

## PREPARATION OF POULTRY FEED FROM SLAUGHTERHOUSE SOLID WASTES: A SUSTAINABLE AND COST-EFFECTIVE APPROACH

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### ABSTRACT

Tannery industries produce significant solid waste, particularly 15-20% consisting of raw hides and skin trimmings from slaughterhouses. These wastes pose environmental and health hazards when disposed of. This study looks into the viability of using SSW, containing 33 percent protein, for the production of chemical-free proteins suitable for poultry feed incorporation. The prepared feed formulations showed enhanced nutritional value, achieving energy levels of 3200 and 3350 kcal/kg for starter and grower feed respectively. Protein content is 22% for starter feed and 20% for grower feed, representing a 7% improvement over traditional feed options. SEM analysis suggested a more uniform structure that might offer consistency in feed formulation and AAS confirmed absence of toxic metal. Feed trials demonstrated comparable growth performance and body weight gain relative to the standard feeds. Therefore, this approach facilitates the establishment of sustainable waste management practices along with reducing feed costs, thereby enhancing economic viability.

**Keywords:** slaughterhouse solid waste, poultry feed, waste-to-product, sustainable agriculture, protein-rich feed

### INTRODUCTION

An ever-increasing cost, declining availability and unsustainable production practices of traditional poultry feed ingredients like soybean meal and maize have led to the quest for better alternatives (Jayatillake (2011). The poultry production costs have increased because of higher price of soybean meal, transportation problem and competition in land space (GAbbas et al. 2023). Although this challenge is a common issue for most feed manufacturers, it is especially prevalent in developing countries because costs of feed form 50–70% of production costs, thereby significantly reducing the profit margins (Nasir et al. 2022). In the light of this growing challenge, collagen-based feed has shown better growth rate, feed conversion efficiency and nutrition wellbeing. Also, it addresses the most paramount need for more cost effective and sustainable feed sources (Park et al. 2021). One such promising avenue lies in utilizing solid wastes from leather industry, specifically raw hides and skin trimmings, which are rich in collagen as well as proteins and hold immense potential as an innovative and sustainable alternative of traditional feed ingredients.

The leather industry is an important contributor to the world economy which produces approximately 23 billion square feet of leather annually. However, only 25.5% of rawhide is converted into finished leather while the rest of the portion is considered as waste (China et al. 2020, Aquim et al. 2010) This waste primarily comprises raw hides and skin trimmings, liming and fleshing waste, and other solid waste that is highly organic and contains toxic substances such as chromium utilized in tanning. Not only does this huge amount of hazardous waste take up a lot of space in landfills, it also poses serious environmental risks. On the other hand, conventional techniques for disposal of these tannery solid wastes including landfilling, incineration, anaerobic digestion, open dumping, and thermal incineration are associated with a multitude of negative effects on the environment, including the polluting of soil and water as well as the emission of greenhouse gases (Noyon et al. 2023). However, there is a lot to think about in tannery solid waste management; CLRI, for example, has done much study in this area. Some

examples of the comprehensive studies include regenerating leather and creating leather blend fabrics with plant fibers like cotton and coconut. But there's still a lot of tannery solid waste that doesn't get proper treatment and ends up becoming a challenge for the environment (Sastry et al. 2024).

Raw hides and skin trimmings represent one of those specific categories of tannery solid waste that has received comparatively less attention, despite the potential for utilization. The trimmings produced during the initial phase of leather processing and consist of collagen and proteins. Unlike other tannery wastes that typically contain high levels of hazardous chemicals, such as chromium, raw trimmings are relatively less harmful and possess significant potential for sustainable applications (Abebaw et al. 2018). Too far, several investigations on raw trimmings have yielded promising results; for example, one study utilized pepsin to enzymatically solubilize goat skin trimmings for the extraction of collagen and bioactive peptides (Pratiwi et al. 2020). An independent inquiry revealed that raw trimmings are converted into non-consumable gelatin intended for industrial use (Maliha et al. 2024). Furthermore, collagen extraction by papain has been achieved, signifying an environmentally friendly approach to transform tannery raw hides and skin into more valuable products. Interestingly, less enthusiasm has been shown to use these raw trimmings in poultry feed yet, even though they contain a high protein level of over 33% (Tapia et al. 2023).

