

Review Article

Hide and Skin Preservation in Ethiopia: Traditional Practices, Improved Techniques, Quality Challenges, and Future Prospects

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Abstract

Hides and skins are important livestock by-products and the principal raw materials for Ethiopia's leather and leather-products industries. Their value, however, depends not only on the number of animals slaughtered but also on how promptly and correctly the pelts are removed, preserved, stored and transported before tanning. Fresh hides and skins contain abundant water, nutrients and microorganisms; delays after slaughter can therefore lead to bacterial putrefaction, hair slip, grain damage, unpleasant odour and irreversible losses in leather strength and appearance. In Ethiopia, these risks are intensified by dispersed small-scale and household slaughter, limited access to suitable salt and drying facilities, long distances between rural producers and collection centres, variable technical knowledge, weak incentives for quality, and exposure to heat, dust, insects and rain. This review synthesizes preservation principles and techniques relevant to Ethiopian conditions, including immediate handling, wet salting, dry salting, air-drying, brine curing, chilling and freezing, and selected emerging approaches such as antimicrobial treatments and improved curing systems. It distinguishes preservation—which slows microbial and enzymatic deterioration—from defect prevention, grading and subsequent tannery processing. Evidence from Ethiopian studies indicates that post-slaughter putrefaction is one contributor to downgrading and rejection, although many defects originate before slaughter or during flaying and cannot be corrected by curing. The review proposes a context-sensitive preservation pathway: clean and rapid collection; species-appropriate curing; controlled drying or salting; raised, ventilated storage; pest exclusion; traceable grading; and prompt transport to processors. It also identifies research needs in locally feasible curing protocols, salt quality and reuse, low-cost drying structures, preservation costs, environmental impacts and incentives linked to raw-material quality. The central conclusion is that preservation should be treated as a coordinated value-chain service rather than an isolated task performed after slaughter.

Keywords

Cattle Hide, Sheep Skin, Curing, Salting, Drying, Putrefaction, Ethiopia

1. Introduction

Hides and skins are valuable by-products of livestock production. In general usage, hide refers to the pelt of a larger animal such as cattle, whereas skin commonly refers to

smaller animals such as sheep and goats. Both contain a collagen-rich dermal structure that can be converted through tanning into leather for footwear, garments, upholstery, gloves

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and other products. Their economic value depends on the size and structure of the pelt, the condition of the grain surface, thickness and substance, and the presence or absence of biological and mechanical defects.

Ethiopia has a large and diverse livestock resource and a long-established leather-processing sector. This creates a substantial potential supply of cattle hides and sheep and goat skins. Nevertheless, livestock numbers do not automatically translate into high-quality raw material. Reviews of the Ethiopian value chain identify poor handling, inadequate slaughter infrastructure, weak market coordination, insufficient preservation, low or inconsistent quality incentives, and defects acquired during the animal's life as persistent constraints [7, 9, 13]. Recent Ethiopian evidence confirms that hide and skin quality problems arise at several stages of the production chain. Defects such as scratches, cockle, scars, flaying damage and putrefaction can reduce leather grades and cause rejection. A survey of hides and skins at the wet-blue stage in Ethiopian tanneries found substantial variation in defect prevalence among cattle hides, sheep skins and goat skins, demonstrating that quality improvement must address pre-slaughter, slaughter and post-slaughter factors together [3, 10, 15]. Preservation is especially important because a freshly flayed pelt is perishable. Warm conditions and retained moisture favour microbial multiplication and enzymatic activity. If the pelt remains untreated, bacteria can degrade proteins and damage the grain and collagen structure. The resulting defects may become apparent during soaking, liming, tanning or finishing, when damage can no longer be reversed. Preservation slows deterioration during the interval between slaughter and processing; it does not restore a pelt already damaged by disease, parasites, branding, scratches, poor nutrition or careless flaying.

The Ethiopian context requires approaches that can be applied beyond large abattoirs. A considerable proportion of slaughter takes place in small-scale and household settings, while collectors may aggregate raw material from geographically dispersed locations. This creates practical challenges: obtaining enough suitable salt, applying it uniformly, drying skins safely during humid or rainy periods, preventing contamination, and moving cured material to buyers quickly. An appropriate recommendation must therefore consider not only technical effectiveness but also cost, labour, water availability, climate, storage, market incentives and environmental management [7, 9, 12].

This review aims to describe the biological principles of hide and skin deterioration; examine conventional and emerging preservation techniques; synthesize evidence on Ethiopian quality problems; and propose feasible improvements for producers, slaughter operators, collectors, cooperatives, traders, extension services and tanneries.

