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Review Article

Hide and Skin Production and its Management Practices - A Review Paper

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Abstract

Hides and skins are raw materials that are among Ethiopia's most important livestock by-products, playing a vital role in the leather industry and contributing significantly to the national economy through export earnings. However, though there is huge raw material resource it is not exploited to its full potential due to a variety of defects that occur at different stages of the value chain. A major focus of the review is on the various defects that reduce the quality of hides and skins. These defects are categorized into pre-slaughter, slaughter, and post-slaughter issues. Pre-slaughter defects include diseases and parasites, branding, scratches, and poor nutrition. Slaughter defects primarily involve flaying cuts and other mechanical damages caused by improper tools and techniques. Post-slaughter problems are related to improper preservation methods, such as inadequate salting or drying, which lead to putrefaction, bacterial growth, and other forms of deterioration. Inadequate storage conditions—marked by humidity, poor ventilation, and pest infestations—further deteriorate skin integrity. Additionally, the transportation of both live animals and raw hides and skins under poor conditions—such as overcrowding, exposure to physical stress, and use of unsuitable vehicles—results in bruises, abrasions, and fold marks.

The paper then delves into the management practices necessary to mitigate these defects and improve the overall quality of the raw materials. It emphasizes the importance of good animal husbandry, including disease prevention and proper handling, to reduce pre-slaughter damages. For post-slaughter management, the review discusses various preservation techniques, such as air drying and salting, and the importance of immediate and proper application of these methods. It also touches upon the need for a standardized grading system to incentivize producers to improve their practices. Finally, the review addresses the marketing and value chain of hides and skins, noting the challenges faced by producers, such as being price-takers and a lack of access to market information. It concludes by underscoring the need for collaborative efforts among livestock producers, butchers, traders, and tanneries, as well as the provision of effective extension services and training, to unlock the full potential of the hide and skin sector and ensure a sustainable supply of high-quality raw materials for the leather industry.

Keywords: Hide; Skin; Defect; Quality

Introduction

Hide and skin production is a critical aspect of the livestock and leather industries, providing raw materials for leather goods, textiles, and other by-products [1]. These raw materials are among Ethiopia's most important livestock by-products, playing a vital role in the leather industry and contributing significantly to the national economy through export earnings. However, the quality of hides and skins produced in Ethiopia remains below its full potential due to a variety of defects that occur at different stages of the value chain [2-4]. The quality of these hides and skins is influenced by various factors, like pre slaughter (animal husbandry practices), peri slaughter (slaughtering techniques) and post slaughter (poor post-mortem handling, preservation methods, storage and transportation defects [1].

Pre-slaughter defects are mainly associated with poor animal husbandry practices, such as branding, tick infestations, and injuries caused by thorny vegetation or sharp objects in grazing areas. These issues result in permanent damage to the dermal layer, which negatively impacts leather yield and quality [2].

Peri-slaughter defects arise during the slaughtering process due to inadequate facilities, unskilled slaughter men, and the use of improper flaying tools. These factors lead to flay cuts, holes, and scores on the hides and skins. Such mechanical damages reduce the usable area and compromise the aesthetic and structural integrity of leather products [5].

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Post-slaughter defects primarily result from poor preservation and storage methods. Inadequate curing, contamination, insect infestation, and microbial deterioration are common, especially in rural areas where access to salt and drying infrastructure is limited. These post-harvest issues can cause irreversible damage, including rotting and hair slip, rendering the raw material unsuitable for processing [6].

Proper management practices are essential to minimize defects, improve yield, and enhance economic returns for stakeholders in the leather value chain [7]. Efforts to manage these defects in Ethiopia include awareness creation among stakeholders, improvement of slaughterhouse facilities, training of slaughter personnel, and promoting better preservation techniques. However, a comprehensive and integrated strategy that involves government agencies, private actors, and international partners is needed to ensure sustainable quality improvement across the entire value chain [3,8,9].

This review examines the key stages of hide and skin production, including pre-slaughter care, peri-slaughter operations, preservation, storage and transportation, while highlighting best management practices to ensure high-quality output. Additionally, it explores challenges such as bacterial degradation, mechanical damage, and poor handling, along with potential solutions to mitigate these issues [2,3,9].

The objective of this article therefore is to;

- Review the defect causing elements of the hides and skins along the value chain and indicate the way forwards for improvement.

Factors Contributing to Hides and Skins Quality Deterioration

Pre-Slaughter Defects

Pre-slaughter defects are those created or acquired during the life of the animal due to husbandry practices on the farm or during transport. These include scratches, marks, dry contamination, horn rakes, and other injuries that may lead to carcass downgrading or rejection [10,11]. Poor animal husbandry can cause significant damage to the living animal skin. Poor feed, disease, infestation, adhering dung (dung-cladding), branding, prod marks, cuts, scratches, and abrasions all reduce the potential quality and cutting values and this reduces both demand and outlets for leathers carrying these defects [12].

The Pre-slaughter handling of livestock has a bearing on the quality of hides and skins; thus, it is an area of interest especially to hides merchants, tanners, and other subsequent chain actors such as footwear and leather goods manufacturers. The quality of hides and skins is compromised in the pre-slaughter stage, mainly due to widespread livestock health constraints, traditional husbandry practices, sub-optimal nutrition, and other problems. The losses attributed to pre-slaughter stage defects exceed those associated with peri- and post-slaughter stages combined. A study in Ethiopia showed that pre-slaughter defects might account for up to 65% of all damages and defects [13-15]. Major pre-slaughter defects include: Scratches, Cockle (ekek), Wounds or scars, Lesions from lumpy skin disease or pox, poor nutrition that cause Poor substance (emaciation), Branding marks, old age and Tick bites. These defects negatively affect the quality of hides and skins (HSs) and are among the leading causes of post-slaughter condemnations or downgrades [10,11].

