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USING TANNERY WASTES IN POULTRY FEED: A MATTER OF CONCERN FOR SAFE POULTRY PRODUCTION IN BANGLADESH

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ABSTRACT: Nowadays tannery waste is a matter of concern because if it used as livestock feed, it could cause health hazards to humans. Therefore, this study was conducted to know the generation rates, utilization, disposal method of tannery solid wastes (TSWs), and inclusion level of it into the poultry feed. Moreover, this study determined the physical and chemical parameters of interest including moisture content, crude protein (CP) levels, and the presence of heavy metals such as chromium (Cr) and lead (Pb) in the poultry feeds that were sold in the studied area. For these purposes, a field survey was conducted with twenty tannery industries. Broiler feed samples were procured from multiple farmers situated in the Savar area of Dhaka. The feed source was classified into two categories, namely registered and unregistered feed mills. According to the study, wet blue trimmings was generated in 3.84% that was used as an ingredient of poultry feed. In addition, 55% of tanneries landfilled their waste, while 30% of them sold it for poultry feed. The utilization of TSWs in poultry feed production in this country was limited to a maximum of 1.314% of the total annual production. Besides, the CP% was determined in the range of 24.24 - 13.32 % and 18.15 - 11.01 % for broiler starters and growers, respectively, where lower CP content was found only in unregistered feed mills. Trace amounts of Cr and Pb were identified in each of the feed samples at very low concentrations. In conclusion, it can be stated that the percentage of tannery solid wastes mixed poultry feed was generated in negligible amounts and the registered companies' feed was found normal in all aspects of the quality tested in the study.

Keywords: Broiler feed, Feed mill, Heavy metal, Physical quality, Tannery solid waste

INTRODUCTION

The Tannery industry holds major economic significance in Bangladesh, despite being recognized as one of the most environmentally hazardous industries globally (WorstPolluted.org, 2016; Abebaw and Abate, 2018; Moktadir et al., 2018). The generation of solid waste in leather industries presents significant hazards to both the atmosphere and public health. The tannery business in Bangladesh produces approximately 175-232 Metric Ton (MT) of solid trash per day while the beam house or pre-tanning process produces most of the total solid wastes (Kanagaraj et al., 2006; Moktadir and Rahman, 2022). Over the past decade, livestock farming and aquaculture industries have been significantly impacted by industrial waste, particularly tannery waste (Shaibur et al., 2019). Conversely, a number of studies have demonstrated that a particular group of people with deceitful tendencies are producing animal feed, specifically for poultry, through the amalgamation of TSWs though this activity is banned by the Supreme Court of Bangladesh (Hossain et al., 2007; Hossain and Hasan, 2014; Mazumder, 2013; Parvin et al., 2017). Moreover, the same scenario is seen in our neighboring countries - India and Pakistan (Sudha, 2010; Mahmud et al., 2011). Various types of TSWs exist, including raw skin cuttings, wet blue shaving dust, low chrome wet-blue scraps, tanned skin-cut wastes, and protein-rich leather shaving dust (Hossain et al., 2007; Ahmed et al., 2017). A significant issue associated with these practices pertains to the utilization of heavy metals, specifically chromium, in the tanning procedures (Hossain et al., 2007). Moreover, it is noteworthy that the concentration of heavy metals in poultry feed, meat, and eggs exceeds the permissible threshold, thereby warranting further consideration (Bari et al., 2015; Ahmed et al., 2017; Hossain et al., 2017; Haque et al., 2021; Ullah et al., 2021; Samad et. al., 2023; Hossain et al., 2023). People in Bangladesh get a significant portion of their required protein from poultry (Haque et al., 2021). The ingestion of chromium and other potentially harmful metallic elements occurs inadvertently through the consumption of contaminated poultry meat and eggs (Ullah et al., 2021; Samad et al., 2023; Hossain et al., 2023). Besides, the Government of Bangladesh aimed to alleviate pollution and promote economic growth

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through the relocation of the tannery industry upstream to a newly established tannery town situated in the Harindhara area of Savar (Whitehead et al., 2019; Moktadir and Rahman, 2022). After the replacement of the tanneries in a new area, the scenario of solid waste generation, utilization, and disposal has not been studied yet. Even the possibility of mixing TSWs to the poultry feed in aspect of total production of poultry feed in Bangladesh has not been determined till now, based on published and available studies. This study can be useful for solid waste management strategies, as it is crucial to obtain information regarding the process steps from which these solid wastes are generated, the desired end product of these processes, and the waste characteristics.

Therefore, the present study was conducted to investigate the generation and utilization scenarios of TSWs, as well as the possible inclusion rate detection in poultry feed, and the nutritional constituents, including physical, chemical, and heavy metal determination in feeds that are currently available in Bangladesh. The hypothesis posited that the utilization of poultry feed containing heavy metal-infused TSWs is infrequent. If it uses for poultry feed, the heavy metal concentration would be low and tolerable for humans.

MATERIALS AND METHODS

Study area and sample size

The study area was Hemayetpur, Savar, Dhaka – the tannery area of Bangladesh – with 23.7986° N, and 90.2680° E coordinates. A total of 120 tanneries operate under the Savar Tannery Estate (Sarkar, 2022). Among them, twenty respondents from twenty tanneries were taken as a sample of the survey by adopting the PPRS (Proportional Probability Random Sampling) techniques (Ridgman, 1990). A total of thirty-six samples of broiler feeds, consisting of eighteen starters and eighteen growers, were collected from farmers located in the vicinity of the tannery area in Savar for laboratory analysis.

