

Hexavalent Chromium in Tannery Solid Waste Based Poultry Feed in Bangladesh and Its Transfer to Food Chain

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Abstract: Solid tannery waste from the Hazaribagh area in the outskirts of Dhaka city is used as the principal component of poultry feed, fish feed and fertilizers. Although total chromium content in tannery waste based poultry feed has been determined previously, no studies appear to have been made on the hexavalent chromium which is much more toxic than trivalent chromium and is a carcinogen. The USEPA method 3060A which involves alkaline digestion to prohibit inter-conversion of Cr (III) and Cr (VI) has been used to solubilize chromium from the samples. The well-established spectrophotometric method (EPA method 7196A) has been employed to measure Cr (VI) concentrations at 540 nm in different samples. A total of 42 samples including solid leather waste, poultry feed, chicken livers and eggs were analyzed. Out of 5 skin-cuts two have shown the presence of Cr (VI). The amounts of Cr (VI) that have been found in 6 of the poultry samples are significantly higher (except one) than those found in skin-cut samples. About 25% of the chicken liver has been found to contain Cr (VI). It is reasonable to assume that this has come from the poultry feed.

Keywords: Hexavalent chromium, tannery waste, poultry feed, Hazaribagh, EPA method 3060A and 7196A.

I. Introduction

The tanning industries of Hazaribagh area of Dhaka city are processing some 220 metric tons of hide a day with an associated release of 600 - 1000 kg of solid waste for each ton of processed hide [2]. At present, several large mills and many locals are involved in converting the solid wastes into protein-concentrate for mixing into poultry feed. Each large mill produces 200-250 tons of protein-concentrate per day [2].

Previously, large quantities of solid leather wastes were disposed of through landfills. This caused leaching out of chromium in the soil making it unfit for cultivation and other uses. Increased environmental restrictions and escalating landfill costs have encouraged the leather industry to develop cleaner technology by minimizing wastes generated and maximizing those reused. Hence, to reduce the landfill problem of chrome leather pieces, they are currently being used as either poultry feed or fertilizer. It is stated in one of the leading newspapers [3] that previously, tannery owners had to spend around BDT 1,000 each time they cleaned the waste but now, they are earning a fortune by selling wastes. Every day the owners sell 1-5 metric tons of tannery waste to traders. It is found that an owner of a Hazaribagh feed factory pays BDT 5 to 15 lakh in advance to collect skin-cut waste per annum [3]. After the collection of solid wastes, they boil the waste in big containers and dry it in the sun for five days. They sell the dried products to middlemen. They are capable of supplying up to 200 kg of raw products every day to the middlemen, who grind and sell those to fish and poultry feed factories. There are around 10 grinding mills in Hazaribagh area. A middleman sells around five metric tons of meat bone every day to various feed factories and retailers across the country. It is also reported that traders used to import a kilogram of meat bone at BDT 10 five years ago, which is now BDT 35 a kg [3]. On the other hand, meat bone made of tannery waste only costs BDT 20 to 22 per kg. Moreover, compared to the imported protein, only half the amount of skin-cut meat bone is required to manufacture one kg of feed [3]. Generally, one kg poultry feed uses 60% meat bone, 40% other ingredients like soya oil cake, ground rice and dry fish [3]. Thus, almost all the feed factories prefer tannery waste-turned meat bone to imported protein. At present, there are around 70 big and medium and 300 small feed factories in the country [2].

A study conducted in 2007 by Dhaka University and Bangladesh Council for Scientific and Industrial Research (BCSIR) revealed higher amounts of chromium in eggs and poultry meat than the tolerable limit. The maximum chromium content of solid waste was found to be 3.2037 % [7]. Data analysis showed that boiling and drying treatments brought no significant change in chromium levels in collected samples. Protein-concentrate sampled from a feed mill at Hazaribagh produced chromium concentration of 2.4901% as element [7]. Cadmium, lead, arsenic, and mercury contents of all samples were also determined. The results obtained here (please delete the word) are in conformity with the fact that 80% tanneries of Bangladesh practice chrome tanning procedure. Whereas chromium has been found in percentage level, other heavy metals are at parts per million (ppm) levels [7].

