmings, salts, lime sludge etc. 98 MT solid wastes were generated every day from the tanneries of Bangladesh.

According to the SHED Report (2002) and UNIDO Report (2006), about 89% of the tannery worker suffered from general illness. They need to take medical treatment sometimes and thus they are getting looser in their income. Therefore, the cost of human health impacts on the cost of living and their social status are evident due to income loss in absentia, loss of working hour, loss of efficiency, saving loss for the treatment and taking medical attention and occurring malnutrition resulting poor health of the earners and their family members.

Sykes [1] indicated some areas in which the leather industry would need to direct technical resources, not necessarily to improve its product, but to comply with social demands which might frequently have the support of legislative action; he also said that essentially industries used resources wastefully and with little thought for the future as well as it contaminated the environment with the by-products of its operations and was therefore uncaring of people.

(Islam [2], Kaisar [3], Rahaman [4]) reported that the untreated liquid and solid wastes of tannery were discharged directly through the roadside drain and deposited to the nearby low lying areas and finally fallen to the river Buriganga which were spreading the environmental pollution. Mondal also did the repeated work and showed the environmental impact of the City Protection Embankment at Hazaribag; as he found the sluice gate remain closed year after year and huge waste and garbage discharged from the tanneries remain stagnant at the upstream and the low lying lands from Lalbagh to Rayer Bazar Shikder Medical College which were filled with those poisonous wastes resulting the land fertility was destroyed and the grass and shrub got faded and stained [5]. Yousuf did the work repeatedly. But nobody showed the data on the exact amount of solid wastes discharged from the leather manufacturing industries and the way of mitigating pollution [6].

Springer concerned about tannery solid wastes and classified it as Hazardous, Non Inert, and Inert with characteristics of Inflammability, Corrosiveness, Reactivity, and Toxicity; he also enlisted the possible utilization of it by following IULTCS compilation of by-products. His work was outstanding and showing the actual possibility of utilization of solid wastes but he did not mention the procedure of by-product production [7].

Brown *et al., were* first to develop the process to extract protein hydrolysate from contaminated leather waste. He extracted gelatin from chromium leather waste subsequently developed a two-step process that allowed a protein product to be isolated in the first step followed by a lower molecular weight, hydrolyzed protein product obtained enzymatic treatment of the remaining chrome sludge, a recyclable chromium product was also obtained. But he was considering only the chrome sludge containing chrome shaving dust and trimmings [8].

Rose *et al.* mentioned the uses of collagen contained in hides and skins as an adhesive as well as they highlighted on the use of collagen in food, cosmetics and brewing industries. This was a hypothetical attempt to use tannery solid wastes by converting it to animal glue and other products but did not mention the process of conversion clearly [9].

Puntener first published the tanner's responsibility for active environmental protection was being assigned more and more importance in the society. He mentioned that the reduction of pollution in tannery waste was being tackled on three fronts, such as, tanneries were optimizing and reducing their overall chemical consumption and improving waste-water purification; tanneries were more efficient in their use of chrome and were selectively employing non-chrome procedures; and lastly, recycling of leather production waste was being more actively promoted. This paper also presented simple environmental balance scheme and showed a new tanning system which supplements existing tanning procedures [10].

Rutland introduced different phenomenon of waste disposal and leather manufacturing. He suggested making all process of tannery be eco-efficient or environmentally conscious, which was reached by the delivery of competitively, priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle to a level at least in line with the Earth's estimated carrying capacity [11].

(Lewis [12], Kumaraguru *et al.*, [13] described about the utilization of the lime fleshings for making tallow or extracting amino acids and free fatty acids; continually, Cantera *et al.*, [14] also mentioned another possible way of using hair for felt manufacturing, organic fertilizer, biogas generation, regeneration of keratin, recover melanin for manufacturing sun-block lotions, manufacturing of nylon 6.6, etc.; Erickson [15] stated about the alkaline hydrolysis process of chrome shaving dust for extraction of amino acid solution which could be used as a new raw material in powder form for animal feed manufacturing, fish feed manufacturing, foam enhancer, etc.; Taylor *et al.*, [16] also discussed about the protein recovery from chrome shaving dust with cost estimation. Finally, Bossche [17] discussed about the uses of incineration for burning of chrome containing sludge and Reutlingen [18] described about the legislation governing tannery solid wastes as feed for animals and toxic sludge for disposal as land fill.