Sample categorization

The twenty tanneries under study were categorized into three distinct types based on their respective capacities for processing raw hides and skins. These types include small, medium, and large tanneries. Small tanneries have a capacity of less than 800 kg/day, medium tanneries have a capacity ranging from 800 to 1050 kg/day, while large tanneries have a capacity exceeding 1050 kg/day. A registered feed company was termed as a company that has a license for feed production by the Department of Livestock Services (DLS), with an approximate production of 125000MT/ year. Whereas, a company that has no license from DLS and produces feed locally was categorized as an unregistered (local) feed company.

Questionnaire development

A carefully designed interview schedule was devised, comprising of a combination of open-ended and close-ended structured queries. The study examined several variables, including the types of raw materials used, the condition of the raw materials upon receipt, the sources and channels of raw material acquisition, the availability of modern facilities for solid waste storage and recycling, the mode of solid waste disposal, the maintenance protocol of the tannery, and the challenges faced by the tannery authority in improving the industry.

Evaluation of physical properties of feed sample

Organoleptic observations were conducted to assess the physical characteristics of the samples, including color, smell, particle size, and the presence of extraneous substances.

Determination of chemical properties and heavy metals of feed sample

For the purpose of determining moisture content and crude protein, the feed samples underwent proximate analysis using the standardized method (Helrich, 1990). The quantification of protein was conducted through the Kjeldahl method, which involves a three-step process consisting of digestion, distillation, and titration following the previous procedure (Rahman et al., 2014). The Analytik Jena novAA 400P Atomic Absorption Spectrophotometer (Analytik Jena, Germany) was used to measure the total levels of chromium and lead (Islam et al., 2022).

Statistical analysis

The descriptive statistics, frequencies, and percentages were used to examine the qualitative data. Chi-square test (Tables 7 and 8) and independent t-test (Tables 9 and 10) were applied to compare the data between registered and unregistered feed companies using SPSS 25 (Assefa and Melesse, 2018). Statistical significance was determined for group differences when the p-value was less than 0.05. The values were presented in the form of mean ± SD (Standard Deviation).

RESULT AND DISCUSSION

TSWs are generated from tanneries pose a significant risk to both environment and human health while the waste products are used for livestock feeds (Parvin et al., 2017). Since the tannery industry has a great economic impact on Bangladesh's finance, its challenges are needed to be studied. In addition, the tannery waste must be dumped, recycled, and reused properly according to the law of the country. In this study, a vast investigation has been carried out to explore the characteristics, waste generation and utilization, challenges, and opinions to overcome the problems of the tannery industry, the possible portion of TSW that can be used in poultry feed, and the quality of poultry feed in Bangladesh.

Tannery characteristics

The present study has unveiled significant characteristics pertaining to the examined tanneries, as depicted in Figure 1. According to Figure 1, the majority of the studied tanneries, specifically 90%, were privately owned while the remaining 10% were categorized as mergers. Approximately 90% of tanneries were relocated from Hazaribagh to the Hemayetpur tannery industrial area which agree with the fact of relocation history of Bangladesh's tannery industry in 2016 (Moktadir and Rahman, 2022). The findings indicated that a significant majority (95%) of the tanneries had established protocols for managing tannery waste. Besides, not only tannery industries but also footwear-making units work with leather in Bangladesh (Rahman, 2017). So, TSWs can be generated from those areas too. However, here we only considered the tanneries for our investigation.

In Figure 2, this experiment gave an overall view of the research tanneries' raw material receiving procedures, characteristics of raw materials, and way of the receiving channel. It was demonstrated that only the Dhaka division provided raw materials to 70% of the sample tanneries, while 85% came from middlemen. However, none of these tanneries obtained their raw materials exclusively from the owner (Figure 2). Because of being a Muslim country, a large portion of raw materials are collected in the season of Eid-ul-Adha – the religious festival of Muslims – by the middleman from all over the country (Khan, 2016). Most of cases, they cured it with salt because salt curing is the popular way of hide preservation. For these reasons, though the raw materials could be received in cured or not cured conditions, this study revealed that 85% of the study tanneries received raw (hides & skin) materials in cured conditions. There was no such tannery that had simply dealt with unprocessed raw materials (Figure 2).