The factors that possibly turn up the oxidation of the trivalent chromium into the hexavalent form are as follows:

- Quality of chemicals, especially, chrome tanning agents,

- Photo-ageing by air subjected to UV lights,
- Oxidation by air favored at high pH,
- High temperature (like heating at 80°C),
- Unsuitable storage conditions, and
- Influence of natural fat.

Oxidation of Cr (III) into Cr (VI) normally occurs in presence of strong oxidation agent in acid environment. But it can also take place in presence of mild oxidizing agents at high pH. In leather processing, liming, pickling and neutralization are the stages when there are possibilities of occurring such conditions [6].

The supposed mechanism of Cr (VI) formation in leather has been proposed by several authors [5, 6]. This mechanism is connected with the oxidation of unsaturated fats by free radicals that are formed by UV light from a molecule whose normal covalent bond is split to create two unstable moieties. These free radicals react with oxygen, developing very reactive derivatives (please delete the word) derivatives such as, peroxides, and radicals such as, HO[•], RO[•] and ROO[•] which are strong oxidants. Probably this is the reason for chromium oxidation in light [6].

It has also been observed [6] that the more the trivalent chromium used and higher the ironing temperature applied, the higher the hexavalent chromium level. Ferreira et al. [5] identified the increased levels of Cr (VI) in the ash from solid tannery waste or leather samples as depending on the temperature and the holding time after heating in the 300-1000°C ranges. The leather ashes showed higher Cr (VI) levels for burning temperatures < 500°C and > 800°C. The longer the holding time, the less Cr (VI) was detected.

Poor storage conditions lead to formation of Cr (VI) from Cr (III) in skin-cuts and leather. The influence of the relative humidity of air might be a reason of Cr (VI) formation in chrome tanned leathers during storage. It was found that Cr (VI) can be formed if the relative humidity of the air is under 35% [6].

The chemical and toxicological behaviors of chromium salts depend on the oxidation state of chromium. The USEPA has listed chromium as one of 129 priority pollutants and it is considered as one of the most noxious heavy metals. Chromium can exist in many oxidation states but its most stable forms are Cr (III) and Cr (VI). Whereas Cr (III) is useful and essential in small amounts for human health and its deficiency causes certain diseases, Cr (VI) is highly toxic and responsible for health hazards like mutation, cancer and cell damage [1].

From the point of view of public health, it would be much more pertinent and important to know how much Cr (VI) is there in the feed and how much is going into chicken and eggs. The present work has therefore been devoted entirely to the determination of Cr (VI) in protein-concentrate, poultry feed, chicken and eggs. The paper focuses on to study the hexavalent chromium status of protein-concentrate at every detail right from the source (e.g. wet blue leather, shaving and crusted parts of leather) to the final product (feed in the market). The possibilities of Cr (VI) entering the food chain through chickens and eggs were also examined.

II. Methodology

2.1 Study area

Hazaribagh is situated on the south-west part of the capital Dhaka with an area of 3.58 square kilometer. It is located between 23°43.85' to 23°44.05' N latitude and 90°21.85' to 90°22.15' E longitude [7].

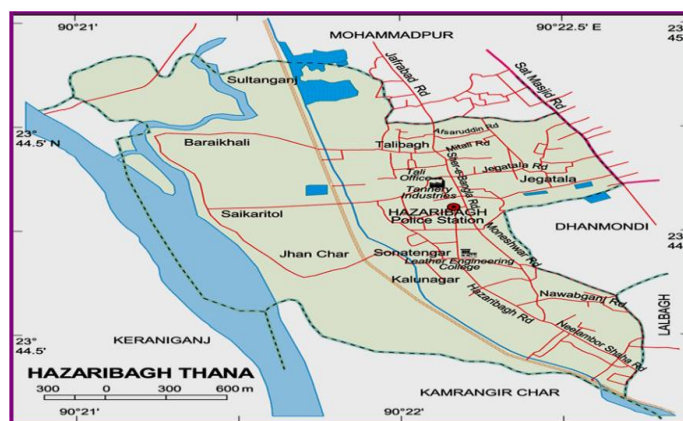


Figure 1: Map of Hazaribagh Area

2.2 Sampling and sample size

For the research purpose, the protein-concentrate production processes practiced at Hazaribagh were first surveyed and observed. In addition, locals of each sampling area were interviewed. The in-depth interview

and the personal observation helped to know the amount of tannery solid waste, the frequency of application of skin-cut wastes in making feeds, feed producers, and the distribution of feeds etc.