Shelly*et al.,* did research work on making Gelatin from wet blue shavings by protein hydrolysis method; Chen *et al.*, [19] also mentioned about the hydrolysis process for protein extraction; Bowden described the conversion of tannery solid waste materials into useful energy like biogas; Crispim *et al.*, [20] also stated the biogas production from tannery solid wastes; Bitisli *et al.*, [21] experimented on using fleshing and vegetable shaving wastes in production porous brick; Puig *et al.*, [22] first suggested about the separate leather estate for all through controlling pollution; Galarza *et al.*, [23] also suggested to control pollution hypothetically.

The study aims to know the soil chemical condition nearest tannery dumping area in Bangladesh.

## 2. Methodology

As the study was related with utilization of tannery solid wastes converting to glue, it required extensive field work for collecting data, experimental work for modifying glue manufacturing process which should not make any harm to our environment on trial and error basis, and laboratory work for analyzing soil, effluent, and the quality of glue produced from the wastes. Thus this study was the combination of experimental research and applied research consisting field survey, analytical works and technological modification. The analytical part of the study was carried out at Institute of Environmental Science (IES), University of Rajshahi and Bangladesh Council of Scientific and Industrial Research (BCSIR) Laboratory, Dhaka. Moreover, the modified method of glue production was followed in the bulk production of animal glue which was carried out in a glue manufacturing factory adjacent to the tannery, M/S. Kalim Leathers located at Hazaribagh.

A total of 60 acres of lands occupied by the tanneries at Hazaribagh of Dhaka city (BSCIC survey report, 2002) was clustered in 5 different blocks (B-1: Monessware Road Block, B-2: Sher-e Bangla Road Block, B-3: Mid Hazaribagh Block, B-4: Sonatangar/Gojmohal Block and B-5: Kalu Nagar Block) for collecting primary data by applying pre-tested unstructured and structured questionnaires.

The survey questionnaire was prepared to find out the number of tannery situated in Hazaribagh area as well as the maximum pieces of cow hide, buffalo hide, goat skin, and

sheep skins processed by those tanneries in a day which was converted into weight as metric ton by applying the formula developed:

$$W = \frac{w \times n}{1000} \quad (1)$$

Here,
W = Weight of Hides/Skins (in MT)
w = Weight of Hides/Skins (in Kg/Piece) *
n = Number of Hides/Skins (in Piece)
*N.B. The average weight of one-piece raw cow hide, buffalo hide, goat/sheep skin are 12 Kg, 22 Kg and 1.5 Kg per piece respectively (UNIDO report, 2006).
Similarly, the amount of solid wastes generated was also quantified by using formula developed based on calculated raw weight of the hides and skins processed.

$$M = \frac{W \times p}{1000} \quad (2)$$

Here,
M = Weight of Solid Wastes generated (in MT)
W = Weight of Hides/Skins processed (in MT)
p = Weight of Solid Wastes generated (in Kg) **
**N.B. 1000 Kg raw hides yields approximately 430 Kg Raw Trimmings, 250 Kg Shavings/Flashings and 20 Kg Crust and Finished Leather Trimming. (Puntener, 1995).
Besides, the number of workers worked in those tanneries was also counted. The researcher used door to door method for collecting required information and made for direct observation, participant observation, and personal interview of related people such as executives, technologists, officers, workers, and experts to find out the impact of tannery solid wastes on people, economy and their socio-economic status.

## 3. Result and discussion

It was observed that 112 working tanneries found in the Hazaribagh tannery area of Dhaka city processed maximum 632.58 metric ton raw hides & skins in a day during the tenure of survey 2011 with involving 882 trimmers (tannery workers) who worked in the solid waste generating process producing 443 metric ton solid wastes.