The Fundamental Pre-Slaughter Factors Affecting Hides and Skins Quality can Among Others be

Nutritional Deficiencies

"Inadequate nutrition is a primary cause of poor hide and skin quality globally. Deficiencies result in hides that are thinner, less substantial, less elastic, and more prone to damage during flaying, handling, and processing. This directly translates to downgrades, lower yields for tanners, and significant economic losses for producers and the leather industry [16,17]." Poor nutrition according to Tesfaye, [18] also confirmed that it leads to weak skin structure and increased susceptibility to damage. Different authors like [19-23] also reported that Poor nutrition negatively impacts the quality of hides and skins by affecting their structure, strength, and overall usability as follow respectively (1) Thin and Weak Hides: Inadequate protein intake leads to poor collagen formation, resulting in thinner, less durable hides. (2) Reduced Elasticity and Strength: Deficiencies in essential nutrients like zinc, copper, and vitamins weaken fiber structure, increasing susceptibility to tears and defects (3) Increased Defects (Scars, Lesions): Malnutrition makes animals more prone to diseases and external injuries, leading to higher defects in hides and (4) Poor Grain Quality: Lack of proper nutrition affects the epidermis, leading to uneven grain patterns and lower market value.

Diseases and Parasites

Skin diseases like mange, ringworm, and lumpy skin disease cause lesions, reducing hide quality [24]; The quality of hides and skins is significantly degraded by diseases and parasites, causing defects that reduce their commercial value by about 30–50% or lead to total condemnation [25].

Tick and Insect Damage

Tick bites and fly strikes result in holes and scars, downgrading the hide [26];

Ticks: Ticks are very common external parasites in the tropics, attacking nearly all types of animals. The economic impact from tick infestation and due to the disease, they transmit is enormous. The damages to the leather caused by tick infestation are generally considerable with persistent scars. Ticks cause an estimated loss of US$ 500,000 directly attributed to downgrading of hides and skins and contribute up to 65% of major visible defects of hides and skins in the Eastern part of Ethiopia [27]. The global loss associated to ticks and tick-borne diseases in cattle is estimated at US$ 13.9–18.7 billion [28].

Mange and Cockle

Mange refers to a group of parasitic skin diseases primarily caused by organisms such as Demodex, Psoroptes, and Sarcoptes. Among these, demodicosis is the most prevalent, followed by ringworm, sarcoptic mange, and psoroptic mange. Studies indicate a 14% prevalence of demodicosis in goat skins, with higher rates observed in Uganda (27.6%) and Southern Sudan (34.3%) in the same species [29]. Cockle is an allergic dermatitis caused by lice and ked infestations,

characterized by itching. The lesions become visible only after tanning the hide (Bayou, 1998). In Ethiopia different studies confirmed that Cockle is a Major Cause of Hides and skins Rejection in different ranges for example the study by Tesfaye and Basa, [30] indicated that "Cockle is responsible for over 50% of the rejections or downgrading of hides and skins. Berhanu and Negussie, [31] on the other hand indicated that" Among the skins rejected, 100% had cockle". "Another study conducted by Melesse and Beyene [32] showed that 49.2% of fresh pickled skins were affected with cockle."

Viral Diseases

The major viral diseases affecting hides and skins are Lumpy Skins Disease (LSD) in cattle and Pox infection in small ruminants.

Lumpy Skin Disease

The Lumpy Skin Disease (LSD) causes different effects on the deteriorating of hides and skins quality that results Skin Lesions and Nodules; Secondary Infections and Fly Infestation; Devaluation and Downgrading of Hides and skins and Economic Loss. Lumpy Skin Disease (LSD) is a viral disease in cattle caused by the Capripoxvirus, and it has significant negative impacts on the quality of hides and skins, which are critical raw materials for the leather industry. LSD causes characteristic skin nodules ranging from 2–5 cm in diameter that may become necrotic and ulcerated. These lesions result in permanent scarring and damage to the skin, reducing its commercial value and usability in leather production." The lesions caused by LSD often result in necrotic areas that, when healed, leave deep scars. Such skins become unsuitable for high-quality leather production due to these defects" [33].

Open wounds from nodules are susceptible to secondary bacterial infections and fly infestation. These further deteriorate the skin quality through increased inflammation, suppuration, and uneven healing. "Secondary bacterial infections of LSD lesions lead to more extensive skin damage and poor healing, aggravating the downgrading of hides and skins." [34]. Hides from LSD-affected animals are often downgraded or rejected by tanneries due to (1) Thickening of the skin; (2) Nodular scarring (3) Inconsistencies in the grain layer. "LSD-affected hides are frequently rejected or relegated to low-grade leather production due to unsightly scars, fibrosis, and granulomatous tissue in the dermis." [35] (Figure 1).

The hide industry suffers significant financial losses due to the rejection and downgrading of skins. In endemic regions, LSD outbreaks can cause a measurable drop in the quality of national hide and skin exports. "LSD is one of the major contributors to the deterioration of hide and skin quality in East Africa, severely affecting export earnings." [36]. Lumpy Skin Disease (LSD) has existed in the COMESA region for over half a century. The disease exhibits widely variable morbidity rates, ranging from 3% to 85%, while mortality is typically low (1% to 3%). However, in severe outbreaks, mortality can escalate to between 20% and 85%. A study conducted in Ethiopia by Mebratu et al. [37] reported a prevalence rate between 75% and 90% in affected herds.

