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Exotic leather from broiler chicken leg skin: Processing and characterization

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Abstract

Broiler chicken leg skin (Cobb-500) is investigated in this study as an unconventional raw material for exotic leather production in Bangladesh. The raw skin contains 65.5% moisture, 28.4% protein, 6.2% fat, and 9.9% ash. Three tanning systems—chrome, semi-chrome, and vegetable—were applied to produce finished leathers, and their physicochemical and structural properties were evaluated. Thermogravimetric analysis revealed that chrome-tanned leather exhibited the highest thermal stability, with collagen degradation onset at ~350°C and ~20% residual chromium oxides, while vegetable-tanned samples degraded earlier with <5% residue. Mechanical testing showed chrome tanning achieved superior performance, with tensile strength (105 kg/cm²), tear strength (19.9 kg/cm²), elongation (19.3%), and shrinkage temperature (101°C). SEM micrographs confirmed compact, well-organized fiber bundles in chrome-tanned leather, contrasting with denser, less flexible structures in vegetable-tanned samples. Chicken leg skin shows strong potential as a renewable, durable leather source, promoting waste utilization and sustainable materials.

Keywords: Poultry; By-product; Tanning; Leather; Physical properties

Introduction

Based on the Mammal Diversity Database of the American Society of Mammalogists (ASM), there are approximately 6,815 recognized mammal species globally (Mammal Diversity Database, 2025). Out of these, 50 species are identified as sources for leather production. About 99% of the world's leather is produced by animals that are primarily raised for their meat, dairy and wool (The Leather Dictionary, accessed 2025). These animals include cows, water buffalo, sheep, goats, zebras, and pigs. The primary sources for leather production are the skins and hides of cattle, sheep, pigs, and goats, contributing 65%, 15%, 10%, and 9% of the total, respectively (Food and Agriculture Organization, 2008). The remaining percentage accounts for the exotic leather. Skins refer to the external covering or integument of small animals such as goats, sheep, and pigs, whereas hides are the external covering or integument of larger animals such as cows, buffaloes, and horses (Covington, T. 2009).

In Bangladesh, the leather industry largely depends on hides and skins sourced from cattle, buffalo, goats, and sheep, which are the most readily available raw materials. Nevertheless, there is a growing demand for diversification. Despite the potential for exotic leather to serve as an alternative material source, its commercial production has not yet been initiated in Bangladesh. Exotic leathers exhibit distinctive characteristics in terms of their appearance, texture, color, and tactile qualities when compared to conventional leather. Exotic leather is typically made from animals that are not commonly utilized in the leather business or from less traditional portions of animals for the purpose of producing leather (Exotic Leather, accessed 2025). Some exotic leathers are subject to protection under CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). Crocodile and snake skins are commonly recognized as exotic leather materials, but there are also unconventional alternatives,