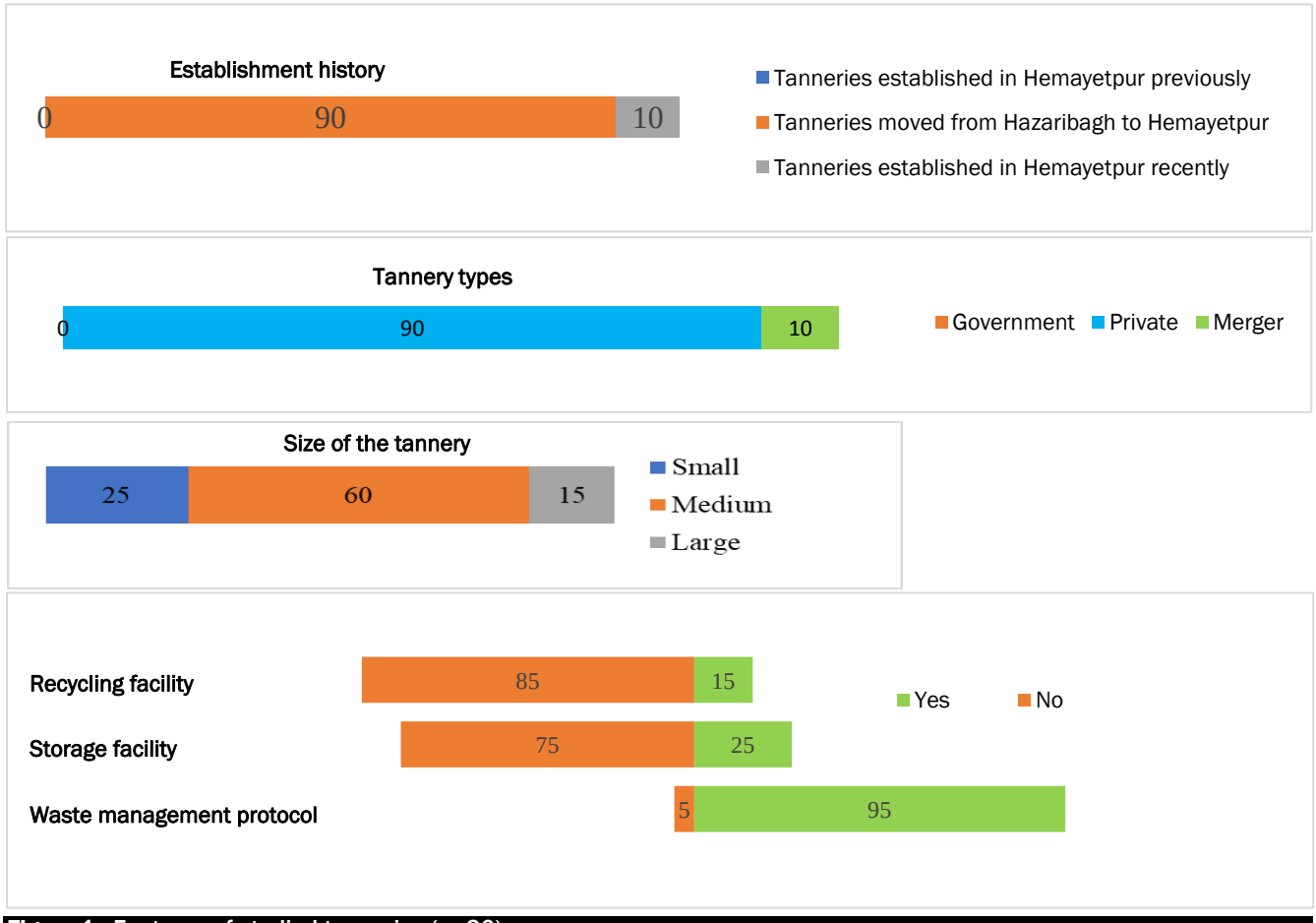

Figure 1 - Features of studied tanneries (n=20)