Some of the previous studies has sought to explain the consequences of feeding tannery solid waste to animals. Prevalent research found incorporating leather waste into chicken feed leads to reduced feed production costs and efficient management of tannery solid waste (Islam et al. 2024). However, there are some researches which have tried introducing chrome containing shavings and splits into poultry feed (Paul et al. 2013). The majority of the findings focused on the feasibility, nutritional value, and safety assessment of the wastes. According to the findings of a comprehensive study, waste from chrome-tanned leather has the potential to increase the protein contents of poultry diets in the form of safe feed supplements (Abebaw et al. 2018). In addition, a previous study investigated the economic implications of feeding poultry using processed tannery waste. The findings of this study suggested that the latter may be able to fulfil the majority of the dietary requirements of poultry at a reduced cost. Furthermore, they discussed the dangers of untreated waste leaking heavy metals and recommended for preventative steps prior to broad implementation (Islam et al. 2024). In this regard, raw hides and skin trimmings are more preferable since they do not carry the risk of heavy metal contamination that could adversely affect poultry health, growth, or other safety concerns.

In light of this, the purpose of this research is to fill in these gaps by determining whether raw hides and skin trimmings may be used as sources of sustainable poultry feed. Using techniques such as Scanning Electron Microscopy (SEM), and Atomic Absorption Spectroscopy (AAS), this study would assess the chemical and nutritional analysis of the prepared feed, as well as the heavy metal content of the feed. Furthermore, nutritional tests are carried out in order to gain knowledge of the impact that it has on the growth, productivity, and overall health of chickens. Additionally, this approach has the advantage of identifying a method that is less harmful to the environment for dealing with solid wastes from tanneries. Also, it makes an attempt for poultry industrialists to get rid of conventional feed additives, which ultimately results in becoming more financially sustainable alternative for them.

## **MATERIALS COLLECTION**

All poultry feed ingredients, including maize, soymeal, rice polish, DRB (wheat husk), Hydance (phytogenic feed additive), DL-Methionine (sulfur-containing amino acid for broilers), lysine (amino acid), DCP (calcium powder), toxin binder (mycotoxins), Sal Stop (formaldehyde + propionic acid), L (layer premix with micronutrients such as CaCO<sub>3</sub>, phosphorus, sodium), Thiabin B1B2B6 (phytogenic feed additive), enzyme blends (glucanases, xylanases, phytases, proteases, lipases, galactosidases), baking soda (NaHCO<sub>3</sub>), and salt (NaCl) were collected from Mim Poultry and Feed Fish, Zero Point, Khulna, Bangladesh. The raw animal hides and skin waste were purchased from a municipal slaughterhouse located at Gollamari, Khulna, Bangladesh, weighing 100 kg.

## **TREATMENT OF RAW HIDES AND SKIN TRIMMINGS**

The Raw hides and skin trimmings were collected from a municipal slaughterhouse located at Gollamari, Khulna, Bangladesh and transported to Moilapota, Khulna, for processing to a butcher. First, the wastes were washed properly to remove any dirt or contamination present. The trimmings were then chopped into 5 cm x 5 cm pieces and boiled in distilled water for 30-35 minutes to enhance protein extractability

(Chen et al. 2021). After boiling, hair was scraped off, and the hair free raw trimmings were sun-dried for 36 hours to ensure complete organic material breakdown as previously emphasized (Li et al. 2019). After drying, the slaughter house raw hides and skin trimmings were grinded twice into a fine powder form that would be suitable for poultry feed, as finer particle size improves digestibility and nutrient assimilation (Ren et al. 2024). The treatment process is shown in Figure. 1.