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including leather sourced from fish skin, or the belly/stomach of a cow. Chicken leather is also an alternative source of exotic leather. Chicken leather is derived from the skin of chickens, primarily sourced from their legs and feet. This type of leather is a by-product of the poultry industry. Chicken skin, on its own, is thin and lacks the necessary durability for extended use. However, through a distinctive tanning process, chicken skin is transformed into a finished leather. Recently, chicken leather has attracted considerable attention due to its potential as an ethical and eco-friendly substitute for other types of leather, despite its less widespread use compared to more conventional alternatives. Karthikeyan and Chandra (2017) have explored the potential of utilizing chicken leg skin to establish a new niche in the fashion industry. They crafted various items such as wallets, wristwatch straps, and key rings from this material. Prior to their work on chicken skin, they also investigated Himantura stingray skins, offering tanners a practical method for producing soft and flexible leathers (Karthikeyan *et al.* 2009). Similarly, Alla *et al.* demonstrated that puffer fish skin can be transformed into value-added hand gloves and have future plans to focus on crafting therapeutic footwear and other high-grip products using fish skin leather (Alla *et al.* 2017). Peris N. Wainaina *et al.* worked with ovine stomachs to craft purses and key holders (Wainaina *et al.* 2022). The growing interest in various leather types is driven by the fact that these animals are primarily raised for their meat, and using their skins for leather production reduces food waste and maximizes the use of every part of the animal. Consequently, Bangladesh has a promising opportunity to manufacture exotic leather from broiler chicken leg skin. Light-Castle, a Netherlands Enterprise Agency, reports that more than 58.39 percent of all chickens in Bangladesh belong to the broiler breed which is 525 million per year. Presently, there are over 53,000 broiler farms operating in the country (Larive International BV and Light Castle Partners Ltd. 2020). Apart from that, additional varieties of chickens, including Layer and Layer Sonali 74 MN, Sonali 250 MN, and Deshi 50 MN, are also being produced. According to the Livestock Economy Report (2022-23) by the Department of Livestock Services (DLS), the average person in Bangladesh consumes 137.38 g of meat per day, including a per capita consumption of 6.8 kg of chicken per year. The country's daily consumption of poultry meat is 3,440 tons, adding up to a total of 1.26 million tons per year (Livestock Economy at a Glance, BLRI, 2022-23). These Chicken processing plants produce a significant amount of solid by-products, which include bones, heads, legs, feathers, and viscera. The skins of chicken legs, along with other valuable by-products, are often used in poultry feed or discarded with solid waste, leading to adverse environmental impacts. These wastes contain proteinaceous materials that serve as a rich medium for microbial growth, resulting in foul odor and potential toxicity to the environment. However, chicken leg skins can be utilized as a raw material for producing exotic types of leather, which can be further transformed into value-added products such as ladies' handbags, purses, passport holders, visiting card holders, key holders, men's wallets, and diary covers. Such leather goods hold significant potential as a source of foreign exchange earnings. Moreover, the incorporation of chicken leg skins into leather production can serve as a valuable complement to traditional raw materials, including bovine, goat, and sheep skins, thereby enhancing the sustainability and resource efficiency of the leather industry. So, Bangladesh has a significant opportunity to produce exotic leather using the skin from broiler chicken legs. In Bangladesh it is rare to produce leather from exotic sources. The treatment and transformation of waste into value-added products not only have the potential to boost a country's economy but also to mitigate environmental pollution and enhance the socio-economic well-being of its people by generating employment opportunities. Unfortunately, due to a lack of awareness these valuable by-products are not effectively utilized in Bangladesh and tanners are failing to capitalize on the potential of the skins.

Therefore, the current study aims to establish an appropriate process technology for the production of finished leathers. This research mainly focused on the transformation of Cobb-500 chicken leg skin into leather, subsequently utilizing it for the production of value-added products.

Materials and methods

Preparation of chicken leg skin for tanning

A total of 500 chicken legs were collected from a nearby poultry shop located adjacent to the Leather Research Institute in Savar, Dhaka, Bangladesh. Afterward, skinning was done using Anti- cutter and blade. Skinning of chicken leg is difficult task compare to other animal. The chicken skins were meticulously cleaned with tap water to remove residual feathers, flesh, and fat, along with any dirt or debris, and preserved in freezer.

Analysis of the chicken leg skin

This pertains to the analysis of the primary constituents of chicken leg skin. We conducted analysis for the moisture content, total ash content, nitrogen content, and fat content of the chicken leg skin.

Determination of moisture content

The moisture content in chicken leg skin can vary depending on several factors such as the breed of chicken, the age of the chicken and the environmental conditions. Typically, raw chicken leg skin has a moisture content ranging from 60% to 70%. To determine the moisture content oven drying method was chosen. For that, 9.6 g of chicken leg skin was placed in a suitable crucible and heated to 105 ± 2ºC for six hours in the oven. The skin was cooled after the specified amount of time and weighed. The moisture content in the chicken leg skin sample was determined by the following equation (1):

$$\text{Moisture content (\%)} = \frac{m-n}{m} \times 100 \qquad (1)$$

where, m = mass of sample

n= mass of dried sample

Determination of nitrogen content and hide substance

The nitrogen content and hide substance of the chicken leg skins were measured with the Kjeldahl method and SLC 7 test procedures, respectively. The nitrogen content was calculated using equation 2, and the hide substance was calculated using equation 3.

$$\text{Nitrogen content, percent by weight} = \frac{4 \times V \times N}{W} \times 100 \qquad (2)$$

where V = volume in ml of sulfuric acid used in the titration,

N= normality of the sulphuric acid, and

W = weight in g of the material taken for the test

Hide substance, percent by weight = % nitrogen x 5.62 (3)