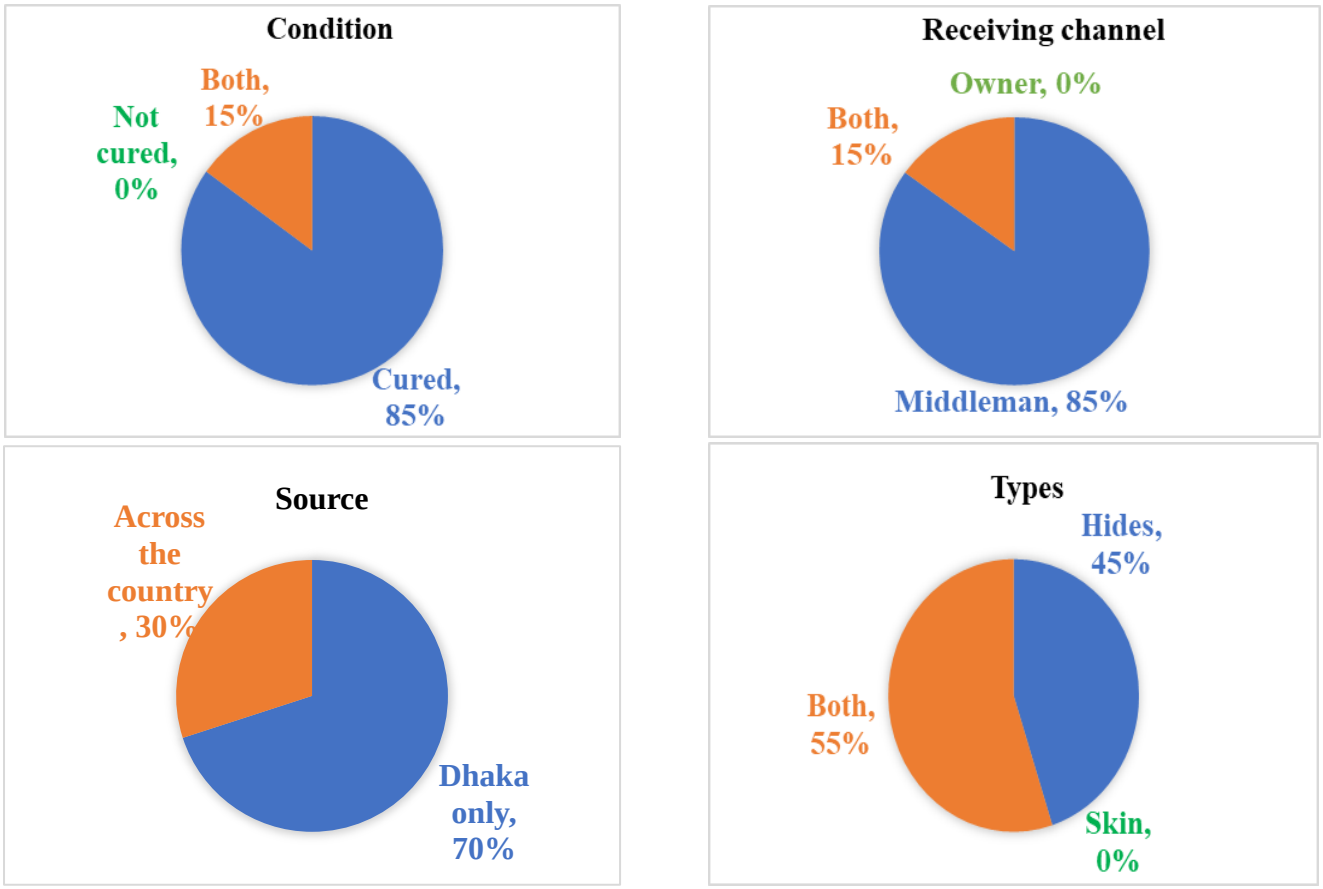

Figure 2 - Characteristics of raw materials and their acceptance rate in studied tanneries (n=20)

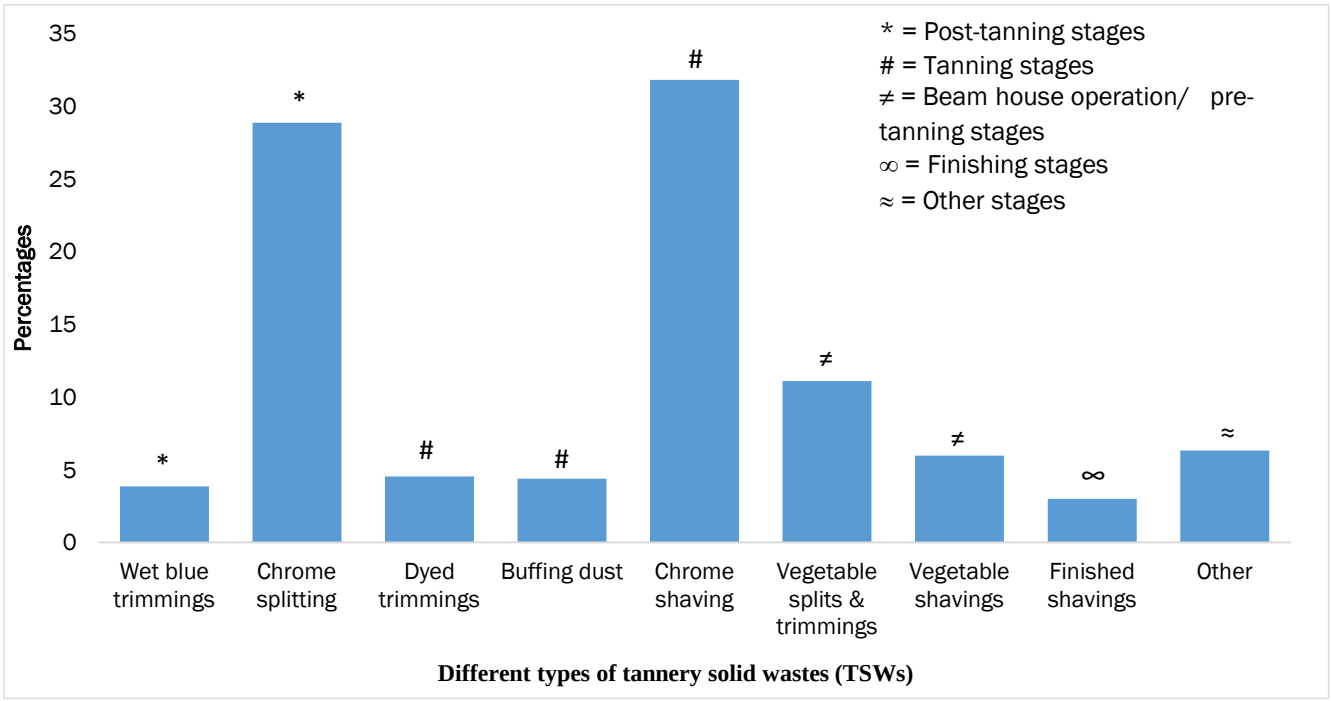

Figure 3 - Different types of TSWs generated in the studied tanneries per day (n=20)

Generation of solid waste and finished leather

The present study provided information regarding the percentages of various forms of TSW generation depending on its overall volume (Figure 3). The most prevalent type of waste generated in the TSWs was chrome shaving, accounting for 31.8% of the total waste. The study demonstrated that various types of solid wastes are produced at different stages of

leather production. For instance, vegetable shavings and splits were identified during the Beam House operation or pre-tanning phase, while wet blue trimmings and chrome splitting were detected during the post-tanning and tanning stages, respectively. Prior research indicates that pre-tanning procedures involve the preparation of animal skin or hide for collagen tanning, which is known to produce a significant amount of TSWs (Kanagaraj et al., 2015; Muralidharan et al., 2022). However, the TSWs' generation rate was found highest in the tanning process which was contradictory to the past study (Humayra, 2020; Moktadir and Rahman, 2022). In Table 1, the average percentage of solid waste generation was 28.88% while the medium-sized tanneries produced the highest amount of TSWs. The finished leather was produced on an average of 22.27 % (Table 1).