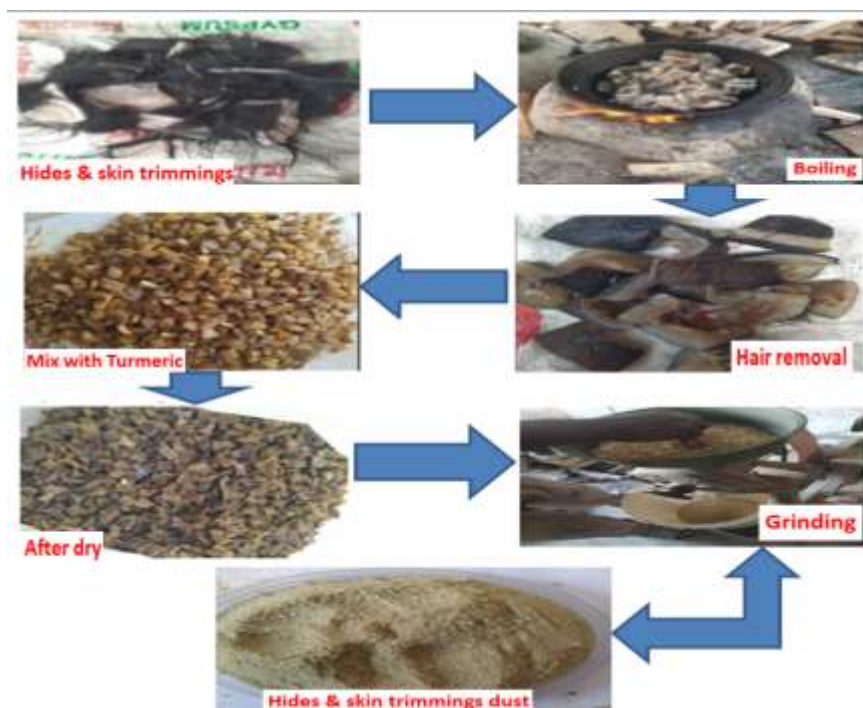


Figure 1. Flow chart of preparing dust from raw hides and skin trimmings.

### KEY COMPONENTS FOR FORMULATIONS OF BOILER POULTRY FEED

Boiler poultry feed is often formulated maintaining necessary components to meet nutritional requirements for growth, health, and productivity. The main energy sources include maize, a digestible carbohydrate, and animal fats or vegetable oils for energy density and palatability. Proteins are also essential that is fulfilled by soybean meal, which a rich plant protein, and animal proteins like fishmeal and meat and bone meal, which also provide essential minerals. Mineral supplementation entails Calcium (Ca) from limestone, and in the same way trace minerals from premixes of calcium and phosphorus from dicalcium phosphate (DCP). Sodium is used as salt or sodium bicarbonate. Different additives like enzymes, crystalline amino acids (methionine, lysine, threonine), vitamin premixes and enzymes enhance feed efficiency, with antibiotics used as permitted. Wheat husk and rice polish, providing fiber and nutrients, are included when economically viable, to ensure a balanced feed formulation. Traditional ingredients and nutrient sources in broiler poultry feed is shown in Table 1.

Table 1 Common ingredients and nutrient sources in broiler poultry feed (Bailey 2020, Belkhanchi et al.2023, Vieira et al. 2014)

Serial no.	Types of Nutrients	Source of ingredients
1.	Energy sources:	➤ Mainly maize ➤ Animal fats and vegetable oils
2.	Plant protein sources:	➤ Soybean meal
3.	Animal protein sources:	➤ Fishmeal, meat and bone meal
4.	Mineral supplements:	➤ Calcium supplements: Limestone. ➤ Calcium and phosphorus supplements: Dicalcium phosphate (DCP), defluorinated

		rock phosphate, bone meal.
		➤ Trace minerals: Trace mineral premixes
		➤ Sodium sources: Salt, sodium bicarbonate
5.	Miscellaneous:	➤ Vitamin supplements: Vitamin premixes
		➤ Crystalline amino acids: Methionine, lysine, threonine
		➤ Non-nutritive feed additives: Enzymes, antibiotics, etc.
***Wheat Husk and Rice Polish Can be used when cost-competitive. ***		