Determination of fat Content

Chicken leg skin is high in fat content. The amount of fat in chicken leg skin can vary depending on various factors such as the age and breed of the chicken. The fat content of a raw chicken leg skin sample was determined according to the SLC 4. Continuous dichloromethane (CH_2Cl_2) extraction is performed on a raw chicken leg skin sample. The extract is dried at 102 once the solvent has evaporated from it.

$$\text{Percentage (\%) of fat} = \frac{M_1}{M_0} \times 100 \qquad (2)$$

Where, M_1 = mass of extract,

M_0 = mass of sample

Determination of shrinkage temperature

The shrinkage temperature of the pelt was determined following SLC 406. A sample measuring 50 mm × 12 mm was cut from the conditioned pelt. Two holes, each of 3 mm diameter, were punched 5 mm from either short end along a line parallel to and equidistant from the long edges. The specimen was mounted between two hooks and immersed in 350 mL NaCl solution. The solution was heated with continuous stirring at a rate of 2°C per minute. The temperature at which the specimen exhibited noticeable shrinkage was recorded as the shrinkage temperature (°C).

Conversion of chicken leg skin to leather

Conventional procedures of chrome tanning, semi-chrome tanning and vegetable tanning process were followed to convert chicken leg skin to usable leather. After the initial step of skinning, chicken leg skins go through a series of processes including pre-tanning, tanning, and post-tanning to finally transform into finished leather.

Pre-tanning stage

Soaking: 300 g of flayed skins were soaked in a solution consisting of 400% water, 0.2% LD600 (Wetting agent) and 0.1% Bactericide (Busan 40L). They were allowed to soak overnight for a duration of 16 hours. On the following day, the skins were subjected to a thorough 30-minute washing process and subsequently drained.

Liming: In the liming process, a mixture of 4% lime and 0.2% Na_2S was used with 100% water. The mixture was left for two days in the same container before being dispersed manually.

Deliming: This process utilized 100% water, 2% ammonium sulfate, and 0.5% sodium metabisulfite, and was carried out over a duration of 40 minutes

Pickling and tanning process

Three types of tanning processes (chrome, semi-chrome and vegetable tanning) were studied. All the procedures are shown in Table I. First column describes about chrome tanning whereas second and third column describe semi-chrome and vegetable tanning process respectively.

Post tanning process for chicken leg skin

The post-tanning process included neutralization, re-tanning, fat liquoring, and fixing. These methods are detailed in Table II.

Finishing procedure of chicken leg skin

Using the same finishing chemicals across three tanning methods promotes uniform quality and appearance in the leather. This consistency simplifies quality control and can lead to cost savings in production. Additionally, it allows for

Table I. Pickling and Tanning process

Vegetable tanning	Semi-chrome tanning	Chrome tanning
Partial pickling Water 50% Formic acid 0.5% (10+30) min run Pretanning syntan 3% run 30 min Mimosa 8% run 60 min 1% Fat + 8% Mimosa 60 min run 1% Fat+ 5% Quebracho 60 min run pH 3.0-3.2	Water - 80% Salt - 8% CO-15 - 0.2% } Run for 15 min 0.5% Formic acid (1:10 dilute) (10+10) min run 0.1% H2SO4 (1:20 dilute) (15+15+60) min run 0.2% Hypo 15 min run pH 2.7-2.9 5% Chrome syntan 60 min run 5% Chrome 60min run 1% Sodium formate 30 min run 0.5% Sodium bi-carbonate (10+10+25)run Preservative 0.2% run 20 min pH 3.5-3.8	Water - 80% Salt - 8% CO-15 -0.2% } Run for 15 min 0.5% Formic Acid (1:10 dilute) 15 min run 0.1% H2SO4 (1:20 dilute) (15+15+60) min run 0.2% Hypo 15 min run pH 2.6-2.8 8% Chrome (4% + 4%) interval 30 minute 90 min run Sodium formate 1% 30 min run 1% Sodium bi-carbonate (1:20 dilution) 10+10+40 min run pH 3.6-3.8 Preservative 0.2% 20 min run Unload and pile up