Table 1 - Generation rate of the total amount of TSW and final products in study tanneries

Variables	Type of the tannery	Percentage (%)	Average percentage
Waste generation	Small	27.94	28.88
	Medium	30.01	
	Large	28.69	
Final product generation	Small	21.69	22.72
	Medium	22.62	
	Large	23.85	

Table 2 - Utilization mode of TSW

Variables	Frequency	Percentage (%)
Fuel	12	60
Fertilizer	4	20
Poultry feed	6	30
No use	11	55

Table 3 - Disposal mode of TSW

Variables	Frequency	Percentage (%)
Landfilling	11	55
Open dumping	7	35
Incineration	9	45
No specific /documented method	13	65

The utilization and disposal of solid tannery waste

This research provided the overall concept of the utilization and disposal mode of TSW (Table 2 and 3). According to Table 2, a proportion of 30% of participants revealed that TSW was utilized as poultry feed, while there was no reported usage of TSW as cattle feed. The research findings indicated that solely wet blue trimmings were utilized and marketed for poultry feed among the various categories of solid waste examined, while most of the people utilized it as a means of fuel production (Table 2). The experiment demonstrated that the tanneries disposed of the solid waste by landfilling mostly, followed by incinerating and open dumping (Table 3) which agreed with the previous study (Moktadir and Rahman, 2022).

Contribution of TSW (wet blue trimmings) in poultry feed

The present investigation has revealed that wet blue trimmings were utilized solely as a source of poultry feed or as a constituent of the poultry feed among all of the TSWs, as indicated in Table 4. This experiment only took into account the annual quantities of wet blue trimmings and poultry feed production to assess the percentage of TSW mixed poultry feed. According to previous studies, the daily production of TSWs is determined to be 210 Metric tons (MT) (Saha et al., 2021) and 200-250 tons per day (Hossain et al., 2007; Ahmed et al., 2017). By assuming that producers incorporated wet blue trimmings at a ratio of 10% of the total volume of poultry feed, the estimated annual production capacity of TSWs mixed poultry feed would be 29433.6 MT. On the other hand, according to the report of IDLC (2020), total poultry feed production per year is 2240000 MT. According to Table 4, the annual proportion of TSW mixed poultry feed production was 1.314%. This percentage was deemed insignificant in terms of potential human health hazards. According to the

previous reports, the percentage was found to be significantly high for both animal and public health (Rahman et al., 2014; Ahmed et al., 2017; Hossain et al., 2017). The observed disparities between the outcomes of the present investigation and prior reports may be attributed to variations in sample size and composition, as well as differences in the methodology employed for data analysis. The high percentages of heavy metals could be readily discerned if the samples were exclusively obtained from the tannery waste mixed feed and if the computation was not predicated on the overall yearly production of livestock feed.

Table 4 - Contribution of TSW (wet blue trimmings) in livestock feed

Parameter	Quantity
Total TSWs production per day	210 MT (Saha et al., 2021)
Total wet blue trimmings waste production per day (3.84% of TSWs) (Figure 3)	8.064 MT
Total wet blue trimmings waste production per year (8.064 × 365 days)	2943.36 MT
Probable amount of TSW (wet blue trimmings) mixed poultry feed production per year [maximum 10% inclusion level]	29433.6 MT
Total poultry feed production per year	2240000 (IDLC, 2020)
Percentage of TSW mixed feed per year	$\frac{29433.6}{2240000} \times 100 = 1.314\ \%$

Table 5 - Challenges of the tannery industry in Bangladesh

Challenges	Frequency	Percentage (%)
Lack of skilled manpower	7	35
Difficulty in assessing buffer zone/dumping site	13	65
Lack of sufficient land for tannery expansion	9	45
High transportation cost	14	70
High labor cost	17	85
Unrest political situation in Tannery Worker Union	18	90
Unstable leather market	6	30
Fluctuation of raw hides & skin supple	4	20
High availability of synthetic goods in the market	9	45
Lack of Govt. support	8	40

Common challenges

The study focused on the difficulties and obstacles encountered by tannery industries in their efforts to improve the industry (Table 5). The present study identified political unrest within the tannery workers union as the primary obstacle, with a significance level of 90%. The tannery labor union are formed 58 years ago to ensure workers' rights but this organization's activities are sometimes hampered by political unrest and labor disputes (Sohel, 2019; Tuhin et al., 2022). After that, the high labor cost was placed in the second position may be due to the increasing livelihood cost of the people. The high transport cost both inside and outside of the country was identified as a major problem too (Table 5). The small number of effluent treatment plants (ETPs) in our country, rocketing up fuel prices, dependency on a single mode of transportation, also the raising labor cost are fueled the soaring transportation cost (Sakamoto et al., 2019; Shahriar et al., 2021; Bhowmick and Ghosh, 2022).

Respondent's opinion

In this survey, participants were asked for their thoughts on how the industry as a whole may be improved (Table 6). The present investigation revealed that a majority of 85% of participants expressed a desire for the government to furnish tannery proprietors with low-interest loans. The majority vote was in favor of granting demesne for industry expansion and reducing the VAT percentage on imported instruments, tools, and machinery. Some believe that improving transportation infrastructure, regulating the leather market, preventing the import of synthetic leather products from abroad, and establishing institutions to educate tannery workers are the keys to the sector's growth (Table 6).