2. Review Approach and Scope

This is a narrative review of technical guidance and published literature relevant to hide and skin preservation, with

emphasis on Ethiopia. Sources include Ethiopian studies of defects and value-chain constraints, technical guidance on curing and small-ruminant slaughter, and recent reviews of hide and skin management. The evidence was synthesized thematically around deterioration mechanisms, preservation methods, implementation conditions, quality outcomes and research gaps. This paper is not a systematic review: no exhaustive database search, duplicate screening, formal risk-of-bias assessment or meta-analysis was undertaken. Consequently, findings should be interpreted as a structured synthesis rather than a quantitative estimate of the effectiveness of each method.

A limitation of the available evidence is that many Ethiopian publications focus on overall quality defects, production and marketing rather than controlled comparisons of preservation treatments. Where technical recommendations are drawn from general hide-and-skin manuals, they are identified as general principles that should be adapted to species, climate, logistics and processor requirements in Ethiopia.

3. Biological Basis of Deterioration

3.1. Composition and Perishability

The dermis contains collagen fibres arranged in a three-dimensional network, together with water, non-collagenous proteins, fats, salts and other components. The outer grain layer contributes to the appearance and performance of finished leather. Immediately after flaying, the pelt remains moist and warm, and microorganisms from the animal, slaughter environment, tools, hands, soil and containers can contaminate its surface. Nutrient availability and high-water activity permit bacterial growth unless the pelt is cooled, dried or treated with an effective curing agent.

Preservation seeks to create conditions unfavourable to microbial growth and autolytic activity [14]. Drying lowers available moisture; salting draws water from tissues and reduces water activity; refrigeration slows microbial growth; and freezing substantially slows deterioration while the material remains frozen. These methods do not sterilize the pelt. Contamination can persist, and deterioration can resume if curing is incomplete or the material becomes wet and warm during storage. The effectiveness of preservation therefore depends on maintaining appropriate conditions throughout storage and transport, rather than simply applying a curing treatment once. General leather-processing research also emphasizes the need to consider preservation alongside the environmental performance of subsequent processing stages [11].

3.2. Putrefaction and its Consequences

Putrefaction is microbial decomposition of tissue components. Signs may include abnormal odour, hair or wool loosening, slimy areas, discoloration and weakening of the grain or fibrous structure. Damage can be uneven, with poorly

salted folds, thick regions, head and leg areas, or tightly stacked wet material deteriorating before the rest. Inadequate curing can also result in local bacterial damage that becomes evident only during processing. Preservation is necessary because raw hides and skins are susceptible to bacterial attack after flaying, particularly when moisture and temperature permit microbial multiplication. Conventional salt curing remains widely used, but incomplete application can leave areas vulnerable to deterioration. Research on alternative curing methods has therefore examined reduced-salt and salt-free treatments, natural antimicrobial substances and physical methods such as chilling [12, 17].

Ethiopian evidence confirms the relevance of post-slaughter deterioration. In a study at Sheba Tannery, putrefaction was recorded among post-slaughter defects in hides and skins, alongside grain cracks and insect damage [8]. A study of 6,530 hides and skins also reported putrefaction and found that major defects were associated with reduced physical properties of crust leather and rejection losses [16]. These observations support the need for effective preservation, but they do not imply that all rejection is caused by poor curing.

3.3. Defects That Preservation Cannot Repair

Defects are often classified by when they arise. Pre-slaughter defects include scratches, wounds, ectoparasite damage, cockle, pox lesions, branding, scars and poor substance. Slaughter defects include knife cuts, holes, poor pattern and damage caused by inexperienced flaying. Post-slaughter defects include putrefaction, grain cracks associated with drying or storage, beetle damage and other handling or processing damage. The categories can overlap: poor storage may aggravate a pre-existing wound, while excessive or uneven drying may create new defects. [8] documented frequent scratches and cockle, as well as flaying cuts and post-slaughter damage in material examined at a northern Ethiopian tannery. [16] found that defects were associated with lower tensile strength, tear strength and elongation in crust leather. More recent research around Bahir Dar identified scratches and cockle among common goat-skin defects and holes and cockle among common sheep-skin defects [10]. These findings show why preservation must be integrated with animal health, parasite control, correct flaying and careful transport. Ethiopian studies further demonstrate that defects arising at different stages of the production chain can reduce hide and skin grades and the physical performance of finished leather [8, 10, 16].

4. Hide and Skin Production and Preservation Context in Ethiopia

4.1. Sources and Collection Pathways

Raw hides and skins enter the value chain from municipal

and private abattoirs, slaughter slabs, butcheries and household slaughter. In many rural locations, slaughter is not followed immediately by delivery to a tannery. A collector or local trader may assemble material from several locations before transporting it to a larger market or processing facility. Each additional handling and storage step creates an opportunity for contamination, moisture gain, pest damage or delay.

