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Research Article

Extraction and Optimization of Tanning Material from *Osyris lanceolata* Barks: Cleaner Leather Tanning Processing

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Tanning is a processing mechanism that prevents the collagen fibers from putrefaction to maximize the hydrothermal stability of leather. Tannin agents extracted from plants were used in leather production in a process called vegetable tanning. Vegetable tanning is an eco-friendly tanning method when compared to chrome tanning. Chrome tanning is the most common method of tanning hides. Currently, chrome tanning, which is extracted from chrome ores, is used in more than 80–90% of the leather tanning industry, but the most serious environmental issue associated with tanneries is chromium. This implies that the presence of chromium both in wastewater and in leather waste has a significant environmental impact and a high cost for landfills. However, currently, vegetable tanning and other tanning materials take up a 10–20% share of the leather tanning industry. Even today, most commercial vegetable tanning is a mimosa. In this study, a new alternative material and chrome-free tanning process using the barks of the *Osyris lanceolata* plant barks which reduces the environmental pollution load in terms of wastewater and solid wastes would be introduced. The study also aimed to improve the extraction and optimization mechanisms of tannin material from the bark of the *Osyris lanceolata* plant, which grows in Dera Hamusit Woreda in Ethiopia's south Gonder Amhara region. In addition to these, the chemical and physical properties of experimentally treated leather were analyzed. This study's results show that the bark of *Osyris lanceolata* contains (18.72%) tannin with 96% tanning strength (96%), and 49 percent purity. Also, leather treated with this tannin showed good shrinkage temperature (84.5°C), and organoleptic properties results such as tensile strength, tear strength, and elongation were 7.1 N/mm^2, 19 N, and 45%, respectively. Besides that, the FTIR analysis shows that the bark of the *Osyris lanceolata* plant has a phenolic compound that is used for tanning purposes. This study clearly shows that extracted tannin from *Osyris lanceolata* has the potential to be used as an alternative tannin material in the leather tanning industry.

1. Introduction

Tanning leather is a process that permanently alters the protein structure of the skin and prevents the fibrous protein collagen in animal skins from purification, maximizing the thermal stability of leather. Tanning can be performed with either vegetable or mineral methods. Chromium is a serious environmental issue associated with tanneries and is now used in the tanning industry in between 80 and 90% of leather [1]. Chrome released as solid and liquid from tannery requires a high cost of effluent treatment plants [2, 3]. Although trivalent Cr (III) is less toxic than Cr (VI) due to its inability to permeate cell membranes [4], both chromium species have been linked to the inhibition of biological processes, including those in humans [5–7]. Vegetable tanning is the oldest known leather-making process and was done by treating hides and skins with leaves and barks containing tannin. The diversification of vegetable tannins resources can save the expenses of transport and final products which represent an ecological approach. Tannins or natural polyphenols are water-soluble and can precipitate alkaloids, gelatin, and other solutions from protein. Collagen stabilization occurs when 15–40% of the tannins, per dry weight of skin are absorbed and incorporated into the collagen fiber matrix [8]. Previously, several researchers attempted to mitigate the conventional tanning-related problem by using plant-based tanning methods, which are environment-friendly options that decrease BOD and COD loads in leather processing. This research aimed to extract eco-friendly tanning materials from locally accessible plants to minimize tannery effluent and replace mineral tanning agents.

1.1. Chemistry of Vegetable Tannins. Tannins are grouped into two main types: hydrolyzable and condensed tannins, according to their structural features. Condensed tannins are found in monocotyledonous and dicotyledonous plants, while hydrolyzable tannins are only found in dicotyledonous plants [9, 10]. Hydrolyzable tannins are types of tannins that have a molecular weight of 500–3000 Da. Hydrolyzable tannins contain gallic acid esterified with glucose [11]. Gallotannins and ellagitannins are two types of hydrolyzable tannins [12]. Gallotannins, on hydrolysis, yield gallic acid and glucose. Ellagitannins, on hydrolysis, give ellagic acid and glucose. Hydrolyzable tannins have the characteristic property of undergoing hydrolysis to form a "bloom." They produce leather with a yellow or greenish cast and good lightfastness [13]. The hydroxyl groups of the carbohydrates are partially or esterified with phenolic groups such as gallic acids in gallotannins or ellagic acid in ellagitannins [14]. Hydrolyzable tannins are polygalacturonic glucose and/or polygalacturonic quinic acid derivatives with 3 to 12 gallic acid residues per molecule. Hydrolyzable tannins can be extracted from different vegetable plants, such as chestnut wood, oak wood, Tara pods, myrobalans, and Aleppo gall [15–17]. The condensable tannins are not prone to hydrolysis, but they are liable to oxidation and polymerization to form insoluble products known as "tannin reds" or "phlobaphenes" [18].

1.1.1. Osyris lanceolata Plant. *Osyris lanceolata* is a hardy evergreen shrub or small tree that blooms in the winter. Its fleshy, yellowish-green fruits turn bright red to purple-black when ripening. They are very decorative and will attract birds to your garden. *Osyris lanceolata* is a 2–6 m tall multistemmed evergreen hardy shrub or small tree. It has a smooth, dark brown to blackish bark, with young branches blue-greenish. The leaves are alternate, about 13–50 mm long, sharp-pointed, blue-green, often with a waxy bloom, smooth, thick, and leathery. The flowers are small, yellowish-green, and produced in axillary clusters on long, slender flowering stalks. The flowering time is from September to February. The fruits are fleshy and small (about 15×10 mm), becoming yellow and ripening bright red to purplish black. They are crowned with a persistent calyx. Fruiting occurs from May to September [19–21]. Hermaphrodite flowers in the axils of upper leaves; peduncles are solitary, usually 1-flowered, occasionally flowers in 2-3-flowered dichasia; male flowers are both axillary and terminal, often panicled, with each peduncle usually terminating in an umbellate cluster of flowers; flowers are rarely solitary or in 2-3-flowered dichasia [22, 23].