Table II. Post tanning process for chicken leg skin

Process	Chemicals %	Veg.tan	Chrome	Semi-Chrome
Neutralization (45 min)	Water	100%	100%	100%
	Nutralization Syntan (S. Ng)	2%	1%	1%
	Sodium fomate	0.5%	0.5%	0.5%
	Sodium bi-Carbonate	-------	0.5	0.5
	Water	100% (40^o)	100% (40^o)	100% (40^o)
Retanning (90min)	RS_3 (Resin syntan)	2%	4%	4%
	Dye	2%	2%	2%
	Synthetic fat	3%	3%	3%
	Syntan	8%	8%	8%
	Water	100% (55^o)	100% (55^o)	100% (55^o)
Fat liquoring (60 min)	Natural fat + Fish base	4%	4%	4%
	Semi synthetic fat	4%	4%	4%
	Preservative	0.2%	0.2%	0.2%
Fixing (30 min)	Formic acid	1.5%	1.5%	1.5%

Table III. Finishing procedure of chicken leg skin

Process	Chemical	Quantity (Parts)
Season Coat	Pigment	100
	Wax	30
	Lustre	100
	Matting Agent	150
	Water	420
	Encryl XE	100
	Enkathanes	100
Apply 2 cross spray coat, dry well, kiss plate at 75℃/50 kg. Spray 2 times and dry well.		
Top Coat	Enkathane top TL	500
	Matting Agent	100
	Sensol SW	10
	Water	350
	Wax TRA	20
	Cross linker	20
Spray 2 times light cross, dry well.		

a more streamlined process, enhancing overall efficiency. The finishing process of the manufactured leather given in details at Table III.

Thermo gravimetric analysis

Thermal stability of the chrome, semi-chrome and vegetable tanned leather was determined by simultaneous thermal analysis (STA) (STA 449 F3, NETZSCH, Germany). This analysis was conducted under an inert atmosphere. The samples were heated from room temperature up to 600°C at a constant heating rate of 10°C/min.

Structural analysis of processed leathers

The morphology of chicken leg leather was examined using a Field Emission Scanning Electron Microscope (FE-SEM, Model: JSM-7610F, Japan). This technique allowed direct observation of the fiber morphology of the leather. For FE-SEM sample preparation, the specimens were sputter-coated with a thin layer of platinum (~1 nm thickness).

Physical testing

The physical properties, such as tensile strength (kg/cm²) and percentage elongation, water vapor permeability (mg/cm²), ball burst test (kg/cm²), Baumann tear strength (kg/cm²), color fastness, shrinkage temperature (°C), softness, ash content (%), and pH were evaluated to assess the mechanical performance of the chicken leg leather by the SATRA TM, IULTCS, and SLC standard methods.

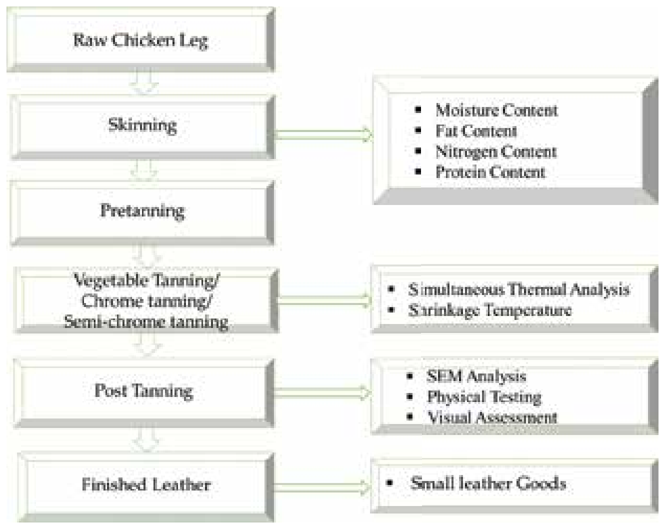

Fig. 1. Flow chart for plan of experiments on chicken leg skin

The experiment was carried out in the study illustrated in Fig. 1.

Results and discussion

Characterization of chicken leg skin

The moisture content of raw chicken leg skin was measured at 65.5 ± 0.3%, falling within the range of 60% to 70%. In addition, the nitrogen, protein, fat, and ash contents were found to be 4.5 ± 0.05%, 28.4 ± 0.1%, 6.2 ± 0.1%, and 9.9877%, respectively (Table IV). These values provide important insights into the nutritional composition of the skin.