Figure 1: Severe case of LSD with skin nodules covering the udder and teats. Source FAO, Severe form of LSD with skin lesions in the head, neck, limbs and entire body. Source FAO, 2017.

Sheep Pox

Sheep pox is a highly contagious viral disease of sheep and goats. Morbidity can reach 70% to 90% in indigenous breeds and up to 100% in newly imported ones [38]. The disease causes huge economic losses to the leather industry. Skin lesions typically involve all layers of the epidermis and dermis, and the healing process is slow, often resulting in permanent scarring, which severely downgrades hide and skin quality.

Bacterial Diseases

Dermatophilosis, also known as Streptothricosis, is an exudative, pustular dermatitis affecting cattle, sheep, goats, and horses. It is more prevalent in young animals and in those subjected to prolonged exposure to moisture. Malnutrition and mechanical trauma are additional predisposing factors. The causative organism, Dermatophilus congolensis, grows in the outer layers of the skin, leading to the formation of thick, adherent scabs. This bacterial infection causes significant hide and skin damage. One of the most notable effects on leather is the formation of a "pinhole appearance" on the surface, which severely compromises leather quality and commercial value. A study conducted in the Ethiopian highlands reported a 15.4% prevalence of dermatophilosis in cattle, highlighting its economic importance in regions where livestock production is a key livelihood [39].

Fungal Disease

Ringworm is a contagious fungal infection affecting the superficial layers of the skin and hair. It is caused by dermatophyte fungi, commonly Trichophyton, Microsporum, and Epidermophyton species. In livestock, particularly cattle and goats, ringworm presents with distinctive circular, hairless lesions often located on the head, neck, ears, and shoulders. These lesions may become thickened, scaly, or crusty over time. The impact of this disease on hides and skins quality can be; (1) Physical Damage: The infection causes hair loss and thickened, crusted skin, which negatively affects the smoothness and uniformity of the hide or skin surface. (2) Permanent Scarring: In severe or untreated cases, healing can result in permanent scars, reducing the commercial grade of hides and skins. (3) Tanning Problems: The lesions may interfere with proper tanning due to uneven absorption of tanning agents in damaged areas and (4) Economic Loss: Affected hides and skins often require downgrading or rejection by tanneries, leading to significant economic loss for producers and processors [40-48].

Scratches

Scratches are a very common type of damage on hides and skins that significantly reduce their quality and market value. These defects are commonly caused by: Thorns, Barbed wire fencing, Horn rakes (from other animals)and Goad punctures (often found on the

buttocks, caused by sharp, pointed tools used for driving livestock) and their Impact on Quality can be reduced Value: Scratches and puncture marks lead to downgrading in quality, affecting leather strength and appearance; processing Issues: Deep scratches may tear during tanning, making the hide unsuitable for high-quality leather products and Aesthetic Defects: Scratches result in blemishes, making the leather less desirable for upholstery, footwear, and fashion goods. These problems on the hides and skins can be minimized by (1) Replacing barbed wire with plain fencing wire.(2) Polling (dehorning) or horn tipping and(3) Proper handling techniques [40-47].

Branding

The branding can have different forms such as Hot-iron, chemical branding and therapeutic branding for disease treatment, as well as decorative scarification (Figure 2).

Hot-iron

Hot-iron branding is a common method for identifying livestock ownership, but it significantly damages the quality of hides and skins. The burn often penetrates deep into the hide, making the affected area unusable for leather production. Branding is typically done on high-value areas such as the rump, back, or thigh, which further reduces the economic value of the hide. To minimize damage, livestock owners should avoid branding prime hide areas and instead use less valuable regions such as the hump, lower legs, cheeks, pate, horns, or hooves [40-47].

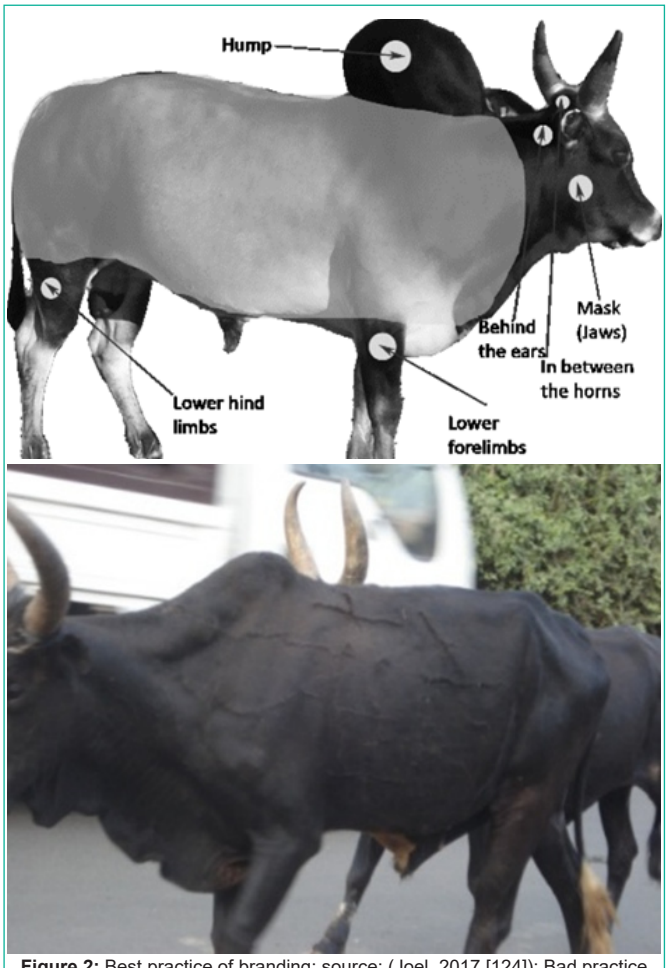

Figure 2: Best practice of branding; source; (Joel, 2017 [124]); Bad practice of branding; source; (Teklay et al, 2019 [125]).