Overall 42 samples were collected in pre-cleaned plastic or glass sample bottles. Samples were collected from different spots at Hazaribagh and from its adjacent areas. These areas were the neighborhood of Hazaribagh Police Station, feed mills at Hazaribagh, Hazaribagh bazaar, New-market bazaar and Nimtoli poultry market. Fifteen chickens and seven eggs were randomly sampled from these areas where local feed producers of Hazaribagh usually supply chicken feed to different poultry sellers at cheap rates. In addition, chicken age and body weight were considered during sampling. This was done because with time there is a possibility of occurrence of Cr (VI) into the fleshy parts of chicken through biotransformation and bioaccumulation from the poultry feed. All the samples were categorized into four different groups as mentioned in table 1:

Table 1: Sample categorization with characteristics

Groups	Sample no.	Sample Categorization (Solid waste)	Characteristics	Sources
Group A	1	Wet blue skin-cuts	Fleshing part	Tannery industries in Gajmahal, Jhan Char, and near Hazaribagh Police Station.
	2	Wet blue skin-cuts	Mixture of different parts (dumped in open space)	
	3	Faded greenish-blue skin-cuts	Mixture of different parts (dumped in open space)	
	4	Skin-cuts	Mixture of different parts (stored inside the room)	
	5	Faded greenish-blue skin-cuts	Shaving (lower split)	
Group B	6	Raw feed	Solid wastes boiled + dried in open space	In front of Feed mill 'a' at Hazaribagh
	7	Raw feed	Solid wastes boiled + dried in open space	Feed mill 'b' at Hazaribagh
	8	Raw feed	Ground mixture after sun-dried	Local Producer
	9	Processed feed	Processed feed	Local Producer
	10	Processed feed	Processed feed	Hazaribagh bazaar
	11	Processed feed	Processed feed	Hazaribagh bazaar
	12	Processed feed	Processed feed with vegetable mix	New-market bazaar
	13	Processed feed	Processed feed	New-market bazaar
	14	Processed feed	Processed feed	Hazaribagh bazaar
	15	Processed feed	Processed feed	Nimtoli poultry market
	16	Processed feed	Processed feed	Nimtoli poultry market
	17	Processed feed	Processed feed with vegetable mix	Nimtoli poultry market
	18	Processed feed	Processed feed with vegetable mix	Nimtoli poultry market
19	Processed feed	Processed feed with vegetable mix	Nimtoli poultry market	
20	Processed feed	Processed feed	Nimtoli poultry market	
Group C [Chickens (both broiler & layer)]	21-22	Liver	Age: 2-3 weeks Weight: 625-750 g	Nimtoli poultry market
	23-27	Liver	Age: 6-8 weeks Weight: 1500-1850 g	
	28-30	Liver	Age: 2-3 weeks Weight: 580-820 g	Hazaribagh bazaar
	31-35	Liver	Age: 6-8 weeks Weight: 1400-1750 g	
Group D [Eggs (both broiler & layer)]	36-42	Albumen & Yolk	Brown eggs	Hazaribagh bazaar

2.3 Sample digestion (USEPA method 3060A)

Alkaline digestion is the recommended method to solubilize both water-insoluble and water soluble Cr (VI) compounds in solid waste samples, where there is the possibility of conversion of Cr (VI) into Cr (III). The

pH of the digestate was carefully adjusted during the digestion procedure. The sample was digested using 0.28M Na_2CO_3 /0.5M NaOH solution and heating at 90-95°C for 60 minutes to dissolve the Cr (VI) and stabilize it against reduction to Cr (III) [8]. EPA Method 7196A is the most applicable and reliable method for analysis of Cr (VI) solubilized in the alkaline digestate. It is highly selective for Cr (VI) and little interferences are encountered when it is used on alkaline digestates [9].