### 3.1 pH

It was found that solid wastes do not impact pH of soil as much it affects in Company Ghat area. The pH of this area is found 4.08 which indicate that the solid wastes is decomposed in this low land and the acidic leachate come out by the decomposition contaminating and reducing the soil ph.
On the other hand, due to the heavy suspended solids present in the effluents sludge banks are formed in the receiving body and present an unsightly appearance. The suspended matter gets deposited on the bed and decomposed and reducing the soil ph. Anaerobic conditions may develop in such sludge beds resulting in the emanation of foul odors and buoying up of dark colored sludge particles to the surface. Local people mentioned that some vegetables and crops were cultivated in this low land during winter season many years before; but at present this land is becoming uncultivable. They also mentioned that this place is overflowed during the rainy season and the wastes are carried to the river Buriganga.

### 3.2 Soil organic matter

Solid wastes generated from tannery mainly contain hair & wool, hide scraps, fats and fleshings. All these wastes are biodegradable in nature. Chemically, hair & wool contains keratin, hide scraps contain collagen, fats and flashings contain fatty acids and collagenous tissues (Dutta, 1999). Moreover, these wastes contain polyamide based organic matter. So when these wastes become decomposed by bacterial digestion system, the residues are mixing with the soil and increase the soil organic matter.
It was found that solid wastes impact soil organic matter directly. The percentage of soil organic matter is beyond the soil standard in every places of the sample location. It was much higher (13.7%) near the flood protection embankment (Beribandh) than any other location. Because most of the wastes being dumped here. Kalunagar is far away from the previous place and thus the soil of this place is less contaminated. It seems that if the soil contains more organic matter then the soil becomes more fertile. But this is not true in all cases. Because, these protein wastes containing high amount of carbon, nitrogen and toxic materials which reduce the soil fertility (Sharma, 2003).

### 3.3 Total nitrogen

From the previous discussion it is found that, Solid wastes generated from tannery containing protein based wastes referring to collagen, keratin, fatty acids, etc. It is known to all that all proteins are made up of large number of units known as amino acid residues, each of which is composed of a small number of atoms. An amino acid, like other materials that go to make up a polymer, is bi-functional, that is, it has two places at which it can join on to something else. In the case of amino acid, these two places are amino group and the carboxyl group. The amino group contains nitrogen.
There are twenty different amino acids found in the hides and skins. Consequently, the amino group of one amino acid can join with the acid group of another amino acid, and this process can continue, so that a long chain of amino acids attached to one another can be built up and form the polyamide bondage.
When the protein wastes are decomposed then the polyamide bondage is broken down. Amino residue is coming up and mixing with soil and the soil bacteria further breaks the amino groups and nitrogen is come out. It has been found in the analysis that the total nitrogen content of the soil collected from S-1 near to the embankment much higher than any other places due to the close dumping of solid wastes. Gradually the values of nitrogen content have been reduced.
It has also been observed that raw trimmings are being dumped by the roadside on the embankment, but in other places the fleshing's and other solid wastes bonding with chemicals being dumped which contain less nitrogen and are not easily decomposed.
Moreover, local poor people are using dried solid wastes for fireworks for cooking purpose resulting the emanation of nitrogen to air. This is another cause of reducing the soil nitrogen in the sampling places.

### 3.4 Total chloride

When the tannery waste gains access to cultivable lands or when the land is irrigated with such waste, it loose fertility. The wastes may change the characteristics of the soil and also may interfere with the water uptake of the plants. It influences the metabolic activities of the plants, resulting into reduced yield.

Chloride is one of the important indicators of soil pollution. Common salt adds to salinity of water. The salts concentration level in soil more than 1.35% is harmful to the plant life. Salts reduce the fertility of agricultural land. If the salt builds up in soil exceed the trees or crops salinity tolerance reduction in growth or even death of the plant could occur. The high content of salt in sludge might prevent its use for composting and soil conditioning. Also the accumulation of sodium in the soil can cause deterioration in soil physical properties specially in porosity and permeability to water. High concentration of sodium affects the fertility of the soil. This is called 'Sodium hazard' to the soil. It corrodes the metal also. The local people have mentioned that their metallic home appliances are being poured in this area within a few years (Sharma, 1999).