2. Materials and Methods

The study used both qualitative and quantitative approaches to assess the properties of plants and treated leather with extracted tannin. The research and experimental work have been carried out at the Ethiopian Institute of Textile and Fashion Technology, Bahir Dar University, Ethiopia, and Bahir Dar Tannery, Ethiopia. The study data were analyzed with tables, pictures, and graphs.

Materials. The material used for performing this study was sheep pickled pelt from Bahir Dar Tannery, Ph. paper, weighting balance, jar, stove, sieve, beaker, and magnetic stirrer, and chemicals used for performing the study, sodium bicarbonate, *Osyris lanceolata* powder solution, brown dye, Basyntan D, (re-tanning agents"), Coriamin SA/N (Cationic fat-liquor), polymer RSC, acetone, calcium carbonate, Catalix® LX liq (Lightfast synthetic fat-liquor) from Zimmer Schwarz leather chemicals company which bought by Bahir Dar Tannery and Bahir Dar University.

Raw materials. The 2 kg of collected *Osyris lanceolata* bark was collected from south Gonder Dera Hamusit, Woreda, Amhara region, Ethiopian. Figure 1 shows that collecting of *Osyris lanceolata* plant.

2.1. Tannin Extraction from Osyris lanceolata Plant. The 2 kg of *Osyris lanceolata* bark collected from south Gonder Dera Hamusit, Woreda, Amhara region, Ethiopian, collect barks was dried in sunlight for five days. After the plant has dried, grind the bark with a grinding machine to a particle size of 0.5–0.6 mm [24]. After this, we used a central composite design experiment to prepare the tanning material from the *Osyris lanceolata* plant. The extraction method used for this study was the decoction method. The researcher conducted seventeen trials using central composite design experiment software in which tannins were extracted from vegetable materials using water as a solvent at temperatures ranging from 40 to 90°C and concentrations (4–15 g/mL [25]), and the duration ranged between 1 and 2 hours [26]. Extraction efficiency improves with higher temperatures during extraction. It thus renders the cell wall permeable, increases the solubility and diffusion coefficient of the compound to be extracted, and decreases the viscosity of the solvents, thus facilitating their passage through the solid substance and the subsequent separating process. The rate of extraction increases along with the number of extraction steps [27]. Figure 2 shows filtration and filtrated extracts.

2.2. Phytochemical Analysis. The plant extract was subjected to preliminary qualitative phytochemical screening for steroids, alkaloids, flavonoids, tannins, saponins, and phenol based on the following standard methods:

(a) Ferric Test.

A ferric chloride test is used to determine the quality of tannin (Zhou et al. [28]) by preparing one gram of powdered from *Osyris lanceolata* barks, adding

Figure 1: The collecting of *Osyris lanceolata* plant.

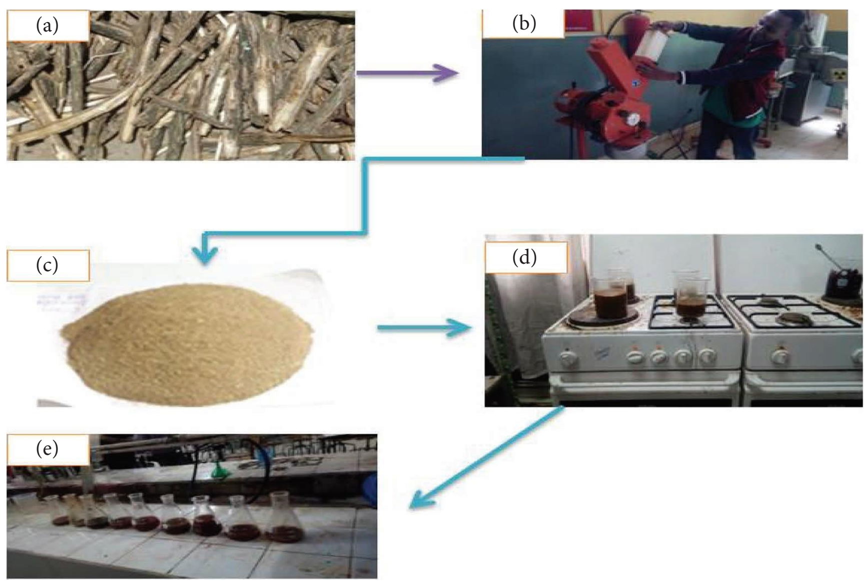


Figure 2: Filtration/filtrated extracts.

10 mL of pure water into the beaker, and then mixing. The solution was boiled for five minutes before the researcher added two drops of a 5% aqueous solution of iron chloride [29]. Figure 3 shows that the phytochemicals analysis with ferric chloride.

2.2.1. Determination of Total Soluble Solids. Two liters of the solution were extracted from a known amount of ground vegetable tanning materials using water as a solvent. One gram of kaolin was added at the base of the filter paper, and the filtrate was collected in a flesh beaker as soon as it became optically clear. The paper was kept full, and the funnel and the collecting vessels were also covered at the time of filtration. Fifty (50) ml of the filtrate was pipetted into a porcelain basin for evaporation at 27°C. It was dried and weighed until a constant weight was obtained [30].

$$\text{Total soluble solids percent by weight} = \left(\frac{w2}{w1}\right) \times \left(\frac{v1}{v2}\right) \times 100, \quad (1)$$

where $W2$ = weight in a gram of the residue left after drying. $W1$ = weight in a gram of the tanning materials taken. $V1$ = volume of the test solution in ml made up originally. $V2$ = volume in ml of the test solution taken or pipetted out.