Table IV. Chemical composition of chicken leg skin

Characteristics	Value in %
Moisture content	65.5 ± 0.3
Nitrogen content	4.5 ± 0.05
Protein content	28.4 ± 0.1
Fat content	6.2 ± 0.1
Ash content	9.9877

Reversibility effect

Chicken leg leather displayed a distinctive reversibility effect. This phenomenon was observed when the leather was placed in hot water at around 70°C causing it to rapidly contract and thicken. Subsequently, when these shrunken leather pieces were placed in cold water, they promptly relaxed and regained approximately 90% of their original size. This observation suggests that these leathers successfully passed the reversibility effect test. Noted that, the tanned leathers are unique due to their ability to regain original shape after exposure to moisture and heat. When it shrinks from hydrothermal effects, the leather can often be restored by simply allowing it to dry properly, making it a durable choice for various applications. This reversible transformation adds to its appeal for artisans and consumers alike.

TGA profile for tanned chicken leather

The thermogram curves for chicken leg leather tanned using vegetable, semi-chrome, and chrome methods are presented in Fig. 2. This analysis focused on the thermal breakdown of the leather samples.

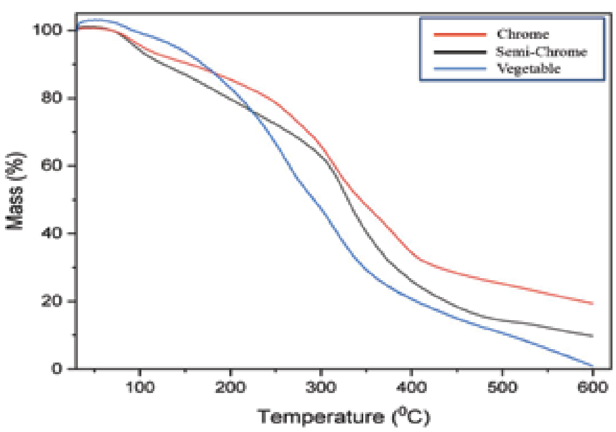

Fig. 2. TGA curve of chrome (a), Semi-chrome (b) and Vegetable (c) Tanned leather

In the first stage (~120), all samples lost 3–5% mass due to moisture evaporation. Vegetable tanned leather showed slightly higher loss (5%) than semi-chrome (4%) and chrome tanned (3%) leathers, reflecting greater hydrophilicity from polyphenolic tannins. The second stage (~200–350) involved collagen decomposition. Vegetable tanned leather degraded earliest with 45–50% loss, semi-chrome showed 38–42% loss, and chrome tanned leather had the highest stability (30–35% loss) due to chromium (III) crosslinking. In the third stage (~350–600), residual organics decomposed, leaving 20% ash in chrome tanned, 10% in semi-chrome, and <5% in vegetable tanned leather. The higher residue in chrome tanned leather is attributed to stable chromium ox-ides, while vegetable tanned leather, being mostly organ-ic, left minimal residue.

Effect of tanning system on the fiber structure of chicken leg leather

The SEM cross-sectional analysis revealed distinct differences in fiber bundle arrangement among the leathers produced by different tanning systems. Chrome-tanned leather exhibited well-defined and intact fiber bundles, with minimal