2.4 Reagents used

Nitric acid, sodium carbonate, sodium hydroxide, magnesium chloride, and phosphate buffer (K_2HPO_4 , KH_2PO_4) were all of analytical grade. All the chemicals have been purchased from Merck, Germany and used without further purification.

Digestion solutions were prepared by dissolving 20.0 ± 0.05 g NaOH and 30.0 ± 0.05 g Na_2CO_3 in reagent water in a one-liter volumetric flask and diluted to the mark. The pH of the digestion solution was checked before using. The pH was 11.5 or greater.

The spiking solution [1000 mg/L Cr (VI)] was prepared by dissolving 2.829 g of dried (105°C) $\text{K}_2\text{Cr}_2\text{O}_7$ in reagent water in a one-liter volumetric flask and diluting upto the mark.

2.5 Procedures (EPA methods 3060A and 7196A)

2.5 ± 0.10 g of the sample was placed into a clean and labeled 250 mL digestion vessel. $50 \text{ mL} \pm 1 \text{ mL}$ of digestion solution was added to each sample using a volumetric flask, and also approximately 400 mg of MgCl_2 and 0.5 mL of 1.0M phosphate buffer were added. Temperature of each heating device used in the alkaline digestion was adjusted to 90-95°C by preparing and monitoring a temperature blank. Samples were then continuously stirred (unheated) for at least five minutes using an appropriate stirring device. After that the sample solutions were heated at 80-100°C for at least 60 minutes with continuous stirring. Next, the heated solutions were gradually cooled down to room temperature. Then, the samples were transferred quantitatively to the centrifuge tubes. After centrifuge, the supernatant and the rinses were transferred to a clean 250-mL vessel [filtration was done if necessary after centrifuge]. An appropriate stirring device was placed into the sample digest beaker, and then the vessel was placed on a stirrer, and, with constant stirring, 5.0 M nitric acid solution was added slowly to the beaker drop wise. The pH of the solution was adjusted to 7.5 ± 0.5 . Sulfuric acid (H_2SO_4) was then added to adjust the pH to 1.5-2.5. Different volumes of the extract were transferred to 100-mL volumetric flasks. 2.0 mL of 1, 5-diphenylcarbazide was added to the solution. Then, five to ten minutes were needed to wait for full color development. Finally, an appropriate portion of the solution was transferred to a quartz one-cm absorption cell and its absorbance was measured at 543 nm in a Hach DR/4000 model UV-Visible spectrophotometer [8, 9].

2.6 Inter-conversion of Cr (VI) and Cr (III)

It is known that Cr (VI) is easily reduced to Cr (III) in a reducing atmosphere under acidic conditions. Presumably this is the reason why the EPA has recommended alkaline digestion to be followed for Cr (VI) estimation. In order that Cr (III) is not oxidized to Cr (VI), addition of Mg-salts has been suggested. Nevertheless, questions have been raised as to whether the method underestimates or overestimates the in-situ values of Cr (VI) in soil samples for which the methods have been developed [9]. In fact, it is not possible to arrest the interconversion completely by controlling the pH, because, after alkaline digestion, the pH has to be brought back to 1.5-2.5, the only range at which the colored complex is stable. The step of addition of Mg-salt has also been criticized.

A standard method of checking whether the result of analysis is reliable is spiking. In view of the inherent difficulty in controlling the oxidizing or reducing atmosphere in the samples and in view of the importance of analysis of Cr (VI) which is highly toxic to human health, the EPA seems to have been quite liberal in accepting the results of spiking. In the USEPA statement of work [10] "the method specified criteria for the matrix spike recovery is greater than or equal to 75% and less than or equal to 125%". In USEPA contract laboratory program guidelines [10], it is stated that "if the matrix spike recovery is 30-75% and the sample results are above the minimum detection limit, then the results are qualified". The samples that are being studied here are rather biological in nature, for example, chicken and eggs. It is expected that these samples will be more reducing than the soil samples. Thus, the extended range of spike recovery is expected to be applicable.