The chain commonly includes livestock owners, slaughter operators, collectors, primary traders, wholesalers, transporters, tanneries and leather-product manufacturers. Preservation responsibility can become unclear when the person who flays the animal does not receive a price premium for delivering a well-cured pelt, or when buyers do not communicate clear specifications. Reviews of the Ethiopian sector have identified coordination, infrastructure, quality information and incentive problems as important constraints [7, 9]. Local assessments of hide and skin production and marketing can help explain how these constraints vary between production areas and market channels. Such evidence is important when designing collection systems that link small-scale suppliers with traders, curing facilities and tanneries [6].

4.2. Climate and Infrastructure

Ethiopia's climatic diversity means no single preservation method is equally suitable everywhere. Hot lowland environments can accelerate bacterial growth before curing, while humid or rainy periods can prevent safe air-drying. Dust, insects and rodents may damage exposed material. In cooler highland areas, drying may be possible for parts of the year, but rain, nighttime humidity and uneven airflow can still cause incomplete drying. Transport distance and road access further determine how long a pelt remains untreated.

Small-scale operators may lack raised drying racks, clean washable floors, covered work areas, calibrated weighing scales, reliable water, suitable salt, pest-proof stores or written procedures. These constraints make the simplest technically sound practices particularly important: immediate collection, clean handling, removal of excess flesh, rapid application of the chosen curing method, and protection from rain and direct ground contact.

4.3. Economic Importance and Quality Incentives

A pelt with an intact grain and adequate fibre strength can generate greater value than one with cuts, putrefaction or severe surface damage. However, a producer or collector may incur extra labour and material costs to preserve it without receiving a corresponding price premium. This weakens the incentive to invest in salt, drying structures, storage and training. A grading and payment system that rewards measurable quality can align private decisions with the needs of tanneries [1].

Ethiopian reviews describe the leather sector's potential but

also emphasize quality deterioration and weak value-chain coordination [7, 9, 13]. The practical implication is that technical training should be accompanied by transparent grading, feedback from processors, access to preservation inputs and clear responsibility for losses.

5. General Principles of Good Preservation

5.1. Speed and Hygiene

Preservation should begin as soon as possible after flaying. The pelt should not be left in a warm heap, exposed to sunlight for long periods, or placed on soil, dirty concrete, manure or contaminated vehicle surfaces. Clean knives, tables, containers and hands reduce the initial microbial load. Visible contamination should be managed without unnecessary soaking or delay. The flesh side should be handled carefully, and adhering flesh or fat should be removed using appropriate tools without cutting the dermis.

5.2. Correct Preparation and Species Differences

Cattle hides are thicker and heavier than sheep and goat skins, and they may require different salt particle sizes, handling effort and curing time. Fine, clean salt is generally more suitable for thin skins, while coarser salt can be used for thicker hides, provided coverage is uniform. Folded ears, legs, necks, edges and other difficult areas need attention because uneven treatment can leave pockets of moisture and permit localized putrefaction. Procedures should follow the specifications of the receiving tannery and the selected curing method.

5.3. Preventing Re-wetting and Contamination

Once a pelt has been dried or salted, it must be protected from rain, splashing, condensation, dirty water and contact with untreated pelts. Dried skins should be stored in a dry, ventilated and pest-controlled area. Salt-cured pelts should be stacked and drained according to the curing protocol rather than sealed while excessive free liquid remains. Cured and uncured material should be physically separated and clearly labelled.

5.4. Traceability and Inspection

Each batch should be identified by species, source, slaughter date, curing method and date, and destination. A simple record can help identify recurring failures and establish whether deterioration occurred before collection, during curing, or in transport. Visual inspection should pay particular attention to odour, damp pockets, hair or wool slip, insect damage, contamination and uneven curing. A written standard operating procedure is more reliable than relying solely on

memory or informal practice.

6. Major Preservation Techniques

6.1. Wet Salting

Wet salting is a widely used conventional method. Clean salt is applied to the flesh side of the pelt, allowing salt to draw water from the tissue and lower water activity. The pelt is commonly arranged so that salt remains in contact with the flesh side while brine drains away. Uniform distribution is essential, and the quantity of salt should be determined by the relevant technical standard, pelt size and processor specification rather than by visual guesswork alone [14]. FAO guidance for small-ruminant slaughter describes green salting using salt at approximately 25% of the fresh pelt weight, while also describing brine curing as a separate method [5]. This figure is a technical reference, not a substitute for local standards or tannery requirements. Salt should be clean and sufficiently free from impurities that could stain or damage the material. Thin skins require especially careful application to avoid untreated folds and edges.