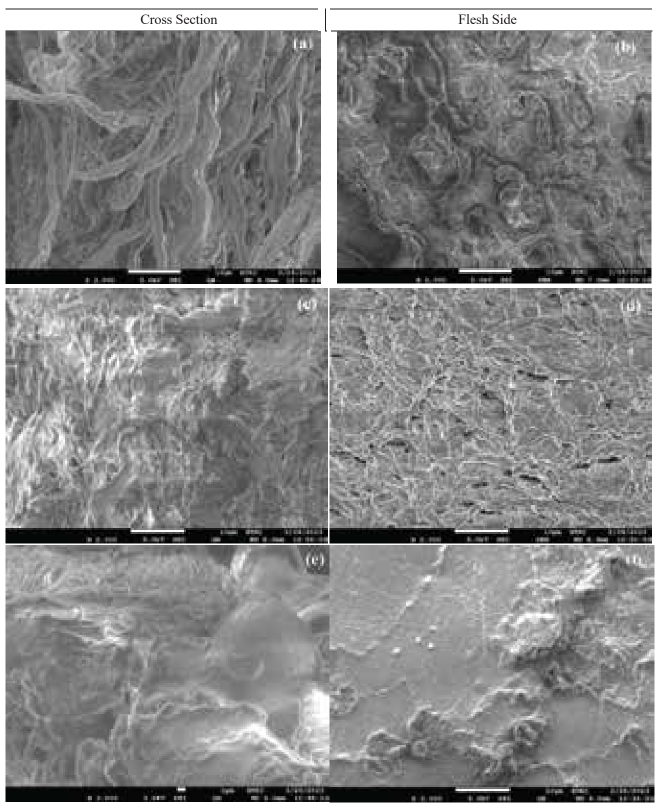

Fig. 3. SEM image of chrome tanned (a), (b); Semi-chrome tanned (c), (d); Vegetable tanned (e), (f)

inter-fiber adhesion or collapse, indicating that chromium salts effectively penetrated and cross-linked the collagen matrix while maintaining an open and organized structure. In contrast, semi-chrome and vegetable-tanned leathers showed disorganized and matted fiber bundles (Fig. 3).

Tensile strength measurements supported these observations, with chrome-tanned leather showing the highest values compared to the other two types. The superior mechanical performance of chrome-tanned leather can be explained by the strong yet flexible chromium cross-links, which allow uniform stress distribution and prevent brittle failure. In contrast, the dense and rigid fiber network of vegetable and semi-chrome tanned leathers restricts fiber mobility under load, resulting in lower tensile strength.

Optical micrograph

Optical micrographs captured at 1000× magnification (Tiny-scope) revealed distinct differences in the surface microstructure of chicken leg skin (Fig. 4A) and goat shoe upper leather (Fig. 4B). The chicken leg skin exhibited numerous minute, closely packed pores, indicating a denser and more compact grain structure. Such tight pore distribution typically results in reduced water vapor permeability, as the smaller openings restrict the passage of moisture through the material. In contrast, the goat shoe upper leather displayed larger and more clearly defined pores, characteristic of a more open and porous architecture. This enhanced porosity of goat leather facilitates better breathability, allowing for improved moisture interaction. Consequently, these structural differences significantly influence comfort and durability in their respective applications, with chicken skin providing less moisture exchange compared to the more breathable cattle leather.

Fig. 4A. Grain side of chicken leg skin (a. chrome tanned, b. semi-chrome tanned, and c. vegetable tanned) (1000x)

Fig. 4B. Grain side of goat shoe upper leather (1000x)

Physical testing and visual assessment data

The comparison of various physical tests of produced leathers (chrome tanning, semi-chrome tanning, and vegetable

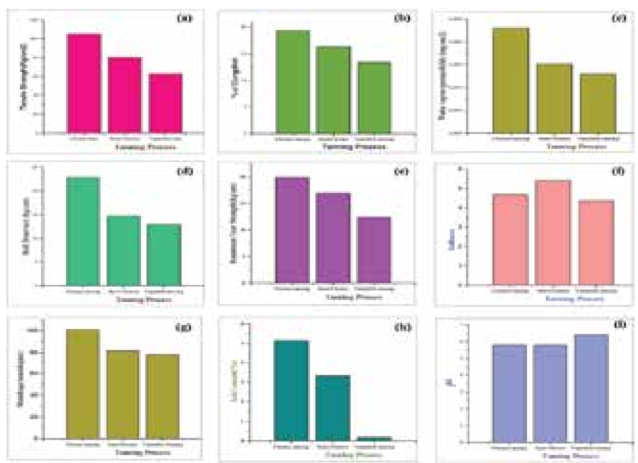

Fig. 5. Physical Test: a. Tensile Strength, b. Elongation at break, c. Water vapour permeability, d. Ball Burst Test, e. Baumann Tear Strength, f. Softness of leather, g. Shrinkage temperature, h. Ash Content, i. pH Value

tanning) shows clear differences in physical, thermal, and chemical performance (Table V). The physical properties for chicken leg leather tanned using vegetable, semi-chrome, and chrome methods are presented in Fig 5.