## BROILER POULTRY FEEDS FORMULATION

Boiler poultry feed formulations are customized to meet the specific nutritional requirements of chicken during their two types growth stages, with separate compositions for the starter (first 10 days) and grower (last 25 days) phases. Soybean meal which is a good source of protein is include at 25% in the starter feed to facilitate rapid early growth and reduced to 20% in the grower feed when moderate protein is needed. The primary energy source is Maize which contributes 55% of the starter feed and is slightly increased to about 57% in the grower feed in response to higher energy requirement of growing chicken. Rice polish and wheat husk is consistently included at 10% and 5% in both feeds, which is a cost-effective byproduct rich in nutrients, providing dietary fiber to promote gut health.

Table 2 Traditional broiler poultry feed formulation

Serial no.	Ingredients of Poultry Feed	Starter Feed (First 10 Days)		Grower Feed (Last 25 Days)	
		100 kg batch	% Of composition	100 kg batch	% Of composition
1	Soymeal	25	25	20	20
2	Maize	55	55	57	57
3	Rice Polish	10.	10	10	10
4	DRB (wheat Husk)	5.0	5	5.0	5.0
5	Hydance	5.0	5	5.0	5.0
6	Different Minerals & Miscellaneous	3.0	0.3	3.0	3.0

Complementary components such as hydance, included at 5% in both feeds that improves the feed's nutrient density and enhance feed conversion ratios, helping poultry gain more weight with less feed. A mix of minerals and miscellaneous additives make up 3% of each feed type, supplying essential vitamins, trace elements, and enzymes to support metabolic functions, skeletal development, and feed digestibility. These well-balanced formulations ensure optimal growth and productivity, addressing the distinct nutritional demands of poultry at different growth stages. Broiler poultry feed formulation aims to provide nutritionally balanced, cost-effective diets tailored to the chicken growth, productivity, and environmental conditions. It requires precise nutrient specifications, including metabolizable energy, protein, amino acids, and minerals, while considering the chemical composition and potential anti-nutritional effects of ingredients to ensure a safe and effective diet. As shown in table 2, a traditional poultry feed can be formulated according to the various growth phases of poultry.

## FEED FORMULATION METHODS

Depending on experience, empirical methods include suggesting combinations of ingredients and modifying them as a result of production outcomes or fluctuations in the raw material market. It tilts towards simplicity and flexibility to market conditions but may not be accurate. On the other hand, trial and error method is globally used that meet the nutrient concentration by modifying the values of the ingredients individually or by using software like Excel. While time consuming, it makes it possible.

Inclusion of both methods, this study offers a vibrant method that incorporate industry standard and research rigors.

## RESULTS AND DISCUSSION

### SCANNING ELECTRON MICROSCOPY (SEM) ANALYSIS

The SEM micrographs (Figure 2.) provide insights into the morphological differences between two poultry feed formulations. Where Figure 2(A) represents a mixture containing traditional ingredients such as maize, soybean meal, rice polish, wheat husk, hydance, and mineral additives, while Figure 2(B) shows a formulation where soybean meal has been replaced with powder prepared from raw hides and skin trimmings. Figure 2(A) exhibits irregular, fragmented particles with a heterogeneous structure, reflecting the varied composition of plant-based and processed ingredients like wheat husk and rice polish. In contrast, Figure 2(B) shows larger, smoother, and more cohesive particles, indicating the compact structure of hides and skin trimmings. Figure 2(A) shows a rough surface texture due to the fibrous nature of plant-based ingredients, promoting better inter-particle mixing and nutrient distribution. In contrast, Figure 2(B) has smoother surfaces with fewer fibrous structures, reflecting the processed nature and reduced fiber content of leather trimmings. The rough, heterogeneous particles in Figure 2(A) indicate potential for enhanced nutrient mixing and bioavailability during digestion, whereas the smoother, cohesive particles in Figure 2(B) suggest a more uniform structure that might offer consistency in feed formulation. Which clearly indicates incorporating leather trimmings as a replacement for soybean meal introduces a novel avenue for sustainable feed production.