Advantages include relatively reliable preservation when correctly performed, lower dependence on weather than air-drying, and retention of flexibility that can facilitate handling. Limitations include the cost and availability of salt, added weight during transport, the need to manage saline drainage, and the risk of putrefaction if salt coverage is incomplete or application is delayed. Salt curing also does not eliminate pre-existing defects. Although salt curing is widely used, the environmental consequences of salt consumption and saline wastewater have encouraged research into cleaner preservation approaches. Reducing unnecessary salt use and improving the collection and management of saline drainage can help limit pollution, provided that preservation effectiveness and leather quality are maintained [12, 17].

6.2. Dry Salting

Dry salting combines salt application with moisture loss during subsequent storage or drying. It can reduce deterioration while producing a material that is less wet than a fully wet-salted pelt. Effectiveness depends on adequate salt coverage, airflow, drainage and protection from rain. If the pelt is folded too early, stacked tightly, or exposed to damp conditions, moisture may remain trapped in the interior.

For Ethiopian collectors operating far from tanneries, dry salting may be worth evaluating where salt is available but transport and storage conditions make wet material inconvenient. However, the method should not be assumed to be cheaper in all locations: salt prices, labour, space, curing time and transport payments must be considered together. The economic and environmental performance of alternative leather-processing practices should be evaluated across the entire production chain. This includes the costs of preservation inputs,

material losses, transport and the management of waste generated during subsequent processing [11].

6.3. Air-drying

Air-drying preserves hides and skins by reducing moisture to a level that restricts microbial activity. The pelt is opened out and dried with sufficient airflow, using clean raised racks, poles or frames. It should not be placed directly on soil or a dirty floor. Drying should proceed evenly; rapid, harsh exposure to intense heat can produce a hard surface while deeper tissues remain moist, and excessive heat or poor handling can damage the grain [14].

Air-drying can be attractive where salt is expensive or difficult to obtain. It is, however, highly sensitive to weather, humidity, airflow, thickness and pelt size. Rain, dew or humid night air can re-wet partially dried material. Open-air drying also exposes skins to dust, flies, beetles, rodents and physical damage. A roofed, ventilated solar dryer or raised drying shed may improve reliability, but its performance and cost should be tested locally before wide promotion [1, 5].

In Ethiopia, a practical approach is to use covered, raised, well-ventilated structures with removable racks and protection from animals and pests. Operators should avoid stacking wet skins and should check thick regions and folds for residual moisture. Drying procedures should be adapted for the rainy season and local humidity, rather than applying a fixed number of hours across all environments. Improved drying arrangements should be evaluated according to drying uniformity, protection from re-wetting, labour requirements and the quality of the preserved pelt. Raised racks and covered, ventilated facilities are practical options to test where open-air exposure creates risks of contamination or incomplete drying [5, 14].

6.4. Brine Curing

Brine curing involves immersing hides or skins in a controlled salt solution. The method can provide more uniform contact than hand-salting when concentration, temperature, cleanliness, immersion time and solution management are controlled. FAO technical guidance describes brine curing using a strong salt solution and notes that the method requires suitable conditions and careful control [5].

The principal barriers to decentralized use are the need for tanks, reliable solution concentration measurement, clean water, handling capacity and management of spent brine. Brine can become contaminated by organic matter and microorganisms, and indiscriminate discharge can increase soil and water salinity. Reuse should only occur under a validated hygiene and concentration protocol; uncontrolled reuse can spread contamination or undermine preservation. The environmental management of curing solutions should be considered alongside preservation performance. Leather-sector research identifies wastewater treatment and cleaner production as important components of reducing the environmental impacts of

leather processing [2, 4].

6.5. Chilling and Freezing

Cooling slows microbial multiplication and may be useful where hides and skins can be delivered quickly to a processing facility with a reliable cold chain. Freezing can greatly slow deterioration during storage, but it requires dependable electricity, freezer capacity and careful thawing. These requirements make cold-chain preservation less practical for many dispersed smallholders and collectors than salting or drying.

Chilling is best considered as a short-term bridge between slaughter and centralized curing, rather than a complete solution where transport delays are long or power supply is unreliable. Any cold-chain investment should be assessed against throughput, electricity costs, maintenance, distance to tanneries and the price premium for better preserved material.

6.6. Chemical and Antimicrobial Approaches

Some industrial systems use controlled chemical treatments or antimicrobial agents to improve preservation or reduce microbial activity. Such approaches require evidence of efficacy, compatibility with subsequent tanning, worker safety, regulatory compliance, and assessment of residues and wastewater. A chemical should not be recommended for household or village use merely because it suppresses microbes in a laboratory. Incorrect concentration or mixing can harm workers, damage collagen, complicate tannery processing or create environmental hazards.