Table V. Physical Testing Data

Parameters	Chrome tanned	Semi-chrome	Veg. tanned	Goat leather (Chrome tanned)	Method
Tensile Strength (kg/cm^2)	105 ± 5	80.5 ± 2	63 ± 5	260 ± 1.20	SATRA TM 43
% Elongation	19.3 ± 5	16.3 ± 1	13.4 ± 5	45.21 ± 10	SATRA TM 43
Water vapour permeability (mg/cm^2)	0.023	0.015	0.013	12.4 ± 8	SATRA TM172
Ball Burst Test (kg/cm)	22.88	14.7	12.98	28.5 ± 3.0	SATRA TM24:1992
Baumann Tear Strength (kg/cm)	19.92	16.93	12.39	30.5 ± 4.5	SATRA TM162:1992
Color Fastness	5	3/4	5	4–5	ISO 7906:2022; IULTCS/IUF 120
Shrinkage tem. (°)	101	82	78	98 ± 3	SATRA TM17:1997
Softness	4.68	5.41	4.36	5.0 ± 0.3	ISO 17235:2015
Ash Content (%)	5.16	3.30	0.20	3.5 ± 0.5	SLC 6
pH	5.8	5.8	6.1	5.2 ± 0.3	SLC 120

Chrome-tanned leather exhibits the highest tensile strength (105 ± 5 kg/cm²), elongation (19.3 ± 5%), ball burst strength (22.88 kg/cm²), and tear strength (19.92 kg/cm²), indicating superior durability and flexibility. It also has the highest shrinkage temperature (101), showing strong thermal resistance, and a color fastness rating of 5, which reflects excellent dye retention. Although it has the highest water vapor permeability (0.023 mg/cm²), making it more breathable. The softness level (4.68) is moderate, and the high ash content (5.1594%) corresponds to the chromium compounds used in tanning, with a safe pH of 5.8. Semi-chrome leather offers a balance between chrome and vegetable tanning, with moderate tensile strength (80.5 ± 2 kg/cm²), elongation (16.3 ± 1%), and tear resistance (16.93 kg/cm²). It features the second highest water vapor permeability (0.015 mg/cm²), its breathability remains within acceptable limits, but has lower thermal stability (shrinkage temperature 82°C and slightly weaker color fastness (rating 3/4). It is also softer (5.41) than the others and has a lower ash content (3.338%) with the same pH (5.8) as chrome-tanned leather. On the other hand, vegetable-tanned leather shows the lowest values in strength and durability parameters, such as tensile strength (63 ± 5 kg/cm²), elongation (13.4 ± 5%), and tear strength (12.39 kg/cm²), along with a lower shrinkage temperature (78°C), indicating less resistance to heat. However, it retains a perfect color fastness rating of 5 and is the firmest (4.36) among the three. It also has the lowest ash content (0.1984%) due to the absence of mineral tanning agents and a slightly higher pH of 6.1, suggesting a more neutral and possibly skin-friendly material. Overall, chrome-tanned leather is ideal for high-strength, durable applications; semi-chrome tanning offers a balanced combination of performance and breathability; while vegetable-tanned leather is suited for traditional, natural, and eco-friendly uses. In this study, semi-chrome leather was slightly softer than chrome leather—an unusual result that may be attributed to the uneven surface structure of chicken leg skin. A similar trend was also observed by Karthikeyan and Chandra Babu (2017), supporting the findings of this study. The leather also exhibits compact and uniform dimensions (Table VI), making it suitable for small leather goods. With a thickness ranging from 0.8 to 1.0 mm, it offers a good balance between flexibility and durability.

Its length varies between 11cm to 13cm, while the width falls within 3.5cm to 4.5cm. These measurements indicate that chicken leg leather is relatively thin and small in size, making it ideal for use in products like wallets, watch straps, card holders, or decorative inlays. Some visual assessments of tanned leathers were listed in Table VII.

Table VI. Measurement of chicken leg leather

Properties	Chicken leg leather
Length	11-13 cm
Width	3.5-4.5 cm
Thickness	0.8-1.0 mm

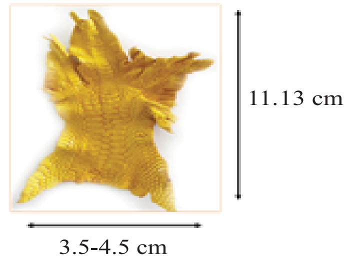

Table VII. Visual assessment of finished leather

Topic	Observation
Color evenness	The leathers were evenly colored.
Color fastness	The surfaces of the leathers were able to hold their color without fading.
Color bleeding	Color transfer was not observed.
Flexibility	Flexible and foldable.
Feel	The leathers had a hardy feel.
Stretch	The leathers had less stretch.
Light fastness	The leathers were able to hold their color against sunlight.
Water fastness	The color was not washed by water.