2.7 Interferences

The chromium (VI) reaction with diphenylcarbazide is usually free from interferences [8]. However, certain substances may interfere if the chromium (VI) concentration is relatively low. Hexavalent molybdenum and mercury salts also react to form color with the reagent; however, the red-violet intensities produced are much lower than those for chromium at the specified pH. Concentrations of up to 200 mg/L of molybdenum and

mercury can be tolerated. Vanadium interferes strongly, but concentrations up to 10 times that of chromium will not cause trouble.

Iron in concentrations greater than one mg/L may produce a yellow color, but the ferric iron color is not strong and difficulty is not normally encountered if the absorbance is measured photometrically at the appropriate wavelength. As far as is known about the presence of these interfering metals in the kind of samples being analyzed here [8], they should pose no problem.

2.8 Spectrophotometric calibration

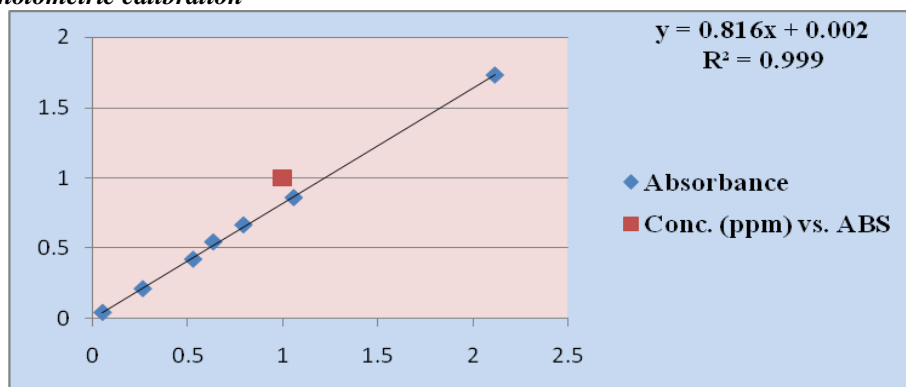


Figure 3: Calibration curve for standard solution [Cr (VI) present in K₂Cr₂O₇]

It is evident that the graph follows the Beer-Lambert law quite closely, the R² value being 0.999. The value of the extinction coefficient has been found to be 42,428 in excellent agreement with the literature values. In addition, Sandell’s sensitivity has been found to be 1.2 ppb cm⁻² and the detection limit 0.0017 ppm.

III. Results

Using the USEPA methods no. 3060A (alkali digestion) and 7196A (spectrophotometry), attempts have been made to determine hexavalent chromium in the following four groups of samples.

3.1 Reproducibility of the results

The Microsoft Excel Program has been used to calculate the standard deviation for each sample that gave measurable readings. It would be found that except two samples, no’s 10 and 34’ where the Cr (VI) concentrations were rather low, the error values are within 15%. The present values can be compared with those obtained by Hossain et al. [7] who measured the total Cr content in egg samples by using atomic absorption spectrophotometry. Their errors ranged from 11% to 44%.

The calibration was checked every now and then and the absorption coefficient (€) values were found to vary over a range. For the calculation of the concentrations, the most recent calibration graphs were used. Although the most quoted absorption coefficient is 40,000 L mol⁻¹cm⁻¹, values as low as 26,000 and as high as 90600 have also been reported in the literature [10]. The charge transfer complex that is supposed to form on addition of diphenylcarbazide to Cr (VI) is quite sensitive to factors like pH and freshness of the reagent.

3.2 Reliability of the results

Spiking has been used to test whether the results obtained were reliable. The spike recovery percentage is 84% for poultry feed, 74.89% for chicken and zero for eggs. According to the criteria fixed by the USEPA [10], the method of analysis is valid for the groups A to C, but not for D.

The consolidated results for each group are given here in tables 2, 3, and 4.