For Ethiopia, any proposed antimicrobial treatment should be evaluated jointly by leather research institutions, tanneries and occupational/environmental specialists. Trials should compare it with established salting or drying methods using microbial indicators, grain quality, physical properties, cost per pelt and impacts on downstream processing. Research on alternative preservation approaches indicates that reducing conventional salt use is a potential direction for cleaner leather production. However, any alternative must be assessed for its preservation efficacy, effects on leather quality, compatibility with tanning and environmental consequences before practical adoption [12, 17]. Until such evidence is available, priority should remain with prompt handling, validated salt curing, controlled drying and good storage hygiene.

6.7. Emerging and Alternative Approaches

Potential alternatives include improved solar dryers, better-designed salt application tables, low-cost humidity monitoring, standardized reusable crates, and digital batch tracking. Biological or plant-derived antimicrobial treatments are also subjects for research, but their effectiveness, consistency, effect on leather quality and environmental fate must be demonstrated. Novel treatments should complement—not replace—basic sanitation and rapid preservation.

A useful innovation is often not a new chemical but a better

delivery system: a community curing point with clean water, weighing equipment, covered work surfaces, trained staff, a secure store and scheduled collection. Shared facilities can spread fixed costs across more pelts and make quality control more feasible than expecting every household to purchase equipment independently. Cleaner leather production also involves improving resource efficiency and reducing waste

throughout processing, rather than focusing exclusively on the preservation stage. The suitability of any proposed technology should therefore be assessed in terms of operational feasibility, product quality, environmental performance and total cost [4, 11].

7. Comparison of Preservation Methods

Table 1. Qualitative comparison of common preservation methods. Relative suitability depends on local climate, species, supply-chain duration, available inputs, tannery requirements and operating costs; the table is not a measured ranking of efficacy.

Method	Main principle	Potential advantages	Key limitations	Ethiopian application considerations
Wet salting	Salt reduces available moisture and microbial activity	Reliable when correctly applied; widely understood	Salt cost; heavier loads; saline drainage; uneven coverage risk	Suitable for collection centres with salt supply, training and drainage management
Dry salting	Salt application plus moisture loss	Can reduce wet weight relative to wet curing	Needs airflow and protection; uneven curing possible	Assess against local salt prices, transport costs and tannery specifications
Air-drying	Moisture removal through airflow	Low chemical input; useful where salt is scarce	Weather-dependent; dust, pests, re-wetting and uneven drying	Use raised racks and roofed, ventilated structures; adapt to rainy seasons
Brine curing	Immersion in controlled salt solution	Potentially uniform treatment at suitable scale	Tank and water needs; concentration control; saline effluent	Most feasible at organized collection/processing hubs with effluent management
Chilling/freezing	Low temperature slows deterioration	Useful for short-term holding with cold chain	Capital, electricity and maintenance costs	Consider near high-throughput abattoirs, not as default for remote households
Validated antimicrobial treatment	Specific agent suppresses microbes	May help under controlled industrial conditions	Safety, residues, compatibility and regulatory concerns	Require local trials and approval; do not use improvised chemical mixtures

8. Storage, Transport and Pest Management

8.1. Storage Conditions

Preservation can fail after curing if material is stored under damp, hot or poorly ventilated conditions. Stores should have a roof that prevents rain entry, a dry floor, adequate ventilation and protection from rodents and insects. Pelts should be raised

off the floor and separated from chemicals, fuels, waste, hides awaiting curing and other contamination sources. Stacks should permit air circulation where required by the method and should not compress wet material in a way that traps moisture.

8.2. Transport

Vehicles and containers should be clean, covered and capable of protecting the load from rain, direct contamination and pests. Cured material should not be mixed indiscriminately

with fresh, untreated pelts. Excessive compression, dragging, sharp hooks and rough loading can create holes and surface damage. Transport scheduling matters: a technically adequate cure may still be undermined by prolonged exposure to moisture or heat during transit.

8.3. Insects and Rodents

Hide beetles and other pests can damage cured material during storage. Preventive management includes screening openings, keeping stores clean, inspecting batches, removing waste and avoiding long storage periods without checks. Chemical pest control, if used, should follow product labels and occupational safety requirements and should not contaminate hides or create unsafe exposure. Regular inspection and first-in-first-out stock rotation reduce the time available for pest damage.

9. Quality Assessment, Grading and Economic Implications

A preservation programme should be assessed using more than the appearance of a cured pelt. Useful indicators include the time between flaying and curing, salt quantity per unit of fresh weight, uniformity of treatment, moisture condition, odour, evidence of hair slip, insect damage, rejection rate, grade distribution and the physical properties of leather after processing. Tannery feedback is essential because some defects become visible only after soaking, pickling, tanning or finishing.