Table VIII. Value of water quality assessment

Tanning Process	Cr (ppm)	TDS (ppm)	COD (mg/ L)	BOD (mg/L)
Chrome-tanning	2330	217	5642	2920
Semi-chrome tanning	1810	218	7469	4460
Vegetable tanning	-	316	17953	11470

Environmental analysis of waste water in different tanning process

The environmental impact of wastewater from different tanning processes—chrome tanning, semi-chrome tanning, and vegetable tanning—shows significant variation in pollution levels. In the chrome tanning process, the concentration of chromium in the effluent is the highest at 2330 ppm (Table VIII), which is a direct result of the use of chromium salts during tanning. It also has TDS of 217 ppm, COD of 5642 ppm, and BOD of 2920 ppm, indicating a moderate organic and chemical pollutant load.

The semi-chrome tanning process produces slightly less chromium at 1810 ppm, but has a higher COD (7469 ppm) and BOD (4460 ppm), suggesting greater organic pollution despite reduced chromium usage. Its TDS level is 218 ppm, nearly equal to chrome tanning. In contrast, vegetable tanning, which uses natural tannins and no chromium, shows no detectable chromium, which is environmentally favorable in terms of heavy metal pollution. However, this method results in significantly higher TDS (316 ppm), COD (17953 ppm), and BOD (11470 ppm), indicating a much higher organic and chemical load in the wastewater. This is likely due to the large quantity of biodegradable organic compounds from plant-based

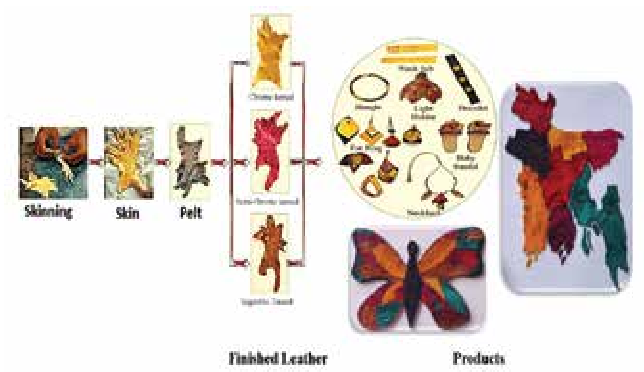

Fig. 6. Graphical representation of life cycle of boiler chicken leg skin

materials. In summary, chrome tanning contributes to heavy metal pollution, semi-chrome reduces chromium but increases organic load, and vegetable tanning eliminates chromium completely but generates the highest overall organic pollution, which demands advanced wastewater treatment before discharge. A simplified representation of leather goods made from chicken leg leather is shown in Fig. 6

Conclusion

The leather industry in Bangladesh primarily relies on cattle, goat, and sheep hides and skins as its main source of raw materials. However, there is a pressing need for diversification in this sector. One potential avenue for diversification is the utilization of chicken leg skin as exotic leather sources. This study characterizes chicken leg leather by assessing its chemical composition, reversibility effect, thermal stability, fiber structure, and mechanical properties across different tanning methods (chrome, semi-chrome, and vegetable). The raw chicken leg skin exhibited a moisture content of 65.5%, with significant levels of protein and ash. The leather demonstrated remarkable reversibility, regaining about 90% of its original size after thermal contraction. Thermal analysis indicated that vegetable-tanned leather had the highest weight loss, while SEM imaging showed a compact fiber structure across all tanning methods. Mechanical testing revealed superior tensile strength and higher water vapor permeability for chrome-tanned leather compared to semi-chrome and vegetable variants. Additionally, an environmental analysis of wastewater highlighted significant chromium levels in chrome tanning, while vegetable tanning produced high COD and BOD levels, underscoring the need for better wastewater management in the leather industry. It has been observed that the physical properties of chicken leg leather are slightly lower than those of goat leather. Semi-chrome tanning was found to be the softer leather compared to chrome tanning alone. Overall, this study has the potential to open new avenues for the leather industry by introducing chicken leg skin as a previously overlooked and largely discarded raw material.

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