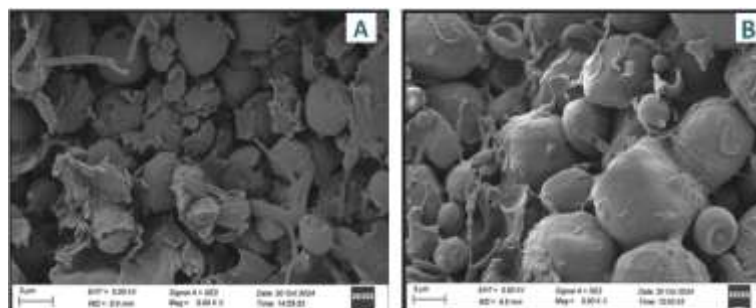


Figure 2. SEM images (A) traditional and (B) prepared feed.

### ATOMIC ABSORPTION SPECTROSCOPY (AAS) ANALYSIS

The table 3 evaluates the elemental composition of traditional and prepared broiler feeds against maximum permissible values, confirming compliance with nutritional and safety standards. Chromium (Cr) is absent in both feeds (0.00%), well below the allowable limit of 0.03%, indicating no detectable contamination. Total sulfur (S) levels are 0.03% and 0.02% in traditional and prepared feeds, respectively, within the 0.05% maximum limit, preventing toxicity while supporting metabolic functions. Lead (Pb) is also not detected (0.00%) in both feeds, adhering to the stringent limit of 0.00001% and ensuring safety from toxic contamination. Calcium (Ca) levels are 0.92% in traditional and 0.93% in prepared feed, below the maximum limit of 0.98%, providing adequate mineral support for bone health. Phosphorus (P) remains consistent at 0.45% in both feeds, below the 0.50% threshold, ensuring a proper balance for skeletal development and metabolic processes. Overall, the prepared feed composition is nutritionally adequate and safe for broiler diets.

Table 3 Comparison of toxic elements in poultry feed

Element	Traditional Broiler Feed Value (%)	Maximum permissible value (%) for Broiler Feed	Prepared Broiler Feed value (%)
Chromium	0.00	0.03	0.00
Total Sulfur	0.03	0.05	0.02

Lead	0.00	0.00001	0.00
Calcium	0.92	0.98	0.93
Phosphorus	0.45	0.50	0.45

### NUTRITIONAL VALUE ANALYSIS OF BROILER POULTRY FEED

The table outlines the nutritional composition of broiler starter and grower feeds, comparing traditional and prepared feed values with the minimum and maximum recommended ranges. For starter feed, the energy content ranges from 3000–3200 kcal/kg for traditional and 3200 kcal/kg for prepared feed, both within the recommended 3000–3200 kcal/kg range. Protein levels are 20% for traditional feed and 22% for prepared feed, meeting the 20–22% requirement for optimal growth. Fat content increases slightly in prepared feed (5%) compared to traditional (4%), within the permissible 3–5% range. Moisture content is slightly higher in prepared feed (10.65%) than traditional feed (9.25%) but remains under the upper limit of 12%. Cellulose and starch values align with recommended limits, with cellulose slightly higher in prepared feed (4.70%) than traditional feed (4.20%). Ash content in both feeds is also within acceptable ranges, ensuring adequate mineral availability.

For grower feed, prepared feed provides higher energy (3350 kcal/kg) compared to traditional feed (3120 kcal/kg), meeting the 3100–3300 kcal/kg range. Protein content is 20% in traditional feed and 19% in prepared feed, within the recommended 18–20% range. Fat content is notably higher in prepared feed (6.5%) than in traditional feed (5.30%), reflecting an improved energy density. Moisture and cellulose levels are slightly elevated in prepared feed, but both remain within the limits of 10–12% for moisture and 3.5–7% for cellulose. Starch and ash content are consistent across traditional and prepared feeds, ensuring the provision of carbohydrates and essential minerals for sustained growth and development. These values confirm that prepared feed formulations align well with nutritional recommendations, with slight improvements in energy and fat content to optimize broiler performance.