2.2.2. Determination of Nontannins. The dry hide powder (6.25 grams) was weighed and put in a bottle of 300 ml capacity containing 100 ml of the unfiltered tannin infusion prepared. Twenty (20) ml of distilled water was then added. The bottle was closed tightly with a stopper and shaken vigorously first by hands for 15 seconds and then transferred to a mechanical rotary shaker and shaken for exactly 10 minutes at 50 to 65 rev/min. The powdered solution was poured on a clean dry linen filter cloth supported by a funnel, drained, and squeezed by hand. One gram of kaolin was added to the filtrate and poured into a single 15 cm pleated filter paper until it was clear. Fifty (50) ml of the filtrate was evaporated in a tarred porcelain dish and dried in an oven at 100°C. It was cooled and weighed until a constant weight was observed. To correct for the 20 ml of water of dilution introduced by the wet hide powder into 100 ml of tannin solution, the residual weight was multiplied by 1.2 [30].

$$\text{Non} - \text{tannins, percent by weight} = \frac{w2}{w1} \times \frac{v1}{v2} \times 100, \quad (2)$$

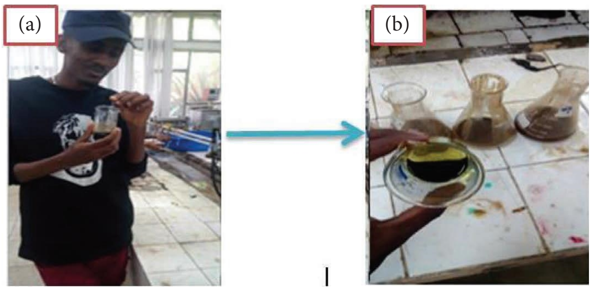


Figure 3: Phytochemical analysis with ferric chloride.

where $W2$ = weight in a gram of the residue left after drying, weight in a gram of the tanning materials taken, $V1$ = volume in ml made up originally, and $V2$ = volume in ml of the test solution taken.

2.2.3. Determination of Tannin Content. The tannins content was determined by finding the difference between the percentages of total soluble solids and the soluble nontannins [30].

2.2.4. Determination of pH. The pH of the solution prepared was determined by adjusting the relative density to 1.05 g/ml at 27°C with cold water, by using a pH meter [30]. Figure 4 shows that the determination of pH.

2.2.5. Test for Tanning Strength of Vegetable Tannins. The hide powder method which is the official method of accurately determining the number of tannins in vegetable tanning materials was used. In this method, the following were determined: total soluble solid, nontannins, tanning strength, tannin purity, and tannins. The pH of the vegetable tannins used was also determined [31, 32].

2.2.6. Hide Powder Preparation. The hide powder was made from ox-hide by soaking, washing in a salt solution, and also in distilled water. The hide was limed, bated, degreased, and dehydrated with acetone, and finally ground into powder by a machine [32, 33].

(1) Chromed Hide Powder Preparation. For each analysis, a multiple of hide powder containing 6.25 g of dry matter, with ten times its weight of distilled water was digested for one hour. One ml of chrome alum solution for each gram of air-dry hide powder taken was added, stirred frequently for several hours, and then allowed to stand overnight. The chromed powder was transferred to clean linen, drained, and squeezed. The cloth containing the powder was placed in a beaker, and the cloth opened out to pour into the powder a quantity of water equal to 15 times the weight of the air-dry hide powder. The powder and water were mixed thoroughly and digested for 15 minutes, after which the cloth and powder were removed and dried to a moisture content of 75% RH. The powder was digested three more times in the same way with distilled water. The cake of chromed powder

Figure 4: The determination of pH.

was thoroughly broken up and mixed until uniformly free from lumps, and its weight was taken. Figure 5 shows that chrome hide preparation Figure 5(a) Hide grinding Figure 5(b) Soaking by chrome alum Figure 5(c) Drying Figure 5(d) Dried, prepared calcium carbonate.

2.2.7. FTIR Analysis Method. Fourier transforms infrared (FTIR) spectroscopy is an important technique used for the chemical analysis of biological substances. Based on this, the extracted tannin, experimentally treated leather, and conventionally treated leather were characterized to determine the extracted tannin relative functional group. FTIR was carried out according to the method [30] (see Figure 6).

2.2.8. Application of Vegetable Tanning Material on Pickled Pelt. Before *Osyris lanceolata* tanning, pelt sheepskin was selected which was free from defects, and then the process was carried out by using the recipe mentioned in Table 1

3. Results and Discussion

3.1. Phytochemical and Vegetable Tannin Extracted Strength Analysis. Several studies have shown that the presence of bioactive compounds in the plant has significant antimicrobial activity, which may improve the quality of leather treated with plant extracts and tannin materials. As shown in Tables 1 and 2, the tannin materials extracted from *Osyris lanceolata* plant extracts showed TDS, nontannin, tannin amount and types of tannin, and the presence of some bioactive compounds. Tannin at the optimum temperature of 65°C, the concentration of 4 g/ml, and a time of 120 minutes for trial number 13 using a ferric test yielded shows condensed tannin with a pH of 4.65. The dark greenish color of the tanning material aqueous solution indicates the type of tannins that were condensed tannins.

3.2. Analysis of Total Soluble Solids. Analysis of total soluble solids for *Osyris lanceolata* bark plants at the optimization temperature = 65°C, concentration = 4 g/ml, and time = 120 minutes. Total soluble solid *Osyris lanceolata* bark plants were optimized at 65°C temperature, 4 g/ml concentration extracted tannin from barks, and 120 min time using the $1747.54 - 3644.48A + 3645.11B + 5.85C$ equation,

(a) (b) (c) (d)

Figure 5: Chrome hide preparation (a) hide grinding (b) soaking by chrome alum (c) drying (d) drying calcium carbonate.