Physical characteristics of broiler starter and grower feeds

The color, smell, particle size, and presence of foreign particles in the broiler starter and grower feeds were observed organoleptically. Only the feed coloration was different in this study; the other attributes were discovered under normal conditions. The particle size of the feed samples depicted in Figures 4 and 5 were nearly identical. The samples were

devoid of any foreign particles or molds, although certain unregistered feed samples contained dusty particles. Figures 4 and 5 demonstrate that three types of color (yellowish, yellow, dark yellow) were found in broiler starter feed and two varieties of color were found in broiler grower feed (brown and light brown). No significant color differences were found between registered and unregistered feed mills for both starter and grower feed (Table 7 and 8). The ingredients used to make natural broiler feed may cause it to change color. Broiler feed is often made up of grains as well as supplements such as vitamins and minerals. These ingredients may come in a variety of colors, and they may also go through processing like as grinding or pelleting, which can alter the appearance of the final feed. Besides, the feed color, odor, form, and particle size have the ultimate effect on a bird's feed intake and performance (Chewning et al., 2012; Farghly, 2017; Kreis, 2019; Gulizia and Downs, 2021).

Table 6 - Opinions of the respondents for the betterment of the industry

Opinion	Frequency	Percentage (%)
Provision of a soft loan from the Govt.	17	85
Allowance of demesne/ land for the expansion of the tannery industry	11	55
Lessen the VAT% for the imported instrument, tools, and machinery	13	65
Establishment of institutions for the training of the laborer	9	45
Control the country's leather market	10	50
Resist the import of foreign synthetic leather goods	18	90
Development of the transportation system	8	40

Table 7 - Difference between registered and unregistered companies' broiler starter feed color

Feed color types / Company type	Yellowish	Yellow	Dark yellow	P-value
Registered	0	3	6	
Unregistered	3	4	2	0.076 ^{NS}
Total	3	7	8	

NS= non-significant (p>0.05)

Table 8 - Difference between registered and unregistered companies' broiler grower feed color

Feed color types / Company type	Brown	Light brown	P-value
Registered	4	5	
Unregistered	4	5	1.00 ^{NS}
Total	8	10	

NS= non-significant (p>0.05)

Table 9 - Comparison of the moisture values between the registered and unregistered companies' commercial broiler feeds

Feed categories	Registered companies' feeds (%)	Unregistered companies' feeds (%)	Level of significance
Starter feeds	12.89 ± 1.28	11.59 ± 0.46	NS
Grower feeds	10.83 ± 0.62	9.96 ± 0.48	NS

NS= non-significant (p>0.05)

Table 10 - Comparison of the crude protein values between the registered and unregistered companies' commercial broiler feeds

Feed categories	Registered companies' feeds (%)	Unregistered companies' feeds (%)	Level of significance
Starter feeds	24.24^{a} ± 1.07	13.32^{b} ± 8.39	*
Grower feeds	18.15^{a} ± 1.03	11.01^{b} ± 0.69	*

The different superscripts indicated a significant difference among the values in the same row; * = p <0.05 (significant)

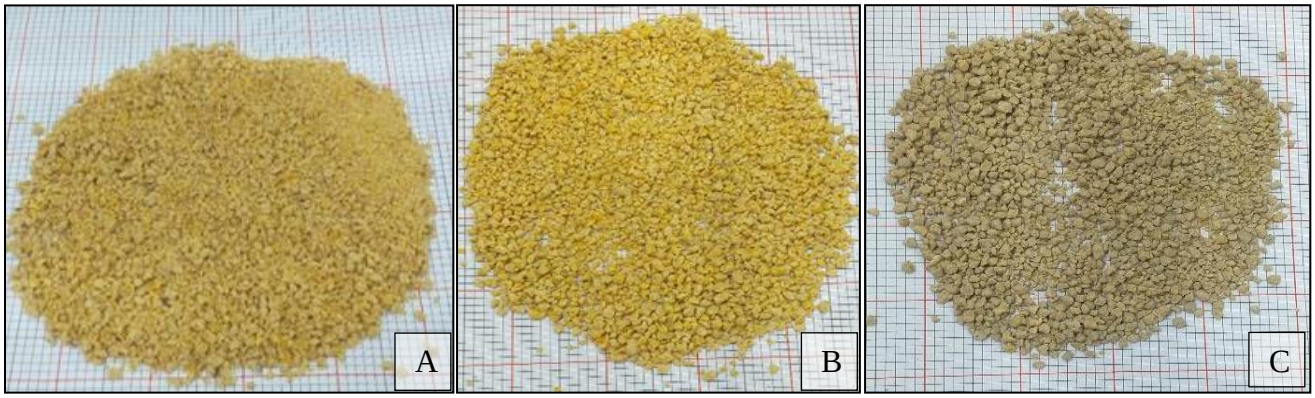

Figure 4 - Color variations of broiler starter feed. Yellowish (A), yellow (B), dark yellow (C)