Table 4 Comparison of nutritional values of broiler poultry feed.

Nutrients	Broiler Starter Feed (%)				Broiler Grower Feed (%)			
	Traditional feed values	Prepared feed values	Min	Max	Traditional feed values	Prepared feed values	Min	Max
Energy kcal/kg	3000	3200	3000	3200	3120	3350	3100	3300
Protein	20	22	20	22	19	20	18	20
Fat	4	5	3	5	5.30	6.5	3	7
Moisture	9.25	10.65	10	12	10.00	10.20	10	12
Cellulose	4.20	4.70	3.5	5	5.45	6.90	3.5	7
Starch	48	55	50	55	50	55	50	55
Ash	6.75	8.67	6	10	7.00	8.20	6	10

### COMPARISON OF CARBOHYDRATE BETWEEN TRADITIONAL AND PREPARED BROILER POULTRY FEED

The bar graph illustrates the carbohydrate content in traditional and prepared broiler feeds, categorized into two types: broiler starter feed and broiler grower feed. In both feed categories, the prepared feed consistently exhibits the highest carbohydrate content, reaching 55% in the starter feed and 62% in the grower feed. These values are almost identical to the maximum carbohydrate levels of 55% and 60% for starter and grower feeds, respectively. In contrast, the traditional feed shows the lowest carbohydrate percentages, at 43% for starter feed and 53% for grower feed, closely aligning with the minimum values of 45% and 53% for these feed types.

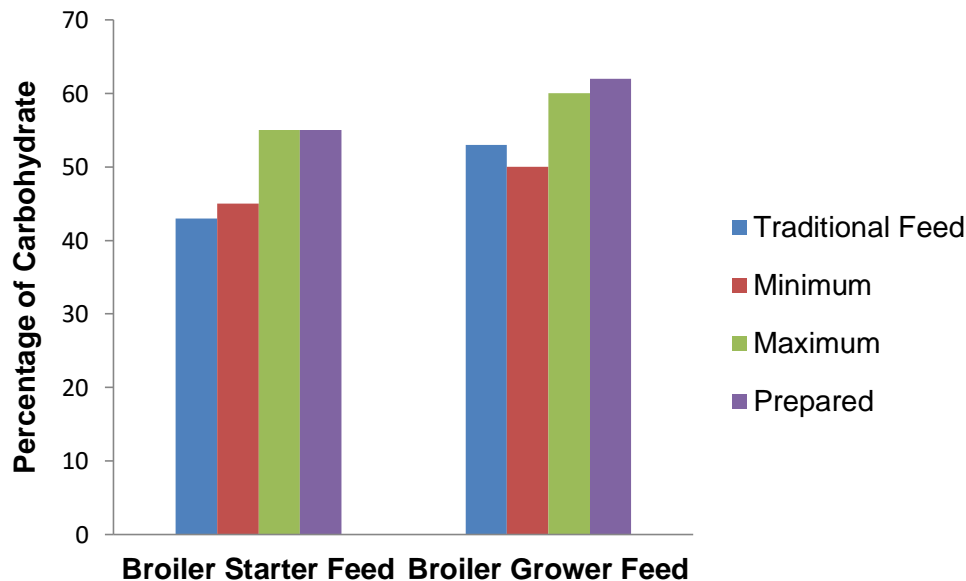


Figure 3. Comparison of carbohydrate between traditional and prepared broiler poultry feed

The data highlights a clear trend where prepared and maximum feeds are formulated to provide higher energy levels, making them more suitable for broilers requiring enhanced nutritional input. Conversely, the lower carbohydrate content in minimum feeds indicates a focus on reduced energy provision, catering to specific dietary requirements. Traditional feeds, with their relatively lower carbohydrate levels, may represent less advanced or optimized formulations. These findings underscore the potential for customizing feed formulations to align with the nutritional demands of broilers at different growth stages, ensuring optimal growth and energy efficiency.