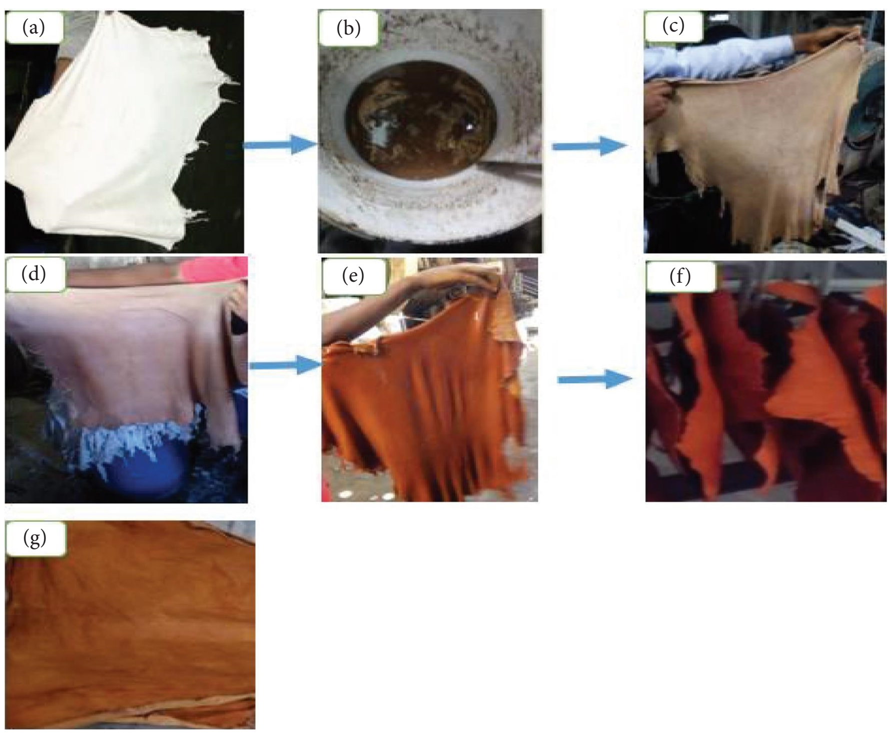


Figure 6: The application of tanning material (a) de pickling (b) tanning (c) apply *Osyris lanceolata* plant (d) mechanical action (e) dyeing (f) overhead drying (g) final leather.

which optimized the optimized design shown in Figure 7. This equation shows that high temperature reduces the TSS, the duration of the extraction of vegetable tannin increases the TSS value, and the concentration of extracted tannin from bark water affects the TSS positively. Figure 7 shows TSS graph analysis for *Osyris lanceolata* bark plants.

3.3. Analysis Nontannins and Tannin. Nontannins *Osyris lanceolata* bark plants were optimized at 65°C temperature, 4 g/ml concentration of extracted tannin from barks, and 120 min time using the $23.75 - 0.0664A + 0.6748B + 2.37C$ equation, which optimized the optimized design shown in Figure 8. The temperature has positive effects on the non-tannin percent, and the duration of the extraction of vegetable tanning material increases the nontannin value. The concentration of extracted tannin from barks also has positive effects, and the optimized equation for analysis from our design experiment is $9.33 - 12.21A + 1.08B + 3.46C$. From this equation, the temperature has a positive effect on the amount of tannin, the time duration for the extraction of vegetable tannin increases the amount of tannin value, and the amount of water affects it positively. Figure 8 shows the nontannin graph for *Osyris lanceolata* bark plants. Figure 9 shows the tannin quantity graphs for *Osyris lanceolata* bark plants.

3.4. Analysis of Purity and Tannin Strength Extracted. The equation used for analysis of purity is the linear equation $0.4013 - 0.0489A + 0.0332B + 0.0964C$. Optimized from the design of the experiment, this equation shows that the temperature has negative effects on the tanning strength of extracted tanning material from the bark of *Osyris lanceolata* plants and that increasing the duration of extraction increases tanning strength, while the concentration of extracted tannin from barks affects positively the tanning strength of extracted tanning material. The equation used to analyze purity was

Table 1: Before *Osyris lanceolata* tanning, pelt sheepskin was selected which was free from defects, and then the process was carried out by using the recipe mentioned in Table 1.

Process	%	Product	Temperature (°C)	Time
De-pickling	0.8 kg	Sheep pickled pelt	30	
	80	Water		
	8%	Sodium chloride		Run 10 minute
Beume (B/O) was checked, it was between 6 and 8				
	2%	RECURCAD PHE (aldehyde type)	30	Run for 1 hr
	1%	Sodium bicarbonate		Run for 20 minute
	0.5%	Sodium bicarbonate		Run for 20 minute
	2%	RecurCAD NT		Run for 30 minute
Check pH = 3–4.5, drain				
Vegetable tanning	100%	Water		
	10%	*Osyris lanceolata* powder solution	45	Run for 1 hr
	5%	Bastamol K		
	20%	*Osyris lanceolata* powder solution		Run for 1 hr
	3%	Basyntan D, (re-tanning agents")		
	100%	Hot water	55	Run 30 minute
	3%	Brown dye		
	3%	Coriamin SA/N (Cationic fat-liquor)		Run for 2 hr
Check pH = 5.7				
	3%	Catalix® LX liq (lightfast synthetic fat-liquor)		
	3%	Polymer RSC		
Fixation	200%	Water		RUN for 1 hr
	0.1%	Oxalic acid		
Drain	150%	Water	50	15 minute
Rinsing	300%	Water	30	20 minute

Table 2: Phytochemical and tannin strength analyses of *Osyris lanceolata* plant.

Test no.	Parameters			Response						
	T (°C)	Conc (g/ml)	Time (minutes)	TDS (%)	Nontannin (%)	Tannin (%)	Purity T/TSS	Types of tannin	Tannin strength T/NT	pH
1	65	15	60	32.675	19.58	13.095	0.401	C	0.668	4.38
2	65	4	60	31.984	19.517	12.466	0.39	C	0.6387	4.3
3	90	15	90	39.714	28.05	11.664	0.294	C	0.4158	4.1
4	90	4	90	34.82	29.472	5.345	0.154	C	0.1815	2.89
5	40	9.5	60	28.89	27.5745	1.314	0.045	C	0.04765	2.7
6	65	9.5	90	29.176	21.827	7.348	0.252	C	0.3366	3
7	65	15	120	31.33	22.246	9.0836	0.289	C	0.4083	3.7
8	40	15	90	25.806	19.968	5.8379	0.226	C	0.2923	2.9
9	90	9.5	120	50.268	32.32	17.94	0.357	C	0.555	4.5
10	65	9.5	90	29.176	21.827	7.348	0.252	C	0.3366	3
11	65	9.5	90	29.176	21.827	7.348	0.252	C	0.3366	3
12	40	9.5	120	31.57	24.615	6.955	0.22	C	0.28255	2.98
13	65	4	120	37.5	19.907	18.42	0.49	C	0.9253	4.65
14	65	9.5	90	29.176	21.827	7.348	0.252	C	0.3366	3
15	90	9.5	60	46.25	26.847	19.403	0.419	C	0.7227	4.57
16	65	9.5	90	29.176	21.827	7.348	0.252	C	0.3366	3
17	40	4	90	24.64	24.18	0.46	0.018	C	0.019	2.4

$0.2682 - 0.0391A + 0.0294B + 0.0500C$. This equation demonstrates that temperature harms the purity of tanning material extracted from the bark of *Osyris lanceolata* plants, increasing extraction duration increases tanning material purity, and water amount has a positive effect. Figure 10 shows analysis of purity and tannin strength extracted.