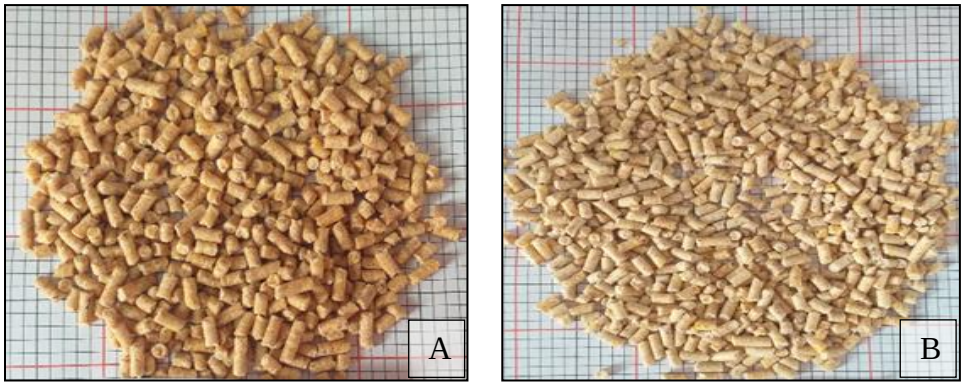

Figure 5 - Color variations of broiler grower feed. Brown (A), light brown (B)

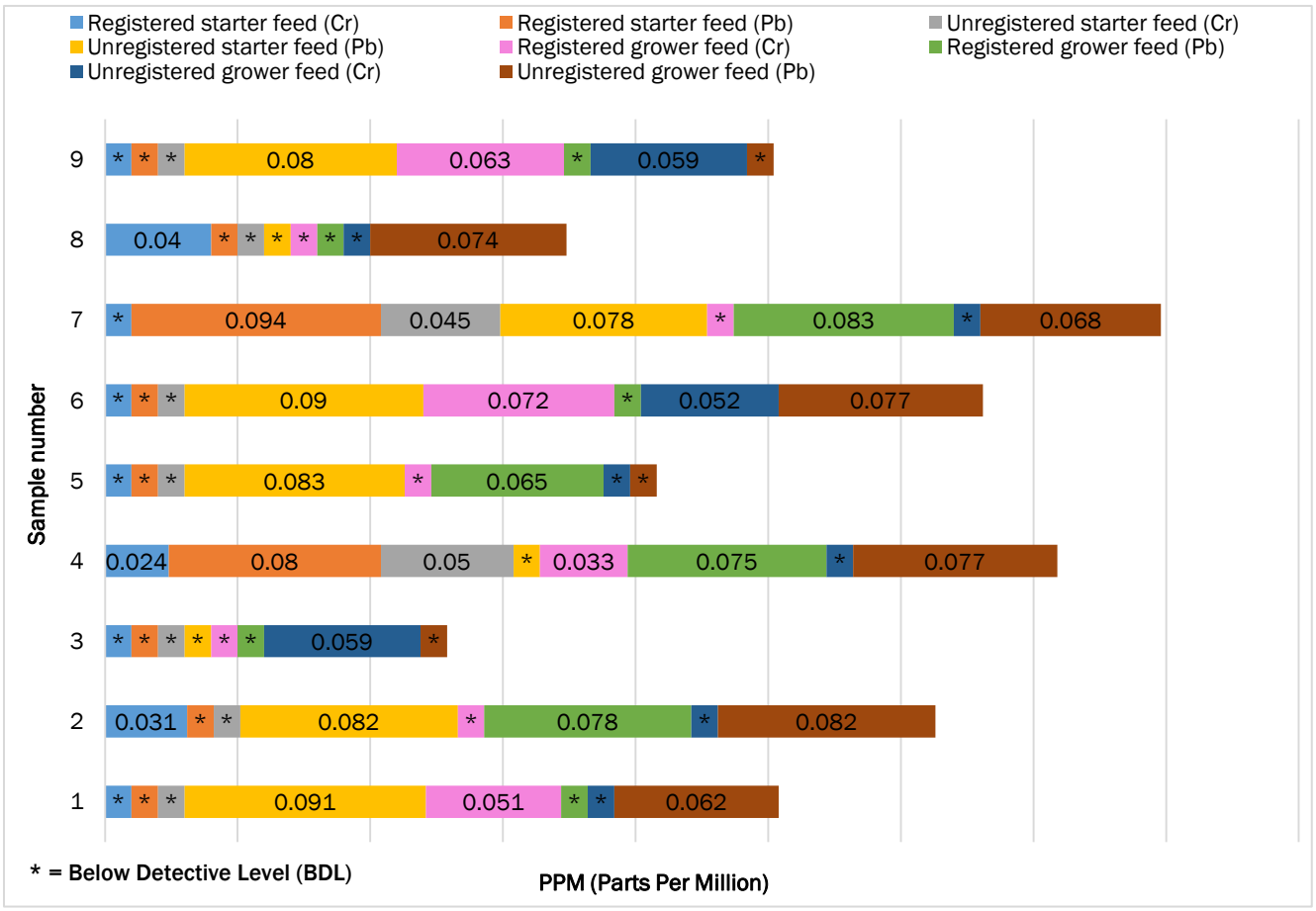

Figure 6 - Heavy metal (Cr & Pb) concentrations in starter and grower broiler feed at registered and unregistered feed companies.

Moisture percentages in broiler feed

The difference between moisture percentages of registered and unregistered poultry feed was non-significant (Table 9). Moisture percentages were found between the range of 10.83% to 12.89% and 9.96% to 11.59% in starter and grower feed, respectively which agreed with the previous studies (Rahman et al., 2014; Hossain et al., 2023). The moisture range of starter feed was observed slightly above the normal value of poultry feed compared to the previous report (Vakili et al., 2015). High moisture content is favorable for fungal development. Fungi contamination destroys the quality of feeds.