Table 2: Amount of Cr (VI) in tannery solid waste

	Sample no.	Characteristics	Amount of Cr (VI) in mg/kg
Group A (Solid leather waste)	1	Fleshing part	nd
	2	Mixture of different parts (dumped in open space)	nd
	3	Mixture of different parts (dumped in open space)	0.1950 ± 0.0162
	4	Mixture of different parts (stored inside the room)	0.1258 ± 0.0127
	5	Shaving (upper split)	nd

nd = Not detectable

Table 3: Amount of Cr (VI) in poultry feeds

Group B (Poultry Feeds)	Sample no.	Categorization	Amount of Cr (VI) in mg/kg	Spike Recovery
	6	Solid wastes boiled + dried in open space	nd	84%
	7	Solid wastes boiled + dried in open space	0.2714 ± 0.0394	
	8	Solid wastes boiled + dried in open space	0.4184 ± 0.0411	
	9	Processed feed	0.4598 ± 0.0297	
	10	Processed feed	0.0740 ± 0.0240	
	11	Processed feed	nd	
	12	Processed feed with vegetable mix	nd	
	13	Processed feed	nd	
	14	Processed feed	nd	
	15	Processed feed	nd	
	16	Processed feed	0.4234 ± 0.0342	
	17	Processed feed with vegetable mix	0.6062 ± 0.0339	
	18	Processed feed with vegetable mix	nd	
	19	Processed feed with vegetable mix	nd	
	20	Processed feed	nd	

nd = not detectable

Table 4: Amount of Cr (VI) in chicken liver

Group C [Chickens (both broiler & layer)]	No. of Samples	Age (in weeks)	Body weight (in gm) (g)	Concentration of Cr (VI) in mg/kg	Spike Recovery
	21	2	630	nd	74.89 %
	22	2.4	720	nd	
	23	6	1500	nd	
	24	7	1650	nd	
	25	7	1630	nd	
	26	8	1790	0.0940 ± 0.0147	
	27	8	1830	nd	
	28	3	730	nd	
	29	3	760	nd	
	30	3	600	nd	
	31	7	1520	0.1430 ± 0.0174	
	32	8	1720	nd	
	33	8	1750	0.1770 ± 0.0247	
	34	8	1700	0.0860 ± 0.0280	
	35	8	1695	nd	

nd= not detectable

IV. Discussions

It is seen from Table 2 that wet-blue skin-cuts and greenish-blue skin-cuts, sample no's 3 and 4 contain Cr (VI). The samples were chosen randomly and their history was unknown. They could have come from vegetable tanning or from chrome tanning industry. No chromium is expected from vegetable tanning but even with chrome tanning the presence of Cr (VI) is unexpected, because in a tanning process the skins and hides are treated with solutions of basic chromium sulphate (BCS) which is Cr (III) and not Cr (VI). The presence of Cr (VI) is not, therefore, easily explained. However, reasonable explanations can be put forward in the following way:

- (i) Cr (VI) was present as an impurity in the basic chromium sulphate
- (ii) Cr (VI) was formed during storage and the process of tanning
- (iii) Combination of both (i) and (ii)

Various overseas companies including two local ones supply basic chromium sulphate to leather industries. Previously, dichromate had been used as a source of Cr (III). Although majority of the medium and large leather processing units manufacture wet blue products for export, the small ones produce low grade finished leather for domestic market or sometimes act as suppliers to big firms. As cost of the chemicals is an important concern, the presence of Cr (VI) as an impurity cannot be ruled out.

The favorable conditions under which Cr (III) can be oxidized to Cr (VI) have already been discussed. Thus if the chemicals are stored for a long time when the temperature goes up and especially if they are kept in the sun and exposed to UV radiation, there is the possibility of some Cr (III) being converted to Cr (VI). In the

leather processing itself, some Cr (III) is oxidized to Cr (VI) at high pH values when alkali solution, sulphide etc. are added and thus, leather from other countries too contains some Cr (VI) [4].