3.4.1. Analysis of Powdered Hide. The results of moisture, ash, and protein analyses of freshly prepared hide from natural hide and experimental hide are summarised in Table 3. Triplicate results on a single sample are in good agreement, and those for separate samples from the same treatment are in reasonable agreement for natural hide. Powder hides from natural hide retained more (10.2–13.12%) than did those from an

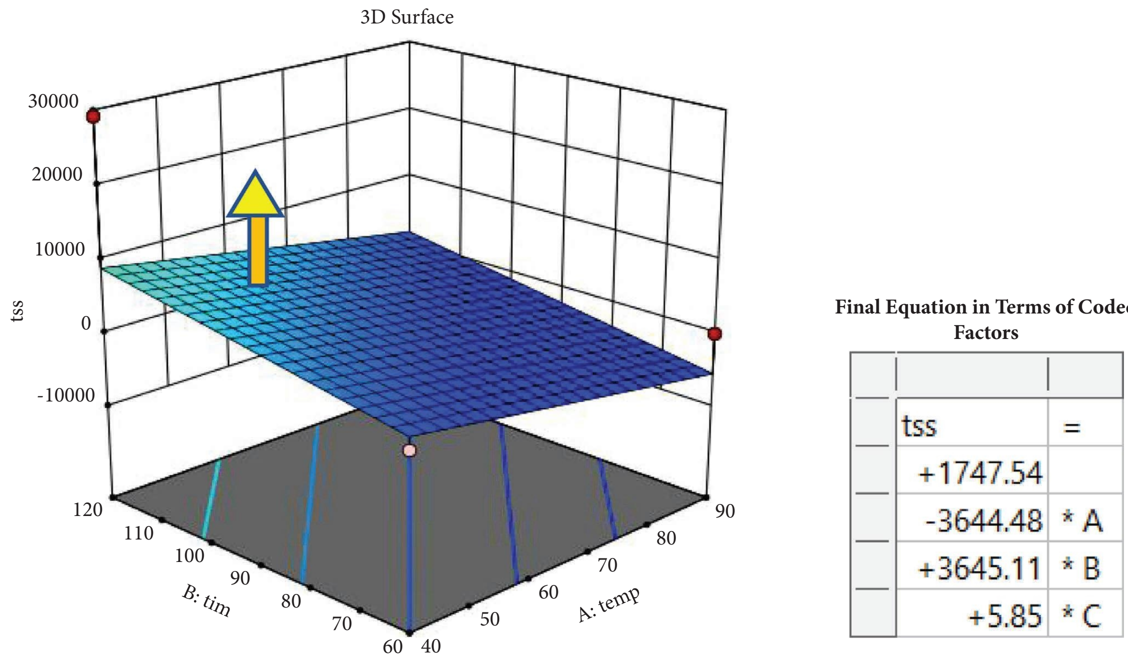


Figure 7: TSS graph analysis for *Osyris lanceolata* bark plants.

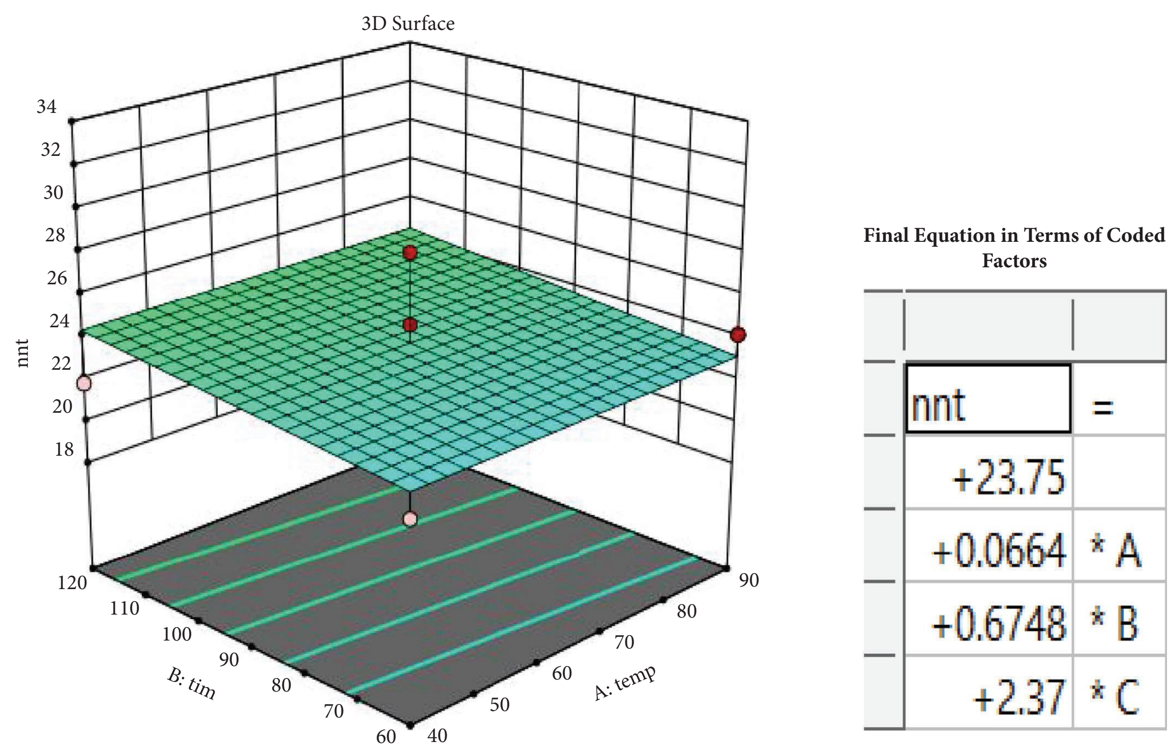
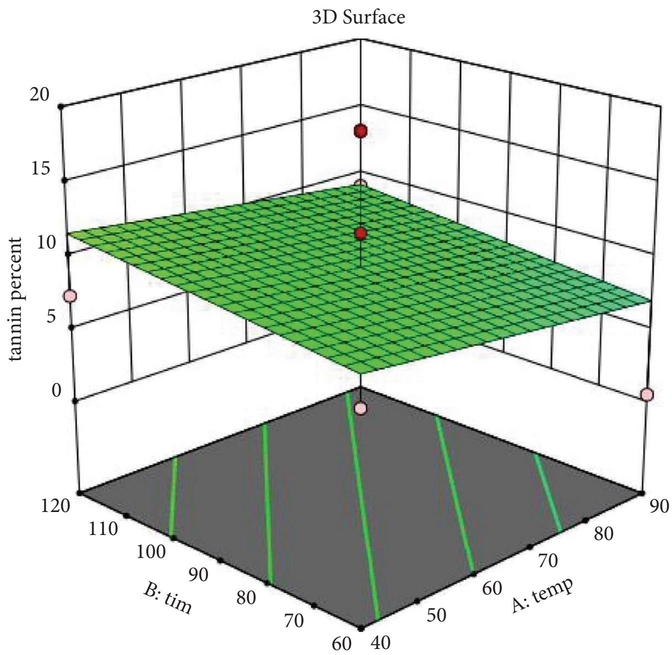