### FEASIBILITY ANALYSIS

The given data based on the Rokeya Poultry Firm, Fakirhat, Bagerhat, Bangladesh, the table 5 presents a comparison of feed consumption and body weight gain for broiler poultry fed traditional and prepared feed over a five-week period. In the first week, the feed consumed per chicken is slightly higher for traditional feed (0.180 kg) compared to prepared feed (0.155 kg), with the average body weight gain also marginally higher for the traditional feed group (0.185 kg vs. 0.172 kg). As the chicken progress to the second week, both groups show a decrease in feed consumption per chicken for prepared feed (0.350 kg vs. 0.385 kg in traditional), but the average body weight gain remains relatively similar between the two formulations (0.268 kg for prepared vs. 0.280 kg for traditional). By the third week, feed consumption per chicken continues to be slightly higher in the traditional feed group (0.570 kg vs. 0.520 kg), and the body weight gain is almost identical for both feed types (0.478 kg for traditional vs. 0.470 kg for prepared), showing consistent growth rates despite the differences in feed intake.

In the later weeks, from week four to five, the feed consumption per bird increases for both groups, with traditional feed showing higher intake (week 4: 0.845 kg vs. 0.810 kg, and week 5: 1.115 kg vs. 1.010 kg for traditional and prepared feed, respectively). The body weight gains continue to be close, with slight advantages in body weight for traditional feed (week 4: 0.581 kg vs. 0.590 kg, week 5: 0.667 kg vs. 0.675 kg). Cumulatively, by week 5, birds on traditional feed consume 3.095 kg of feed and gain 2.191 kg in body weight, while those on prepared feed consume 2.845 kg of feed and gain 2.175 kg, showing a small but consistent difference in favor of the traditional feed in terms of both feed consumption and weight gain. These findings suggest that while the prepared feed formulation supports similar growth performance, the traditional feed formulation may provide slightly better efficiency in terms of feed-to-weight conversion.

Table 5 Comparison of traditional and prepared broiler feed based on consumption

Age (Week)	Traditional Broiler Poultry Feed				Prepared Broiler Poultry Feed			
	Feed consumed per Broiler Chicken (KG)	Cumulative Feed Consumed (Kg)	Average Body Weight Gain per Broiler Chicken (Kg)	Cumulative Body Weight per Broiler Chicken (Kg)	Feed consumed per Broiler Chicken (KG)	Cumulative Feed Consumed (Kg)	Average Body Weight Gain per Broiler Chicken (Kg)	Cumulative Body Weight per Broiler Chicken (Kg)
Week 1	0.180	0.180	0.185	0.185	0.155	0.155	0.172	0.185
Week 2	0.385	0.565	0.280	0.465	0.350	0.505	0.268	0.440
Week 3	0.570	1.135	0.478	0.943	0.520	1.025	0.470	0.910
Week 4	0.845	1.980	0.581	1.524	0.810	1.835	0.590	1.500
Week 5	1.115	3.095	0.667	2.191	1.010	2.845	0.675	2.175

### COST ANALYSIS OF PREPARED SLAUGHTERHOUSE RAW HIDES AND SKIN TRIMMINGS POWDER

The cost breakdown for processing 100 kg of raw hides and skin trimmings is shown here. 100 kg of raw skin trimmings initially cost 500 taka, since 1 kilogram cost 5 taka. The cost of cleaning, chopping, boiling, and hair removal for 100 kg was 600 taka, whereas the cost of grinding was 1000 taka for the same amount. At 1.5 taka per kilogram, the total cost of transportation for 100 kg was 150 takas. Thus, 2250 taka was the total processing cost for 100 kg of raw hides and skin trimmings. The cost of 1 kilogram of raw hides and skin trimming powder was 68 taka ( $2250 \div 35$ ), as 100 kg of raw trimmings produced 35 kg of raw hides and skin trimmings powder after processing.