Chemical

Chemical branding is an alternative to traditional hot-iron branding and is considered relatively inexpensive and easy to apply. Chemical branding involves dipping a branding iron into a caustic substance (e.g., liquid nitrogen or strong acids/alkalis) and applying it to the animal's hide. This destroys hair follicles, leaving a permanent mark. Some chemicals can cause excessive tissue damage, leading to slow healing, infection, or prolonged pain if not applied correctly [49]. Excessive chemical exposure can reduce hide quality, making it unsuitable for leather production due to scarring or uneven texture [50].

Another form of branding is used by cattle owners as a traditional method for treating diseases in animals. This practice, often encouraged by influential individuals such as traditional healers or witch doctors, involves applying heated objects or knives to the skin, particularly over infected parts of the body. In certain regions of Africa, knife scratches are deliberately inflicted on the skin to decorate the animal. Upon healing, these incisions sometimes result in blackened hair growth due to increased melanin production in the hair follicles [51,52]. While these practices are culturally significant, they can negatively affect the commercial value of hides and skins by causing permanent scars and pigment alterations that reduce their quality for leather processing [53].

Mechanical Damage

"Mechanical damage from cattle horns is a common source of hide damage, particularly in regions where long-horned cattle breeds are prevalent. Injuries typically occur on the abdomen, forequarters, or hindquarters. If left untreated, these wounds often become infected with bacteria or parasites, leading to tissue necrosis ('sloughing'). This results in scar tissue formation and significant hide deterioration, reducing leather quality [40-47]."

"Thorn" and "Stick-grass" lesions: In certain parts of the world, skins, particularly sheepskins, suffer from a defect referred to as "thorn," a condition which arises when small thorns or sharp burrs and grass seeds work their way into the substance of the skin and remain embedded there. This grass, Cenchrus biflorus, is quite common and has disastrous effects in parts of North Africa. It is also known as "Heskaneet," the Arabic name, or "stick grass [54]."

Improper Handling

Rough handling before or during slaughter, as well as incorrect flaying techniques, can lead to cuts, scratches, and other defects in hides and skins [55]. Improper animal handling in the hours and days preceding slaughter has significant negative effects on hides and skins quality and market value. These defects primarily result from physical injuries, physiological stress responses, and contamination [55].

Physical Injuries (Bruising, Cuts, and Scratches): Impact: Rough handling (beating, poking with sharp objects, overcrowding, slipping on floors, improper restraint) causes bruises, abrasions, cuts, and scratches. These defects damage the grain layer and connective tissue, reducing usable area, downgrading quality, and increasing trimming waste. Blood from injuries also stains hides [56,57].

Physiological Stress Responses: Hide/Skin "Burn" or "Slicking"-Impact: Stress (fear, exhaustion, dehydration, extreme temperatures, etc.) disrupts the hair follicle connection, causing the hair/wool to loosen and slip easily during processing, making the hide unusable [58]. Poor Tanning Response-Impact: Stress-induced biochemical changes in collagen structure led to uneven dye uptake or incomplete tanning penetration [59]. Reduced Hide **Plumpness/Increased Dryness-Impact:** Dehydration and stress cause flaccid, dry hides that are more susceptible to damage during processing [60].

Contamination: Dirty environments (exposure to mud, feces, and urine) during transport, lairage, and animal movement lead to significant hide/skin quality deterioration. The major once being; (1) stains and Discoloration-Deeply embedded dirt, fecal matter, or urine can cause permanent stains, reducing hide value and aesthetic quality [61]. (2) Bacterial Growth and Putrefaction-Contaminated hides harbor bacteria (e.g., Clostridium, Pseudomonas), leading to putrefaction, "hair slip," and collagen degradation if flaying is delayed or storage conditions are warm/humid [62]. (3) Increased Processing Costs-Heavily soiled hides require aggressive chemical scouring, which damages the grain layer and raises production costs [63].

Housing Condition

Livestock housing conditions significantly impact animal health and the quality of hides and skins. Poorly maintained pens can lead to scratches, bruising, and dirt contamination [64]. Well-designed housing and farm layouts enhance hide and skin quality by minimizing stress and disease risks while improving management efficiency [64]. Housing facilities and barn interior materials should be easy to clean and sanitize to maintain hygiene [65].

Regular cleaning of animal housing, feeding troughs, watering systems, and surrounding areas reduces health risks and prevents prolonged exposure to dung, which can cause skin irritation and grain damage [64,65].

All materials used in animal husbandry, such as racks, fences, walls, gateways, and flooring materials, should not have loose nails, projections, or abrasive surfaces. Passages, pens, and stalls should be constructed to allow animals to enter and move freely without physical obstructions, and floor surfaces must provide solid, non-slip footing for the animals. Keeping animals clean is an essential part of hide and skin quality improvement [66,67].