Figure 8: The nontannin graph for *Osyris lanceolata* bark plants.

experimental hide (7.0–7.9%) when they were air dried, most probably because more surface area was exposed during the experiment. Ash content on a moisture-free basis was uniform (0.36–0.4%) for natural hide and (0.29–0.34%) experiment hide. Protein calculated from the total nitrogen determined on dry material was (91.5 to 95.6%) for natural hide and (90.4 to 93.6%) for experimental hide samples.

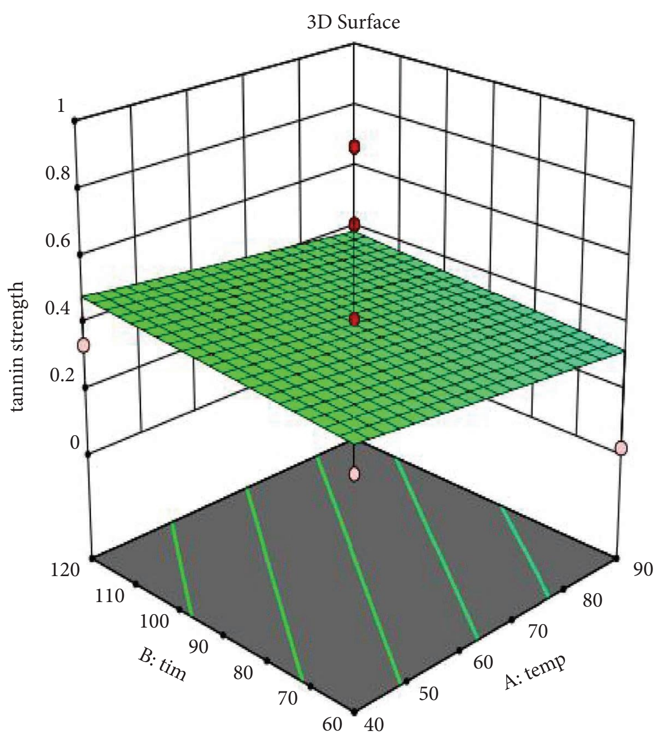
3.5. FTIR Analysis of Osyris lanceolata Plant. This shows the FTIR analysis of *Osyris lanceolata*. The results can be summarised as follows: Regarding the number of peaks, there are more than five peaks, indicating that the analyzed chemical is a complex chemical. The peaks contained a single bond area (2500–4000 cm^{-1}). There are peaks between 3000 and 3200 cm^{-1} that were found, informing us there is an



Final Equation in Terms of Coded Factors

tannin percent	=
+9.33	
-1.21	* A
+1.08	* B
+3.46	* C

Figure 9: The tannin quantity graph for *Osyris lanceolata* bark plants.



Final Equation in Terms of Coded Factors

tannin strength	=
+0.4013	
-0.0489	* A
+0.0332	* B
+0.0964	* C

Figure 10: Analysis of purity and tannin strength extracted.

aromatic structure. The narrow band at less than 3000 cm^{-1} responded to the C-C bond. Regarding the double bond region (1500–2000 cm^{-1}), a huge and sharp peak was detected at about 1700 cm^{-1}. This forms some carbonyl double bonds, which can be from ketones, aldehydes, esters, or carboxyl groups. Peaking at below 3000 cm^{-1}, responding to the single bond of carbon. A peak indicating C-C bonding was detected in the triple bond region (2000–2500 cm^{-1}). Several peaks were detected in the double bond region (1500–2000 cm^{1}): above 1775 cm^{-1}, informing active carbonyl groups, which should be from ring-carbonyl carbons. Range of between 1750 and 1700 cm^{-1}, describing simple carbonyl compounds, which is due to the bonding between methyl (CH_3) and the benzene ring. There was a sharp

Table 3: The analysis of powdered hide.