Bangladesh has an abundant supply of raw hides and skins. It is not always possible to send the hides and skins to tanneries immediately after flaying because the sources of collection and the tanneries are not generally located in the same area. The time gap between the flaying operation and the start of tannery operations vary from one to two months. If hides and skins are not cured just after flaying, they get completely putrefied within 2 to 3 days. Curing is, therefore, the process by which we can protect putrefaction of raw hides and skins. Normally it is done by applying common salt on flesh side of the flayed hides and skins in our country. This is called wet-salting method of curing. This is the cheapest way of curing.

Therefore, when the raw trimmings are dumped in the low land of the area salt also be dumped along with the wastes. Thus the salt level of soil is found high in the Beribandh of the sampling location. It is washed out by the overflowed water to other places of it.

### 3.5 Total organic carbon

Soil carbon is the generic name for carbon held within the soil, primarily in association with its organic content. Soil carbon is the largest terrestrial pool of carbon. Humans have, and will likely continue to have, significantly impacted on the size of this pool. Soil carbon plays a key role in the carbon cycle and thus is important in global climate models.

Soil carbon is primarily composed of biomass and non-biomass carbon sources. Biomass carbon primarily includes various bacteria and fungi. Non-biomass carbon sources or substrates reflect the chemical composition of plant biomass and primarily include cellulose, starch, lignin and other diverse organic carbon compounds. Some of the substrate carbon will bind to the mineral soil becoming encapsulated in soil aggregates.

Soil carbon improves the physical properties of soil. It increases the Cation Exchange Capacity (CEC) and water-holding capacity of sandy soil and it contributes to the structural stability of clay soils by helping to bind particles into aggregates. Soil organic matter, of which carbon is a major part, holds a great proportion of nutrients, cations and trace elements that are of importance to plant growth. It prevents nutrient leaching and is integral to the organic acids that make minerals available to plants. It also buffers soil from strong changes in pH. It is widely accepted that the carbon content of soil is a major factor in its overall health. Although exact quantities cannot be documented but it is calculated that on an average 1.85% of total organic carbon is good for soil structure.

Tannery solid wastes are mainly protein based wastes which are the polymers of amino acids, fatty acids etc. Amino acids have two functional groups; one is amino group which contains nitrogen and other group is carboxyl group containing carbon. Therefore, all these organic materials contain high amount of nitrogen, Hydrogen and Carbon.

The sample location, refers to the Beribandh near Flood Protection Embankment is the main dumping ground of tannery solid wastes. This is why the decomposition of protein produces high amount of organic carbon here.

### 3.6 Total Chromium

Chromium is a lustrous, brittle, hard metal. Its color is silver-gray and it can be highly polished. It does not tarnish in air, when heated it burns and forms the green chromic oxide. Chromium is unstable in oxygen, it immediately produces a thin oxide layer that is impermeable to oxygen and protects the metal below.

A suite of industrial activities has led to widespread Cr contamination within soils and natural waters. Although Cr is an essential element for humans, the hexavalent form is toxic, mutagenic, and carcinogenic (National Research Council, 1974). As such, the widespread presence of Cr in the environment poses a serious threat to human and animal welfare. The toxicity of Cr, however, is a function of oxidation state. Hexavalent Cr, which typically exists as the oxyanion chromate ($CrO_4^{2-}$), has a high solubility in soils and groundwater and, as a consequence, tends to be mobile in the environment.

The high amount of chromium has been found in the soil near embankment which is the main dumping ground of the tannery solid wastes. It has been observed that there is no plant or trees and even grass cannot grow on this soil. It has also been observed that poor people living on this area are using dried solid wastes for their daily fireworks. Therefore, trivalent chromium can easily be converted to the hexavalent chromium by heating. So the poor people living in this area are not aware as much as they can protect themselves from chromium toxicity. Thus there is a huge possibility to spread the chromium pollution among the local people and their lives become endangered.

The above data focuses on how the solid wastes containing toxic chemicals used in tanning process could be injurious to human health as the proper safety precautions are not taken; some are known human carcinogens causing cancer. Despite this, many workers complained that their tannery did not supply protective equipment such as gloves, masks, boots, and aprons, or supplied it in insufficient quantities. Additionally, they are not well informed and aware about the occupational safety and hazards. They are not practicing Occupational Safety and Health rule in their workplaces. Therefore, they are suffering from various diseases and losing socio-economic status.