Ethiopian studies show that defects can affect both grading and finished-leather performance. [8] reported substantial pre-slaughter and slaughter-related defects and documented post-slaughter problems in material inspected at Sheba Tannery. [16] found a 32.7% overall rejection rate in the studied sample and reported significant reductions in tensile strength, tear strength and elongation associated with major defects. These are study-specific results and should not be treated as a national rejection estimate. Studies assessing defects at different stages of leather processing reinforce the importance of distinguishing the prevalence of defects from their consequences for finished-leather quality. This distinction is essential when estimating the economic benefit of a preservation intervention and avoiding attribution of all losses to post-slaughter handling [8, 15]. A simple enterprise calculation can compare preservation options. Total cost should include salt or other inputs, labour, water, structures, storage, losses, transport and disposal of saline waste. Benefits should include the difference in sale price by grade, reduced rejection, reduced weight or quality loss where relevant, and fewer disputes with buyers. A method with a low input cost may be economically inferior if it leads to a high rate of rejection; conversely, a technically effective method may not be adopted if its cost is not recovered through prices. Buyers and tanneries can support adoption by publishing simple grading criteria, providing feedback

and paying transparently for quality. Where feasible, contracts or collective marketing arrangements can reward correct curing and traceability. Payment rules should be understandable to small-scale suppliers and should distinguish defects that curing can prevent from defects caused before slaughter.

10. Environmental and Occupational Considerations

Preservation methods have environmental consequences. Salting generates salt-contaminated drainage, and brine systems produce saline wastewater that can affect soil structure, vegetation and freshwater quality if discharged without control. Salt should therefore be applied on surfaces designed to collect drainage, and waste brine should be managed according to applicable environmental requirements. Uncontrolled discharge into streams, irrigation channels or agricultural land should be avoided.

Air-drying generally requires fewer chemical inputs but can create odour and nuisance if raw material is left to decompose before drying. Cleaning water and fleshings should be managed to prevent contamination and vectors. Chemical preservatives require documented safety data, proper storage, protective equipment and safe handling; improvised chemical mixtures are inappropriate.

Workers may be exposed to knives, biological contamination, salt dust, heavy wet hides, slippery floors and chemicals. Practical controls include training in safe flaying, cut-resistant handling practices where appropriate, cleanable work surfaces, handwashing, protective footwear and gloves suited to the task, safe lifting methods and first-aid access. Community curing facilities can improve hygiene if they are designed with drainage, ventilation and worker safety from the outset. Broader sustainability assessments also emphasize the need to consider resource consumption, waste generation and environmental impacts across the leather life cycle. Consequently, an alternative preservation technique should be evaluated not only for its immediate effectiveness but also for its effects on later processing stages and the overall environmental burden [4, 11].

11. Challenges of Hide and Skin Preservation in Ethiopia

11.1. Knowledge and Practical Skills

A lack of practical training can lead to delayed curing, uneven salt application, unsuitable drying, folding before adequate drying, and poor storage. Training should be demonstration-based and species-specific. It should cover the sequence from flaying to curing, how to recognize early putrefaction, how to avoid grain cuts, and how to record and inspect batches.

11.2. Input Access and Affordability

Salt supply, quality and price can vary by location. Collectors may also lack scales, clean working surfaces, drying racks, tarpaulins, protective clothing and secure stores. Input packages or shared facilities may help, but support should be based on a local cost analysis and a sustainable operating model rather than one-time distribution. Local assessments of production and marketing constraints can help identify where shared facilities, improved input access and better coordination between suppliers and buyers are most needed. Such interventions should be tailored to local supply volumes and transport arrangements [6].

11.3. Fragmented Supply and Delayed Collection

Small batches from dispersed sources make it difficult to apply consistent protocols and fill transport loads quickly. Collection routes, scheduled pickup, local aggregation points and simple communication systems can shorten delays. Community curing centres may provide a practical interface between household slaughter and formal processors.

11.4. Weak Grading and Incentives

When prices do not reflect preservation quality, suppliers have little reason to invest in better methods. Transparent grade definitions, inspection at purchase, feedback from tanneries and documented reasons for downgrading can strengthen incentives. Grading should be applied consistently and should not penalize suppliers for defects beyond their control without a clear explanation [1].

11.5. Limited Ethiopian Comparative Evidence

The available literature contains useful defect surveys and broad reviews, but relatively little accessible controlled evidence comparing wet salting, dry salting, air-drying and improved low-cost systems across Ethiopia's agroecological zones. Research is also needed on the cost per acceptable pelt, seasonal performance, salt contamination, microbial indicators and the relationship between curing practices and finished-leather performance.