Sample[a]	Moisture (%)	Ash (%[b])	Protein (%[b])
NH	13.12 ± 0.1	0.36 ± 0.02	91.9 ± 1.61
NH	10.2 ± 0.1	0.40 ± 0.06	95.8 ± 1.89
EPH	7.9 ± 0.2	0.29 ± 0.06	93.6 ± 0.56
EPH	7.0 ± 0.1	034 ± 0.09	90.4 ± 0.10

[a]Two separate samples from each treatment were analyzed in triplicate, NH-natural hide, and EPH-experimental hide. [b]On a dry weight basis.

intensity absorption in the absorption areas of 3670 and 3550 cm^{-1}, which allows the compound to contain an oxygen-related group, such as alcohol or phenol. A narrow band at 3000 cm^{-1}, indicates unsaturated compounds or aromatic rings. A narrow band below 3000 cm^{-1}, showing aliphatic compounds. In the fingerprint region (600–1500 cm^{-1}), a strong signal was found at about 1500 cm^{-1} indicating an aromatic ring. Figure 11 shows that FTIR analysis of extracted tannin from *Osyris lanceolata* plant bark.

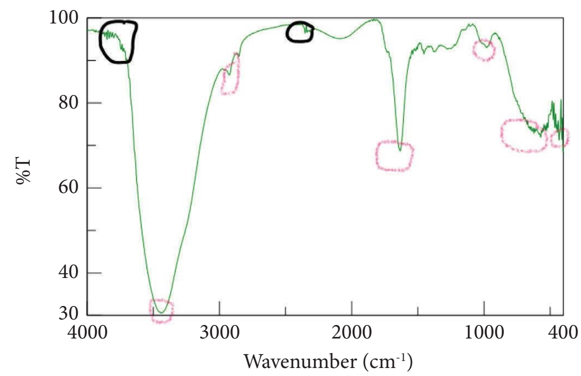


Figure 11: FTIR analysis of extracted tannin form *Osyris lanceolata* plant bark.

3.6. Shrinkage Temperature. Shrinkage temperature is the temperature at which the leather starts to shrink in water or overheating media. This property is used to characterize the thermal stability of the leather. It provides information about the degree of tanning because the better the cross-linking reaction between the collagen and tannins, the higher the shrinkage temperature. Good-quality leather should have a minimum shrinkage temperature of 75°C. During this study, the shrinkage temperature was 84.5°C, which is comparatively good when compared with other inorganic chemicals except chrome tanning.

3.7. Organoleptic Properties Analysis Experimental and Control-Treated Leather

3.7.1. Tensile Strength. Tensile strength is the capacity of a material or structure to withstand loads tending to elongate it. It also determines the maximum tensile stress, or tension, that the leather can sustain without fracture. Leather treated by tannin extracted from *Osyris lanceolata* barks under six experiments shows 343 to 350 N. The following tensile strength graph shows that the maximum tensile and elongation under different experiments (1) maximum force of 303 N and an elongation at a maximum force of 42%, experiment (2) has a maximum force of 359 N and an elongation at a maximum force of 42%, experiment (3) has a maximum force of 333 N and an elongation at maximum force of 57.5%. Experiment (4) has a maximum force of 270 N and an elongation at a maximum force of 31% for the material that can be stretched, experiment (5) has a maximum force of 319 N and an elongation at a maximum force of 39% for the material that can be stretched and experiment (6) has a maximum force of 343 N and an elongation at maximum force of 45.6% for the material that can be stretched. The study shows that using extracted tannin *Osyris lanceolata* bark for tannin skin purposes 12.36 N/mm^2 tensile strength and 42.6% elongation which were above the permissible limit for leather production making. Figure 12 shows that statistical result of tensile strength test leather treated with *Osyris lanceolata* bark plant.

3.7.2. Tear Strength. Tear strength is a measure of how well a material can withstand the effect of tearing. It is specifically measuring material resistance to the growth of any cuts when under tension, measured in N/mm. This method is intended for use with any type of leather. Leather treated by tannin extracted from *Osyris lanceolata* barks under six experiments shows 15 to 20 N. The following tensile strength graph shows maximum tear strength graph shows that trial number one has a maximum force of 15 N and an elongation at a maximum force of 117.6%, trial number two has a maximum force of 24 N and an elongation at a maximum force of 57.5%, and trial number three has a maximum force of 333 N and an elongation at maximum force of 57.5%. Trial number four shows a maximum force of 17 N and an elongation at maximum force of 166.8% for the material that can be stretched, trial number five shows a maximum force of 20 N and an elongation at maximum force of 188.4% for the material that can be stretched, and trial number six shows a maximum force of 20 and an elongation at maximum force of 316.2% for the material that can be stretched. Figure 13 shows the tear strength of leather treated with *Osyris lanceolata* bark plants.

3.7.3. Analysis of Rub Fastness and Abrasion Resistance of Experimental Leather. The test cloth is put on the grating and stag using stainless steel wire. The cloth swatches are rubbed together to see how much color rubs off on the test cloth. The scale was arranged from one up to five, so the experimental leather shows good rub fastness and abrasion-resistant which indicates that treated leather with extracted tannin has good reactivity with dyestuff during the dyeing process. Table 4 shows the analysis of rub fastness and abrasion resistance of experimental leather.

3.7.4. Pollution Load Analysis. Osyris lanceolata extracted bark tannin showed a good result in a reduction in pollution loads such as BOD, COD, and TDS in comparison with the

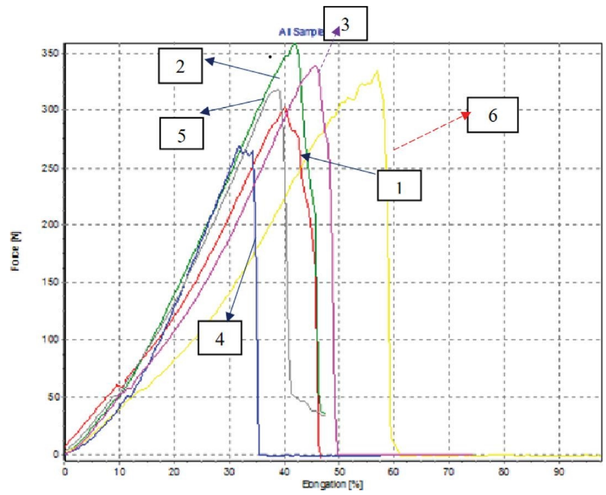


Figure 12: Statistical result of tensile strength test leather treated with *Osyris lanceolata* bark plant.