Live Animal Transport

The Key Impacts of Live Animal Transport on Hides and Skins Quality Are

Physical Damage: Bruising, scratches, and wounds caused by rough handling, overcrowding, or improper transport conditions can lead to defects in hides and skins [20,21]. Stress-Induced Degradation: Prolonged transport without rest, food, or water increases stress, leading to dehydration and lower hide quality due to reduced collagen stability [68,69]. Disease and Contamination: Poor hygiene during transport can lead to bacterial contamination, dung stains, and parasitic infections, reducing the market value of hides. Fluctuations: Exposure to extreme heat or cold during transport can cause hide defects such as hair slip and putrefaction [70,71].

The transportation of animals to central slaughterhouses should be considered, because damage to the hides and skins can also occur during this step of the process. The avoidance of overcrowding to reduce animal stress levels, the presence of sawdust on the floor of the vehicles to minimize slipping and the absence of sharp edges (nails and bolts) to prevent scratches and cuts will all contribute to increased quality of the animal hide and skin. Bruising of the animal can cause downgrading of leather. Bruises are lesions or injuries on the animal that occur mainly on the hip and shoulder areas of the hide and, to a lesser extent, on the bends, backs, sides and shanks. They can be attributed to three major causes: crowding, bumping and rushing, which could result in trampling [72].

Peri-Slaughter Defects in Hides and Skins

Peri-slaughter (or slaughter-related) defects in hides and skins primarily occur due to improper handling during the slaughtering process.

These defects include:

Blows or Bad Throwing on the Killing Floor

Rough handling, such as forceful blows or improper casting of animals, can cause bruises which causes dark spots, reducing leather quality; blood stains that lead to discoloration and bacterial growth; grain damage/ tissue damage that affects the smoothness and strength of leather and finally what is encountered is Economic Loss that implies lower-grade hides and skins fetch reduced prices in the market [63,73,74].

Bad Bleeding

The blood staining and discoloration as the result of this incomplete bleeding leaves blood residues in the hides and skins, leading to dark spots and stains that reduces the aesthetic and commercial value of the leather [75,76,77]. Increased bacterial growth-the residual blood provides a nutrient-rich medium for bacteria, accelerating hides and skins decomposition/putrefaction which cause hair slip, foul odor, and weakening of collagen fibers [78,79]; Reduced tanning efficiency-Blood proteins interfere with chemical processes during tanning, leading to uneven dye uptake and poor leather quality [76,77]; Lower Market Value- Blood stained hides and skins are often downgraded or rejected by tanneries, causing economic losses [75]. The Prevention Measures of these quality deteriorations can be: Ensured proper sticking and bleeding time (at least 5-7 minutes for cattle), Use clean slaughter techniques to minimize blood retention, implementing rapid hides and skins removal and curing to prevent bacterial degradation [78].

Flay Cuts or Scores

Incorrect flaying techniques, like Flay cuts or scores caused by poor knife handling during skinning can create holes, scars, or weak spots, leading to downgrading in hides and skins quality and market value [80]; deep cuts can damage the grain layer/cause structural Damage, affecting the tensile strength and aesthetic appeal of the leather [81]; hides and skins with excessive cuts are often rejected or classified as lower grade, impacting profitability [82]; flay scores can lead to uneven tannin absorption, causing defects in the final leather product because of having processing difficulties [63].

Knife Damage/Holes

Poor slaughter techniques, such as excessive stabbing or punctures, degrade hides and skins value [83]; knife damage (cuts, scores, or holes) during flaying or post-slaughter handling decreases the usable area of hides and skins, leading to downgrading in quality. This result in financial losses for producers and tanners due to lowered market value [84,85]; holes and cuts compromise the structural integrity of the hides and skins, making it prone to tearing during processing. Defective areas often require patching or are discarded, reducing the yield of high-quality leather [86]; damaged hides require additional labor and chemicals for repair, increasing production costs. deep cuts may render parts of the hide unusable, leading to waste [87]; holes and knife marks can lead to uneven dye absorption and surface defects in finished leather, affecting its aesthetic and functional properties [63].

Poor Pattern and Vein Marks

Irregular flaying patterns and visible vein marks reduce the usable area of the hide [84,85]; both poor pattern and vein marks degrade the quality of hides and skins, affecting their usability in leather production. Proper animal care, hygienic slaughtering, and effective preservation techniques are essential to minimize these defects [88,89].

Dragging Carcasses on the Ground

The practice of dragging animals on the ground during slaughtering has significant negative impacts on the quality of hides and skins. These are:- the contaminates hides with blood, manure, and stomach contents, increasing bacterial load and dirt adherence [79]; dragging causes abrasions, scratches, and bruises on the hides/skins, reducing their value for leather production [90]; contact with the ground introduces dirt, feces, and other contaminants, making the hides harder to process [91,92]; improper handling can lead to blood retention and inadequate removal of flesh, affecting the tanning process [93]; defects from dragging lower the commercial quality, leading to economic losses for farmers and tanneries [13].

Inefficient Stunning

Inefficient stunning can lead to: - Blood Splashing (Hemorrhages) i.e. Poor stunning causes incomplete bleeding, leading to blood spots that degrade hide quality [94]; Pelt Damage (Bruising & Scratches) problems like animals struggling due to ineffective stunning can cause hide damage from thrashing [95]; reduced hides and skins market value defects like blood stains, cuts, and poor grain structure reduce commercial value of the hides and skins [96]; increased bacterial contamination-Stress-induced glycogen depletion raises pH, making hides and skins prone to bacterial degradation [97].