Table 3 shows the results of poultry feed analysis. Cr (VI) is present in 6 of the 15 samples analyzed. Except for sample no. 10, the amounts of Cr (VI) (mg/kg) in the remaining 5 samples are significantly higher than those found in skin-cut samples. Apparently, this is surprising because of the fact that skin-cuts are only one component of the poultry feed. So the proportion of Cr (VI) should be less. The production of poultry feed involves boiling of the skin-cuts at 80-100°C followed by sun drying for 5 days. This is the most favorable condition for the conversion of Cr (III) to Cr (VI). Poor storage condition may also aggravate the situation further.

Analysis of chicken liver for Cr (VI) has been shown in Table 4. Only 4 chickens out of 15 pieces have been found to contain hexavalent chromium in their livers. These chickens were bought from the local market on a random basis and were not fed upon the poultry feed containing Cr (VI) under controlled conditions. The number of chickens studied here may not be statistically significant, but even then more than 25% of the chickens contain Cr (VI) from 86 to 177 ppb levels. It is reasonable to believe that Cr (VI) have come from the poultry feed produced from skin-cut tannery waste. The four chickens showing the presence of Cr (VI) were big in size (body weight: 1500-1790 g) and relatively old (7-8 weeks).

None of the egg samples had Cr (VI) at the detection level. Interestingly, the spiking recovery was also found to be negligible. The results obtained may indicate either (i) there was no detectable Cr (VI) in eggs (ii) it could not be measured by this method even if there were any. Hossain, et al. [7] found total chromium of ~ 1 ppm in the chicken eggs. It is possible that eggs contain reducing species that convert Cr (VI) to Cr (III). In fact, the antioxidant, glutathione has its precursors in raw eggs and possibly prevents the formation of Cr (VI). The fact that spike recovery is ~ 0% tends to suggest that the reducing atmosphere persists even when the egg is heated. The spike recovery values show a gradual decrease from 84% to ~0.00, as the matrix shifts from poultry feed to chicken liver to egg. The internal atmosphere of living beings seems to be more reducing than that of non-living things.

Workers in the tannery industries are being exposed to Cr (VI) in more ways than one. While handling the chemicals and skin-cuts and preparing poultry feeds, they are being in dermal contact with Cr (VI). To bring all pieces of skin-cuts into sunshine uniformly, these pieces have to be turned upside down occasionally and this will throw some of them into the air and may enter the nostrils of the workers as particulate matter. Skin-cuts are also being used as fuels for boiling themselves for making feeds and also for cooking food. The persons involved in burning skin-cuts certainly breathe in a lot of particulate matter in the form of smoke which is likely to contain some Cr (VI). It has been reported that Cr (VI) as small as 0.000008 mg/m³ may cause respiratory trouble [1]. A report published in a local newspaper, the Daily Star quotes an inhabitant of the Hazaribagh area, saying "My niece has been suffering from asthma for the last two years while my nephew for one year" [3]. Dermal contact causes skin burning and other problems.

Apart from these direct exposures, more alarming is the situation when Cr (VI) enters the food chain. About 25% of the chickens analyzed here have been found to contain Cr (VI). Poultry feeds based on tannery solid waste are mostly produced in Dhaka and distributed throughout Bangladesh. If Cr (VI) is present in the same percentage of chicken all over Bangladesh, the hazard to public health is highly significant. As is well known, toxicity of Cr (VI) is enormous and its ill effects include cell damage, mutation and even cancer.

Hossain, et al. [7], have analyzed eggs from Dhaka and the adjoining districts such as Narayanganj, Gazipur, Munshiganj, Narshingdi, even Tangail and Mymensingh. In each case they have found total chromium in the range of 1-3 ppm. In our case, we have attempted to estimate Cr (VI) in only a few eggs of Dhaka city and the results have been negative. To be more confident many more samples should be investigated into and preferably with an alternative technique such as ion chromatography.

V. Conclusion

In the interest of public health, the production of poultry feed from the tannery waste should be banned. However, in a country like Bangladesh it would be very difficult to enforce this ban, because it is a profitable business and a large number of people derive direct or indirect benefit from it. Treating the waste and bringing the heavy metals to safe levels should be a better option. This would address the disposal problem of solid tannery waste to a considerable extent and the treated waste would find better use in the production of highly proteinaceous poultry feed and other useful byproducts like glue and sodium dichromate without any deleterious effect.

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