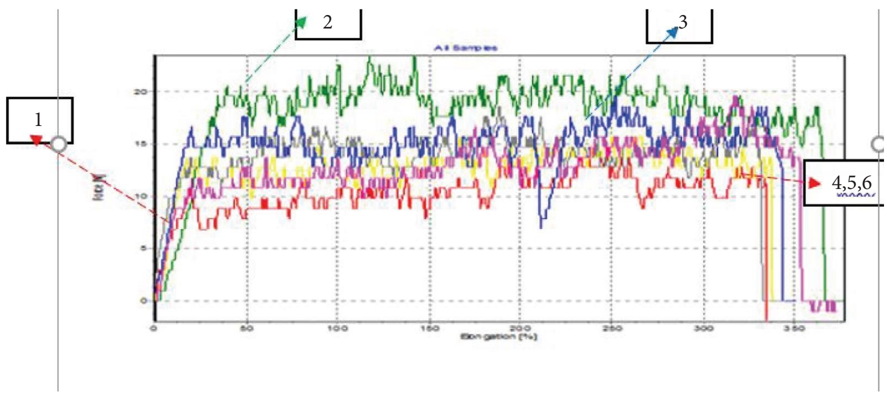


Figure 13: Tear strength of leather treated with *Osyris lanceolata* bark plants.

Table 4: The analysis of rub fastness and abrasion resistance of experimental leather.

Characteristics tested	Test result	Minimum recommended value	Test method
Rub fastness greyscale			
Dry/80 cycle	5	>3	ES ISO 11640
Wet/150 cycle	4	>3	
Abrasion resistance			
Dry/7000 cycle	3	>3	ES ISO 12947
Wet/5000 cycle	3	>3	

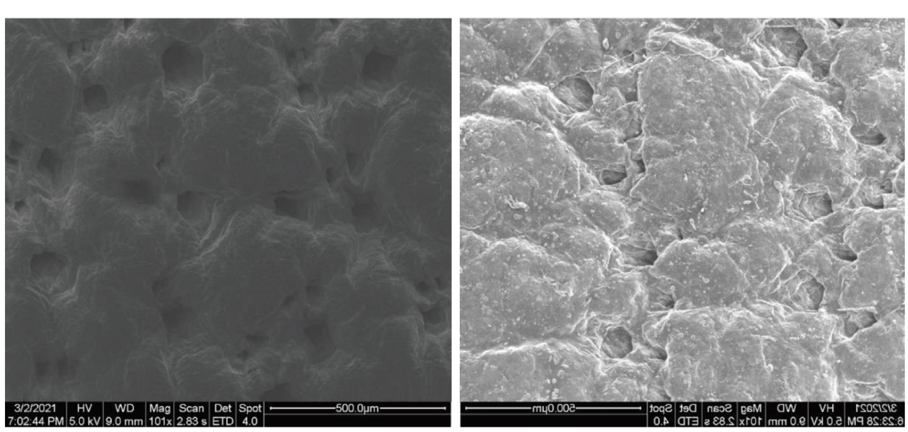


Figure 14: Skin treated with extracted tannin extracted (a) conventional and (b) experimental.

conventionally treated sample which was treated with chrome tanning. Conventionally treated samples showed more amounts of pollution loads in the unhairing process. This study revealed that the experiment-treated sheep skin with *Osyris lanceolata* tanning material reduced 56.7, 69, and 71.8%, and chemical oxygen demand (COD), biological oxygen demand (BOD), total dissolved solids (TDS), and load, respectively.

3.7.5. SEM Analysis. To study the effect of the *Osyris lanceolata* tannin on the structural characteristics of the pelt, scanning electron microphotographs were used to analyze the effect of experimentally treated and conventionally treated with chrome chemicals. SEM analysis was carried out using a FEI-Quanta 200 scanning electron microscope based on the following SEM standards. In the study, the grain surfaces and the cross-section image of conventionally treated and experimental treated sheep skin crust were analyzed using scanning electron microscope. As shown in Figure 14, it is observed that there is no big difference between the conventional and experimental treated samples, but to some extent, the fiber openness was good in chrome-tanned leather rather than in *Osyris lanceolata* barks tannin.

4. Conclusion

Osyris lanceolata bark tannin could be a potential new source of vegetable tanning agent. Under this study during the extractions optimization and characterization tannin from *Osyris lanceolata* plants shows promise for leather tanning and cleaner leather tanning productions. The tanning efficiency of these plants is pH = 4.6 value, which works for vegetable tannin also suitable for tannin extracts from *Osyris lanceolata* plants which introduced a partially pickled tanning process in pretanning and this also suitable for the re-tanning process of leather manufacture. Moreover, the physical-mechanical properties of experimental leather exhibited competitive properties in contrast with the conventional full vegetable-tanned leather. Comparatively, the environmental pollution load by *Osyris lanceolata* tanning has less impact when compared to conventional chrome tanning. Further, there are no vegetable tannin sources in Ethiopia currently, and *Osyris lanceolata* barks are locally available thus exploration of this tannin may lower the import dependency on vegetable tannin. In addition, *the Osyris lanceolata* tree is largely found in Ethiopia and has the great property of being replenished within a few months of being peeled off which addresses the renewability of the material. Therefore, the extracted tannin could get preference as a potential vegetable tanning agent in leather processing as an alternative to commercial vegetable tannin, introducing cleaner leather production and making the tanning industry free from mineral-based independence.

Data Availability

The data collected and analyzed during this study are included in the paper and are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Z.T., T.A., T.G., and E.T. conceptualized the study. Z.T., T.A., B.B., and T.G. contributed to the methodology. Z.T., B.S., and T.B. validated formal analysis. Z.T., T.A., and T.G. investigated the study and wrote the original draft preparation. B.S. and T.B. wrote, reviewed, and edited the manuscript. All authors have read and agreed to the published version of the manuscript.

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