Skinning

Incision Depth: Deep cuts during skinning reduce usable hides and skins area and downgrade leather quality [98]. **Hygiene Practices:** Poor sanitation leads to bacterial growth, causing hair slip and putrefaction [99]. For optimal hides and skins Quality one should use sharp, clean knives to minimize cuts; avoid dragging hides and skins on the ground to prevent contamination and implement immediate curing (salting or drying) to prevent bacterial damage [100].

Slaughtering Techniques, Tools and Equipment's

Proper Slaughtering and Flaying Techniques

Definition of Slaughtering: Slaughtering is the Process of severing the trachea, the main arteries and veins leading to the brain. The knife used must be long, pointed and very sharp. A special knife 18 to 20 inches (45.72-50.80cm) long is the best and the cut should be long, deep and rapid and not a succession of short, shallow strokes. It must be as near the head as possible and must be cut straight down otherwise the shape of the hide will be impaired. Proper bleeding should be done as any blood which is left in the veins and arteries will act as a medium for the growth of the bacteria which cause putrefaction. In order to bleed the carcass properly, it must be hoisted by the hind legs to allow the blood to flow by the force of gravity [101,102].

Tools and Equipment's Used in Slaughtering

Captive Bolt Stunner/ Stunning Gun: The captive bolt stunner (also known as a stunning gun) is a device used in animal slaughter to render animals' unconscious before slaughter, ensuring humane treatment by minimizing pain and distress. It works by firing a retractable bolt into the animal's brain, causing immediate unconsciousness without killing the animal outright (which is typically done afterward by exsanguination) [103]. It is considered a humane method for inducing paralysis before slaughter, as it minimizes animal suffering. It is commonly used in abattoirs and slaughterhouses, particularly in urban areas with better infrastructure. Hides and skins from animals slaughtered using these methods tend to be of higher quality due to reduced self-inflicted injuries (e.g. bruising or struggling). Such hides are more likely to meet the standards of secondary and tertiary markets for leather and other by-products [101,102]. A Captive Bolt Stunner Works: as (1) Penetrative Bolt: Delivers a forceful blow to the skull, disrupting brain function; (2) Non-Penetrative (Concussion) Bolt: Uses blunt force to stun without penetrating the skull; and/or (3) Pneumatic or Cartridge-Driven: Powered by compressed air or a blank cartridge [50].

Axe and Hummer: Using an axe or hammer to slaughter animals—is indeed considered inhumane and outdated, but it is still practiced in some remote areas due to lack of proper tools or knowledge. This method often leads to severe animal suffering, ineffective stunning, and poor-quality hides due to cuts, scratches and wounds inflicted during the struggle [101,102,104].

Rope Straining: The practice of using rope straining during slaughtering, particularly in the interior areas of Arid and Semi-Arid Lands (ASALs), is known to cause defects in hides and skins, primarily in the form of rope marks. This method is still employed in some regions due to traditional slaughtering practices and limited access to modern techniques [105,106].

Knife Stabbing: "The traditional method of knife stabbing during slaughter, often practiced in rural or village settings, has significant negative effects on both animal welfare and the quality of hides and skins. This method is considered inhumane and inefficient, as it often leads to self-inflicted injuries by the struggling animal, resulting in cuts, bruises, and wounds on the hides and skins. These defects

reduce the commercial value of the hides and skins, making them less suitable for leather production (FAO, 2023)."

The Negative Effects of Traditional Knife Stabbing during Slaughter are;

Animal Welfare Concerns: The method often causes prolonged suffering due to ineffective stunning or exsanguination, leading to severe stress and pain for the animal [107].

1. Animals subjected to improper slaughter techniques exhibit extreme struggling, which can result in self-inflicted injuries such as fractures, bruises, and muscle hemorrhages [70,71].

Hide and Skin Damage:

1. Struggling animals frequently sustain cuts, scratches, and deep wounds, which significantly degrade the quality of hides and skins [91,92];

2. Defects such as blood stains, bruises, and knife cuts reduce the commercial value of hides, making them unsuitable for high-quality leather production [108];

3. Poor slaughters techniques contribute to pre-slaughter hide damage, which is a major economic loss in the leather industry [13-15].

To enhance both animal welfare and hides and skins quality, the adoption of pre-slaughter stunning (electrical or mechanical) and proper exsanguination techniques is recommended [107]. Training for slaughterhouse workers on humane handling and slaughter methods can also minimize hide defects [70,71].

Physical strangulation of sheep and goats, a traditional slaughter method practiced in some rural areas; negatively affects hide and skin quality. This method leads to poor bleeding, resulting in blood contamination and veiny hides. Additionally, improper handling often causes soil contamination, further degrading the material. Consequently, hides and skins from such regions are classified as low-grade [40-47].

Electrical Shock: The use of electrical shocks in driving animals through the lairage towards the stunning box has been studied in terms of its effects on hide and skin quality. Compared to physical beating with crude weapons, electrical prods cause less visible damage to the hide, as they do not leave bruises, cuts, or abrasions. However, improper or excessive use of electrical shocks can still lead to stress-related hide defects, such as blood splash or pelt damage, particularly if the animal experiences prolonged distress before slaughter [70,71].

Slaughtering and Flaying

Ripping cuts (incisions): It is worth noting that the shape of the hide is determined by initial ripping (incision) cuts.