### COMPARISON OF COSTING FOR TRADITIONAL AND PREPARED BROILER POULTRY FEED

The table compares the cost of formulating traditional and prepared broiler feeds based on ingredient quantities and unit costs. For the traditional broiler feed, maize (54 kg) is the largest cost component at 34.00 per kg, totaling 1836.00. Soybean meal (26 kg) follows with a cost of 78.00 per kg, amounting to 2020.00. Other ingredients include rice polish (10 kg), wheat husk (5 kg), hydance (5 kg), and various minerals and miscellaneous additives, with their respective costs totaling 360.00, 200.00, 450.00, and 500.00, bringing the total cost of the traditional feed formulation to 5374.00 for 100 kg.

Table 6 Comparison of broiler feed formulation cost

Traditional Broiler Feed Formulation Cost				Prepared Broiler Feed Formulation Cost			
Ingredients	Quantity (kg)	Cost/kg	Total ingredients Cost	Ingredients	Quantity (kg)	Cost/kg	Total ingredients Cost
				Leather Dust*	8.5 kg	65.00	553.00
Maize	54.0 kg	34.00	1836.00	Maize	64.0 kg	34.00	2176.00
Soybean meal	26.0 kg	78.00	2020.00	Soybean meal	0.0 kg	0.00	0.00
Rice Polish	10.0 kg	36.00	360.00	Rice Polish	10.0 kg	36.00	360.00
wheat Husk	5.0 kg	40.00	200.00	wheat Husk	5.0 kg	40.00	200.00

Hydance	5.0 kg	90.00	450.00	Hydance	5.0 kg	90.00	450.00
Different Minerals & Miscellaneous cost			500.00	Different Minerals & Miscellaneous cost			500.00
Traditional feed cost (100 kg)			5374.00	Prepared feed cost (100 kg)			4240.00

The prepared broiler feed formulation replaces soybean meal with raw hides and skin trimmings powder, a more cost-effective alternative. Leather powder is used at 8.5 kg, priced at 65.00 per kg, amounting to 553.00. Maize consumption increases to 64 kg, maintaining the same cost per kg (34.00), totaling 2176.00. Rice polish, wheat husk, hydance, and mineral costs remain the same as the traditional formulation, at 360.00, 200.00, 450.00, and 500.00, respectively. The total cost for the prepared feed formulation is reduced to 4240.00 for 100 kg, reflecting a cost-saving due to the substitution of soybean meal with leather dust. This comparison demonstrates a significant cost reduction in the prepared formulation while maintaining a similar nutritional profile.

Consequently, in traditional way, each broiler chicken consumed 3.095 kg poultry feed over the 35 days of its life cycle that is accounting the total cost of 167 taka (3.095 kg × 54 BDT/taka). On the other hand, this study found that using the prepared feed, each broiler chicken required only 2.845 kg, costing 120 BDT (2.845 kg × 42 BDT/kg). After analyzing the costs of traditional and prepared poultry feed, it had been proved that each broiler poultry chicken saves approximately 47 BDT over the 35 days course of their life cycle.

## CONCLUSION

This research work therefore outlines a new and environmentally friendly means of utilizing raw hides and skin trimmings powder, a dominant tannery solid waste to formulate poultry feeds. SEM analysis demonstrated that compared to traditional feeds the microstructure of prepared feed enhanced with leather powder was more porous and heterogeneous improving absorption and assimilation of nutrients. Regarding the nutritional comparisons, it was found that the prepared feed formulation slightly enhanced the incorporation of the protein, fat, moisture, cellulose, starch, ash and energy values as the traditional feed, and reduced safety constraints values of heavy metals such as chromium, sulfur, and lead, or even undetectable levels. Growth and productivity trials justified the efficiency of the prepared feed, the chickens expressed the weight gain and the productivity indicators approximately at the same level as compared to the traditional chickens feed with prepared feed, and only slim changes concerning the starch and moisture were observed. Notably, economic evaluation derived that prepared feed formulation is a mile cheaper and cost nearly 4,23,940 taka per 1000 poultry throughout their life cycle. This way, this approach would not only offer a sustainable utilization of tannery industry by-products but would also encourage circular economy thought process in the poultry and tannery industries solving feed stock cost issue and waste disposal simultaneously.

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