12. A Practical Preservation Framework for Ethiopia

A workable programme should prioritize actions that can be implemented immediately while building capacity for more standardized systems.

At slaughter: use clean tools and a clean working surface; flay carefully; avoid dragging the pelt on the ground; remove excess flesh without cutting the dermis; and record the slaughter date and source.

Immediately after flaying: do not leave pelts in warm piles. Move them to a designated clean curing area and apply the chosen method as soon as possible.

Where salting is used: weigh or estimate pelt weight using a consistent method; apply clean salt uniformly to the flesh side; pay attention to edges and folds; allow drainage; and follow the receiving tannery's validated protocol.

Where air-drying is used: spread pelts on clean raised frames in a covered, ventilated area; protect them from rain, dew, dust, insects and rodents; and verify that thick sections are adequately dry before storage.

At collection centres: separate fresh and cured material; maintain clean floors and drainage; use labelled batches; keep records of curing inputs and dates; and inspect for odour, damp pockets, grain damage and pests.

During storage and transport: keep material dry and protected; avoid direct ground contact and rough handling; use covered vehicles; and deliver to the processor promptly.

At purchase and processing: grade transparently; document reasons for rejection; return information to suppliers; and link premiums or deductions to clear, observable criteria.

At institutional level: provide extension demonstrations, develop locally validated standard operating procedures, support shared curing infrastructure, and monitor both product quality and environmental performance.

This framework should be adapted to species and local conditions. It does not prescribe one universal salt dose or drying duration because these depend on pelt size, method, ambient conditions and processor specifications.

13. Conclusion

Hide and skin preservation is a critical but only one part of improving the performance of Ethiopia's leather value chain. Fresh pelts deteriorate rapidly when warm, moist material is left untreated, and inadequate curing, storage or transport can cause putrefaction and irreversible loss of leather quality. Wet salting, dry salting and protected air-drying are practical methods, while brine curing and cold-chain approaches may be appropriate in more organized facilities. Each method requires correct execution, protection from re-wetting and contamination, and compatibility with the receiving tannery's specifications.

Ethiopian evidence also shows that many important defects arise before slaughter or during flaying. Therefore, preservation alone cannot resolve quality problems. Improvements need to combine animal health and parasite control, careful flaying, immediate curing, suitable storage and transport, transparent grading, technical training and prices that reward quality. The most promising approach is a coordinated system in which producers, slaughter operators, collectors, extension services, research institutions and tanneries share responsibility for raw-material quality.

Priority actions are to establish locally validated standard operating procedures, strengthen practical training, improve

access to salt and protected drying facilities, develop community or cooperative curing points where feasible, control saline waste, and use tannery feedback to measure outcomes. Comparative field research across seasons and agroecological zones is needed to identify the most cost-effective methods for different Ethiopian supply chains.

14. Recommendations

Promote immediate curing after flaying and provide practical, species-specific training for slaughter operators and collectors.

Adopt written preservation procedures that specify salt quality and application, drying arrangements, inspection, storage and transport according to tannery requirements.

Develop shared, covered curing and storage facilities in high-volume collection areas where individual suppliers cannot afford equipment.

Introduce transparent grading and quality-linked payments, supported by documented feedback on defects and rejection.

Prevent uncontrolled discharge of saline drainage and brine, and incorporate environmental and worker-safety measures into curing facilities.

Fund comparative Ethiopian trials on preservation performance, seasonal reliability, cost, grade outcomes and finished-leather properties.

Abbreviations

ADF	Acid Detergent Fibre
CP	Crude Protein
DM	Dry Matter
EE	Ether Extract
FAO	Food and Agriculture Organization of the United Nations
GHG	Greenhouse Gases
IVDMD	In Vitro Dry Matter Digestibility
IVOMD	In Vitro Organic Matter Digestibility
NaCl	Sodium Chloride
NDF	Neutral Detergent Fibre
pH	Potential of Hydrogen
TDS	Total Dissolved Solids

Author Contributions

Ediris Abdulkadir Meko: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Conflicts of Interest

The author declares no conflicts of interest.