To obtain the best optimum shape of the hide, the following basic incisions should be made on large animals- One long, straight incision down the mid-line, from the chin to the anus (cuts reaching only to the udder or scrotum are not recommended as the shape of the hide is affected as two unnecessary flaps are left, which have to be trimmed off, thus affecting the shape and size of the hide). Two circular incisions on the four legs round the knee, Two similar incisions round the hocks, Two straight cuts on the inside of the fore-legs from the knee to the fore-end of the breast bone, Two straight cuts on the hind legs from the back of each hock to a joint midway between the anus and the scrotum or udder. After the basic incisions have been made, the proper flaying commences [40-47] (Figure 3).

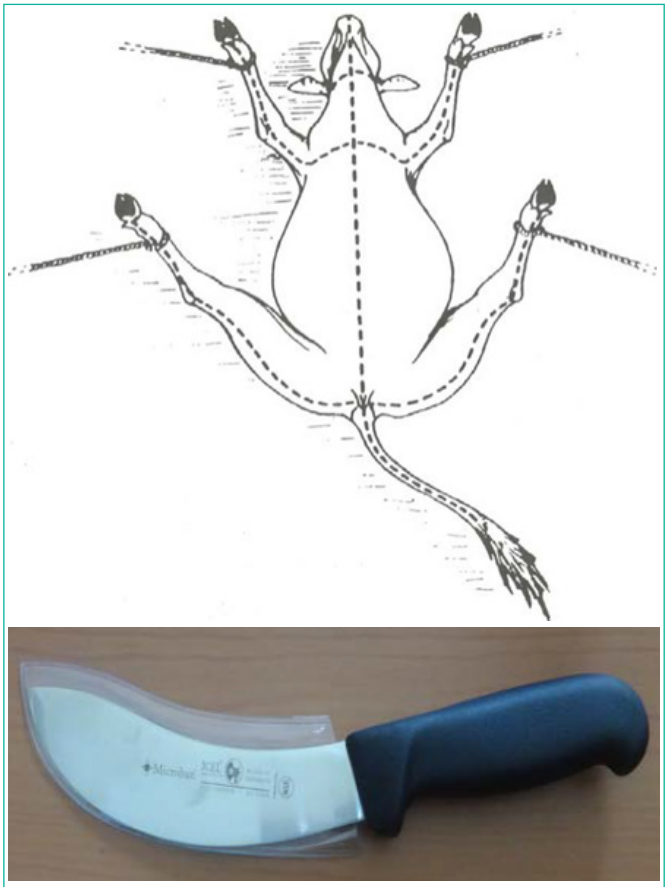

Figure 3: Ripping line; (Joel, 2017 [124]); Ripping knife; source (COMESA, 2014).

Flaying: The flayer should pull the hide away from the carcass with one hand while cutting the subcutaneous tissue with the other, keeping the knife as parallel as possible to the hide to avoid deep cuts. Using rounded-edge knives is recommended to minimize damage to the hide, as excessive cuts and scores can reduce the quality and market value of the skin [40-47].

Post-Slaughter Defects

Cooling of Hides and Skins: "After flaying, hides and skins must be washed with cold water to remove blood and debris. They should then be immediately transported in clean, non-metallic containers to the curing sheds for preservation or directly to the tannery—if located within a 3–4 km radius—for immediate processing, to prevent deterioration due to bacterial activity" [109].

The most prevalent post-slaughter defects arise from preservation and drying methods, including ground drying, shade drying, frame drying, dry salting, wet salting, re-use of salt, and the addition of salt additives. Poor handling can lead to issues such as bruising, sun-induced parasitic infestation, and inadequate long-term preservation methods like cooling and deep freezing. Additionally, storage and transportation defects contribute to post-slaughter

Table 1: Common Preservation Methods of Hides and Skins.

Preservation Methods	Advantages	Disadvantages	Citation
Air Drying (Sun or Shade Drying)	✓ Low cost; ✓ No chemicals required; ✓ Environmentally friendly.	✓ Slow process; ✓ Risk of insect damage; ✓ Ineffective in humid areas.	FAO, 2011; UNIDO, 2012
Wet Salting	✓ Quick and effective; ✓ Reduces bacterial growth; ✓ Suitable for transport over long distances.	✓ Requires large amounts of salt; ✓ Risk of salt contamination in environment.	FAO, 2011; Ahmed et al., 2017
Dry Salting	✓ Effective in dry climates; ✓ Better for long-term storage than wet salting.	✓ Slower than wet salting; ✓ Labor intensive; ✓ Uneven salt penetration	UNIDO, 2012; MoA, 2020
Brining (Soaking in Salt Solution)	✓ Faster than dry salting; ✓ Easy to standardize; ✓ Good preservation quality.	✓ High water use; ✓ Requires tank facilities; ✓ Not suitable in rural areas.	Ahmed et al., 2017
Chemical Preservation (e.g., Boric Acid, Sodium Sulfite)	✓ Reduces salt use; ✓ Effective for short-term preservation.	✓ High cost; ✓ Requires technical skill; ✓ Regulatory limitations.	FAO, 2011; UNIDO, 2012
Refrigeration/Freezing	✓ Preserves raw state; ✓ No chemical alteration; ✓ Effective microbial control.	✓ Very costly; ✓ Requires electricity; ✓ Not feasible in rural Ethiopia	MoA, 2020; Ahmed et al., 2017

quality deterioration, including grain cracks, hide beetle damage, putrefaction, and machine-induced defects [91,92,110].