Finally, the observed effect of tannery solid wastes is mentioned below-

- Land occupied by solid wastes.
- Substantial quantity of solid wastes being dumped by the roadside, which are washed-out filling the drain and canal reducing their carrying capacity.
- Pungent odour come out.
- Scavengers spread out the solid wastes.
- Workers and people suffer from different diseases such as, Allergy, Skin diseases, Nausea, Vomiting, Headache, Sinusitis, Bronchitis, Respiratory problems, Heart diseases, etc.

On the other hand, it was found that a few by-product industries produced animal glue, poultry feed, fish feed etc. from using limited amount of solid wastes generating from

tannery by following traditional method of production which was not scientific and exaggerate the air pollution to the city. It was also revealed that animal glue was produced from using raw trimmings only; to utilize more solid wastes, the manufacturing of Animal glue has been selected as a tool of waste management producing by-product. Its traditional glue manufacturing process was modified and producing animal glue from fleshing's and pickle cuttings (solid wastes) mixing with raw trimmings which imparted better physical and chemical properties compare to the sample glue collected from local market manufactured following traditional method. The effluent generating from glue manufacturing process were collected, analyzed and found similarity with those effluents generating from the tannery. So it can be easily manageable through effluent treatment plant.

The main target of this research have enhanced the by-product industry through process modification and integrating with the main industry so that the solid wastes generated from tannery need not to dump and used at the point of origin triggered to the eco-friendly environment. The findings of this work along with the findings of the previous researchers triggered a hope for further progress in research in the field of leather technology and by-product.

We know that, there are four determinants of organizational structure viz. Strategy, Size, Technology, and Environment. The by-product industry itself small in size, using traditional technology and cannot mitigate the environmental pollution. So, the concern authority would have the strategy that the glue manufacturing industry (by-product industry) must be set up adjacent to the tannery. This study has chosen the location for glue manufacturing which is close to the tannery named M/S. Kalim leather. It helps to collect solid wastes with low labor-costs. Moreover, the solid wastes need not to dump in different locations which avoid the carrying costs involved and reducing the pollution.

Strategically, the layout plan has been drawn including tannery and the by-product industry. So, we can conclude this discussion, as for explosive growth and consistent innovation boundary less organic structure of organization has the suitability depending on its small size and local technology being used. Finally, the effluent might be managed through central effluent treatment plant (CETP). Therefore, this is an aggregate comprehensive batch processing model of production though it faced some limitations as mentioned below:

Raw trimmings, fleshing's and pickle cuttings were utilized in glue manufacturing process but it required high technology to converting other solid wastes into product which is unavailable in the country.

Huge costs were invoked in trial process. Till than the primary cost effective study revealed that the establishment of animal glue production industry incorporating developed modified methods will be profitable venture for new entrepreneurs creating new employment opportunities and scientific waste management approach in the field of tannery industry as well as to ensure the eco-friendly environment, the most urgent need of the day for sustaining foreign currency earning leather industry of Bangladesh.

## 4. Conclusion

Naturally Bangladesh has abandoned supply of raw hides and skins, cheap labourers so that Leather industries of Bangladesh should be operated well with utilizing those available resources. But it was found in the tenure of this study that numbers of tanneries were being reduced gradually year after year due to unplanned industrialization, lack of knowledge of tannery people on environmental concerns and uncontrolled generation and dumping of wastes. It was also notified that huge amount of solid wastes was generated during processing of leather in tannery and spread the pollution over a large area of Dhaka due to uncontrolled dumping of it. It was also observed that in the present system of leather processing, solid wastes generation cannot be minimised for ensuring leather quality as well as there was no scope of set up new mechanism of scientific wastes management plant in Hazaribagh congested area to protect environment from tannery solid wastes pollution. So government has taken initiative to relocate tannery from Hazaribagh to Savar, Dhaka with set up effluent treatment plan for effluent management and dumping ground for scientific dumping of solid wastes.

But it should be considered that solid wastes are the part of valuable resources and required to utilize through process development and modification of by-product industry. And the by-product industry should be set up adjacent to the tanneries which minimising the transportation cost of wastes as well as the wastes would be utilized at the point of origin so that environment would be clean and eco-friendly.

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