References

- [1] Adem, M. (2019) 'Production of hide and skin in Ethiopia; marketing opportunities and constraints: A review paper', *Cogent Food & Agriculture*, 5(1), Article 1565078. <https://doi.org/10.1080/23311932.2019.1565078>
- [2] Alemu, L. G., Kefale, G. Y., Hailu, R., Tilahun, A., Minbale, E. and Eyasu, A. (2024) 'Toward sustainable leather processing: A comprehensive review of cleaner production strategies and environmental impacts', *Advances in Materials Science and Engineering*, 2024, Article 8117915. <https://doi.org/10.1155/2024/8117915>
- [3] Alemu, T. and Girma, M. (2025). Production practices and quality defects of hides and skins in Northern Ethiopia. *African Journal of Rural Development*, 4(4). Available at: <https://afjrdev.org/index.php/jos/article/view/587>
- [4] China, C. R., Maguta, M. M., Nyandoro, S. S., Hilonga, A., Kanth, S. V. and Njau, K. N. (2020) 'Alternative tanning technologies and their suitability in curbing environmental pollution from the leather industry: A comprehensive review', *Chemosphere*, 254, Article 126804. <https://doi.org/10.1016/j.chemosphere.2020.126804>
- [5] Clottey, S. J. A. (1985) Manual for the slaughter of small ruminants in developing countries. FAO Animal Production and Health Paper No. 49. Rome: Food and Agriculture Organization of the United Nations. Available at: <https://www.fao.org/4/X6552E/X6552E00.html> (Accessed: 1 October 2026).
- [6] Debelu, T. (2022) 'Assessment on challenges of hide and skin production and marketing in North Shewa Zone, Oromia, Ethiopia', *Journal of Biology, Agriculture and Healthcare*, 12(20). Available at: <https://www.iiste.org/Journals/index.php/JBAH/article/view/59704>
- [7] Getabalew, M., Mindaye, A. and Zewdie, D. (2021). Hide and Skin Quality Factors and Marketing Systems in Ethiopia: A Review. *Developing Country Studies*, 11(2). <https://doi.org/10.7176/DCS/11-2-01>
- [8] Kahsay, T., Negash, G., Hagos, Y. and Hadush, B. (2015). Pre-slaughter, slaughter and post-slaughter defects of skins and hides at the Sheba Tannery and Leather Industry, Tigray region, northern Ethiopia. *Onderstepoort Journal of Veterinary Research*, 82(1), a931. <https://doi.org/10.4102/ojvr.v82i1.931>
- [9] Kenea, T. (2019). Hide and Skin Value Chain in Ethiopia. *Journal of Marketing and Consumer Research*, 53. <https://doi.org/10.7176/JMCR/53-04>
- [10] Memon, H., Chaklie, E. B. and Birhanu, M. M. (2025). Prevalence and Quality of Common Skin Defects in Tanneries Around Bahir Dar. *Journal of the American Leather Chemists Association*, 120(8). <https://doi.org/10.34314/b5fn5s31>
- [11] Omoloso, O., Mortimer, K., Wise, W. R. and Jraisat, L. (2021) 'Sustainability research in the leather industry: A critical review of progress and opportunities for future research', *Journal of Cleaner Production*, 285, Article 125441. <https://doi.org/10.1016/j.jclepro.2020.125441>

- [12] Samidurai, S., Khambhaty, Y. and Alagamuthu, T. S. (2022) 'Bio-preservation of raw hides/skins: A review on greener substitute to conventional salt curing', *Environmental Science and Pollution Research*, 29(43), pp. 64513–64535. <https://doi.org/10.1007/s11356-022-22027-7>
- [13] Teferi, T. A., Bekele, Z. A. and Gidey, H. T. (2025a). Hide and Skin Production and its Management Practices – A Review Paper. *Annals of Agricultural and Crop Sciences*, 10(2), 1180. Available at: <https://austinpublishinggroup.com/agriculture-crop-sciences/fulltext/aacs-v10-id1180.php>
- [14] Teferi, T. A., Bekele, Z. A. and Gidey, H. T. (2025b). The Techniques of Hides and Skins Preservation: A Technical Manual. *Leather and Leather Products Industry Research Development Center, Manufacturing Industry Development Institute, Ethiopia*. Available at: <https://zenodo.org/records/17276716>
- [15] Teklay, A., Gebeyehu, G., Getachew, T., Yayneset, T. and Sastry, T. P. (2020) 'Ethiopian hides and skin defects and quality status: An assessment at wet blue stage', *Open Access Journal of Waste Management & Xenobiotics*, 2(4), pp. 1–12. <https://doi.org/10.23880/oajwx-16000130>
- [16] Tsigab, T., Bsrat, A., Alemayohu, R., Arefe, M. A., Kumar, N. and Hadush, B. (2020) 'Effects of skin and hide defects on quality grades and physical characteristics of crust leather', *Ethiopian Veterinary Journal*, 24(2), pp. 35–53. <https://doi.org/10.4314/evj.v24i2.3>
- [17] Wu, J., Zhao, L., Liu, X., Chen, W. and Gu, H. (2017) 'Recent progress in cleaner preservation of hides and skins', *Journal of Cleaner Production*, 148, pp. 158–173. <https://doi.org/10.1016/j.jclepro.2017.01.113>