Hides and skins ready for market need to be preserved either by air-drying or wet salting. Selling Hides and Skins to market after backyard slaughter in fresh, ground drying, rope drying, dry salting, wet salting, and smoking is common [111,112]. For example, in Ethiopia, 80% of cattle and 90% of shoats slaughtering is carried out traditionally in the backyard of residential and farming units [113,114].

Preservation/Curing

Curing is the process of preserving hides and skins for longer periods in order to maintain their quality and prepare them for the tanning process. "If tanning facilities are available nearby, green hides and skins can be processed directly without undergoing curing, provided that this is done within six hours of flaying; However, if tanning cannot take place within that critical timeframe, immediate curing becomes essential. This is necessary to preserve the quality of the green hides and skins and to prepare them adequately for subsequent tanning operations" [102] (Table 1).

Storage of Hides and Skins

Storage of hides and skins involves keeping them in a store awaiting dispatch (transportation) or processing. The storage method depends on the type of curing method used, i.e., wet salted or suspension dried. In all cases, wooden platforms made of timber raised to a height of about 6" (15 cm) from the floor are used in the store. The size of the platform for skins is 3 feet by 3 feet (1 meter by 1 meter) and for hides 6 feet by 3 feet (2 meters by 1 meter). Wet salted materials are stored on different platforms from the air-dried ones. Similarly, hides are stored on separate platforms from skins [105].

Storage Requirements for Hides and Skins

Temperature Control: Fresh hides should be stored at low temperatures (0–4°C) to slow bacterial growth [115]. Freezing (-18°C or lower) is recommended for long-term storage [116].

Relative Humidity (RH): Optimal RH should be maintained at 65–70% to prevent excessive drying or moisture buildup [115].

Preservation Methods: Salting: Common salt (NaCl) is applied at 40–50% of hide weight to inhibit bacterial activity [62].

Drying: Sun-drying should be done uniformly to avoid case-hardening [115].

Packaging & Ventilation: Hides and skins should be stored in breathable materials (e.g., wooden pallets) to avoid heat buildup [117]. Stacking should allow air circulation to prevent mold growth [62].

Contamination Issues: Keep hides and skins away from direct sunlight, pests, and chemicals [115].

Folding of Hides and Skins

In wet-salted hides and skins, the pieces are folded flesh side out or hair side inside to prevent damage to the hair side (the grain). This method also helps maintain moisture, as tanneries require the hides and skins to remain wet. For air-dried hides and skins, the pieces are folded lengthwise along the backbone, with the hair side inside (flesh side outside). This protects the grain side, which is the most critical part of the hide/skin in leather manufacturing. Dried hides and skins must be protected from insect damage, particularly from hide beetles and vermin (destructive animals and pests). Insect damage can be prevented by dusting the hair side with insecticide formulations (e.g., green man powder), while vermin-proof storage facilities can keep pests away. Additionally, care must be taken to avoid re-wetting dried hides and skins with water or other liquids. Hides and skins produced and cured in rural or home settings should be stored away from smoke, as it can cause staining and interfere with the tanning process [40-47].

Transportation of Hides and Skins

Transportation requirements for hides and skins are critical to maintaining their quality and preventing deterioration during transit. The key requirements can be;

Pre-Transport Preparation:

Curing/Salting: Fresh hides and skins must be properly cured (salted or dried) to prevent bacterial growth and decay [76,77].

Inspection: Only defect-free, well-preserved hides should be transported to avoid spoilage [118].

Packaging Requirements:

Baled or Rolled: Hides are typically folded flesh-to-flesh and hair-to-hair, then baled or rolled for shipment [113].

Ventilated Containers: If shipped in containers, proper ventilation is needed to prevent moisture buildup [119].

Storage and Handling:

Avoiding Moisture & Heat: Hides and skins must be kept dry and away from direct sunlight to prevent putrefaction [120].

Stacking: Bales should not be stacked too high to avoid compression damage [121].

Transportation Conditions:

Temperature Control: If transported over long distances, refrigeration (5–10°C) may be required [122].

Avoiding Delays: Prolonged transit times increase the risk of deterioration [76,77].

Regulatory Compliance:

Phytosanitary Certificates: Some countries require documentation to ensure hides are free from contaminants [123-128].

Customs Clearance: Proper labeling (e.g., "Salted Bovine Hides") is needed for smooth customs processing [121].

Conclusion and Recommendations

In conclusion it is observed that the quality deterioration of hides and skin in Ethiopia is a contribution of different factors like in the pre (breeding, feeding, physical care, pest and disease control, management of grazing areas and lastly practice in transporting the animals to the market), peri (improper stunning, slaughtering/ sticking/bleeding, flaying and handling) and post slaughter (improper curing, storage and transportation) categories.

Therefore to have improved hide and skin quality it is recommended to; have proper animal husbandry practices, Proper Veterinary Care – Regular deworming and vaccination to prevent diseases; Adequate Nutrition – Balanced feed to improve skin strength; Good Handling Practices – Gentle transportation and improved slaughtering practices; Effective Preservation – Immediate salting or chilling post-slaughter, proper storage and transportation conditions, designing Sustainable Waste Management practices, conducting Research & Development, assisting the sector through Policy interventions & Stakeholder Engagement are among the crucial elements that one needs to consider.

Declarations

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Author's Contribution

All authors contributed equally to this work from its inception up to final preparation of review article.

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The authors declare that they have no conflict of interest with respect to the authorship or publications of this manuscript.

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