Protein percentages in broiler feed

Table 10 presents a comparison of CP percentages between the feeds of the registered and unregistered companies which differ significantly. The range of CP percentages was observed 13.32% to 24.24% and 11.01% to 18.15% in starter and grower feed, respectively which disagreed with the past studies (Hossain et al., 2023; Rahman et al., 2014). The unregistered company's feed had a low amount of protein percentages which indicated that the quality of the feed was poor (Table 10). The aforementioned differentiation can be attributed to the disparity in the caliber of broiler feed sourced from diverse producers, as well as the dissimilarity in the constituents employed for feed formulation. Additional research is advised to uncover the crude protein content of indigenous feed sources. The quantification of crude protein is a crucial task in assessing potential feed options due to its high cost and significant impact on growth and production in the event of a deficiency. Typically, starter rations are characterized by a high protein content, while grower and finisher regimens tend to feature a lower protein content, as mature fowl necessitate a reduced amount of protein (Vakili et al., 2015). According to Rahman et al. (2014), broiler diets typically exhibit a higher protein content in comparison to layer diets.

Heavy metals content of commercial broiler feeds

The study examined the Cr and Pb levels in the feeds of both registered and unregistered companies (Figure 6). The majority of the feed samples analyzed exhibited minimal quantities of Cr and Pb. Values that were below 0.05 mg/Kg, were identified as Below Detective Level (BDL) (Figure 6) (Rahman et al., 2014). That means it was not considered to be a cause for concern in terms of potential health implications. This study agreed with the past study where the Pb percentages are found in BDL (Rahman et al., 2014). In modest amounts, these metals are necessary for the maintenance of certain physiological and biochemical activities, but when they surpass particular levels, they can induce cell dysfunction and, ultimately, poisoning. Previously, the greatest concentration of chromium in broiler meat was discovered, which was greater than the permitted amount – 0 ppm for Cr and 5.00 ppm for Pb - proclaimed by WHO and FAO (Rahman et al., 2014; Islam et al., 2016). The aforementioned differentiation can be attributed to variances in the sampling methodology utilized during analysis, as well as increased awareness among feed producers. Heavy metal contamination sources vary from one element to the next (Sevik et al., 2020). These can vary depending on the kind of soil, environmental concerns, species of animals and product feeds, and geographic location (Khan et al., 2016). Several environmental components have the potential to contaminate poultry feed (Ukpe, 2018). The livestock production system can be exposed to heavy metals through multiple pathways such as inorganic fertilizer land application, air deposition, agrochemicals, and animal waste. This highlights the need for enhanced governmental quality monitoring of feedstuffs supply (Sarker et al., 2017). The utilization of animal waste as a fertilizer and soil amendment may result in the accumulation of hazardous substances in the soil and water due to the presence of heavy metals in it (Oyewale et al., 2019). It can spread to animals via the food chain. In contemporary times, individuals are increasingly aware of matters pertaining to food safety and the potential health risks associated with hazardous substances. A strong regulatory framework for food safety is necessary to guarantee the safety of food products for consumers. The lack of it in Bangladesh has persisted for a considerable duration, leading to significant implications for public health. In order to effectively tackle health challenges across every sector, laws must be applied in a suitable manner.

CONCLUSION AND RECOMMENDATIONS

A wide range of research shows that poultry products contain a significant portion of heavy metals due to the use of tannery solid wastes as an ingredient in poultry feed. This study aimed to clarify the fact that most of the poultry feed-producing companies may not generate tannery solid wastes or heavy metal-containing feed, and using their feed in poultry may not pose a health risk to human. The findings of this investigation demonstrated that the tannery sector produces solid waste of varying attributes depending upon the stages of processing. In a broad sense, the possibility of tannery solid wastes mixed feed production in Bangladesh was very rare. The unregistered companies' feeds contained low protein proving that the feeds' quality was low. Also, the negligible amount of heavy metal in poultry feed proved the fact that a small percentage of tannery solid wastes was present in poultry feed. These findings may be useful for appropriate solid waste management strategies and removing the myth of consuming poultry products.

A detailed study with a large amount of sampling is needed to investigate the true scenario of feed quality in Bangladesh. The TSWs can be a good protein source for feed if they can be collected before the tanning process.

Therefore, further research is needed to recycle the heavy metal-free TSWs as poultry feed. The heavy metals in poultry products may come from different sources other than poultry feed, such as water, soil, and air. So, concentration should also be given to those sources also. Since there is a potential health risk for those exposed to contaminated feed with different heavy metals, additional research is required to determine the quality and sources of heavy metals in feed by analyzing different types of raw ingredients that are used in livestock feed in different regions of Bangladesh.

DECLARATIONS

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Authors' contributions

The first four authors should be considered as first author. M. S. Islam planned, designed, reviewed the writing, and managed the fund of this research. A. S. Protik and M. A. Zannat collected data and samples, conducted laboratory analysis, and collaborated in data analysis. Z. Naim analyzed and visualized data, prepared the original draft, revised and edited the manuscript. M. E. Kabir curated the data and reviewed the manuscript. M. Asaduzzaman and M. Akter reviewed and approved the final version of the manuscript. All authors read and approved the submitted version of the manuscript.

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Data availability

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Consent to publish

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Ethics committee approval

This study had been carried out as a part of partial fulfillment of degree of Master of Science (MS) in Animal Science under the Department of Animal Production & Management, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. Consents of the sellers/shopkeepers had been taken before moving to the collection of the samples.

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