

**Thesis Ref.No.**

**CHARACTERIZATION OF SHEEP AND GOAT SKIN LESIONS CAUSED BY  
DIFFERENT AGENTS AND IMPACT ON THE RESPECTIVE LEATHERS AT  
TANNERIES**

**MSc Thesis**



**BY**

**NIGUSSU FASIL KEDESEGNE**

**Addis Ababa University College of Veterinary Medicine and Agriculture,  
Department of Parasitology and Pathology**

**June, 2014**

**DEBRE ZEIT,**

**ETHIOPIA**

**CHARACTERIZATION OF SHEEP AND GOAT SKIN LESIONS CAUSED BY  
DIFFERENT AGENTS AND IMPACT ON THE RESPECTIVE LEATHERS AT  
TANNERIES**



**A thesis submitted to College of Veterinary Medicine and Agriculture, Addis Ababa  
University in partial fulfillment of the requirement for the Degree of Master of  
Science in Tropical Veterinary pathology**

**BY**

**NIGUSSU FASIL KEDESEGNE**

**June, 2014**

**DEBRE ZEIT, ETHIOPIA**

**Addis Ababa University**  
**College of Veterinary Medicine and Agriculture**  
**Department of Pathology and Parasitology**

As members of the examining Board of the final MSc open defense, we certify that we have read and evaluated the Thesis prepared by **Nigussu Fasil**. **Entitled: Gross and Microscopic Characterization of sheep and goat skin lesions caused by different agents and impact on the respective leathers at tanneries.** And recommend that it be accepted as fulfilling the thesis requirement for the degree of Masters of Science in **Tropical Veterinary Pathology**.

**Dr. Hagos Ashenafi**

Chairman

Signature

Date

**Dr. Birhanu Mekibeb**

External Examiner

Signature

Date

**Dr. Bulto Giro**

Internal Examiner

Signature

Date

**1. Dr. Tilaye Demissie**

Major Advisor

Signature

Date

**2. Dr. Getachew Terefe**

Co-Advisor

Signature

Date

**3. \_\_\_\_\_**

Co-Advisor

Signature

Date

**Dr. Hagos Ashenafi**

Department chairperson

Signature

Date

<b>TABLE OF CONTENTS</b>	<b>PAGE</b>
<b>STATEMENT OF AUTHOR .....</b>	<b>i</b>
<b>ACKNOWLEDGMENTS .....</b>	<b>ii</b>
<b>LIST OF FIGURES .....</b>	<b>iii</b>
<b>LIST OF APPENDICES .....</b>	<b>viii</b>
<b>LIST OF ABBREVIATIONS .....</b>	<b>vi</b>
<b>ABSTRACT.....</b>	<b>vii</b>
<b>1. INTRODUCTION.....</b>	<b>iv</b>
<b>2. LITERATURE REVIEW .....</b>	<b>5</b>
2.1. Skin anatomy and histology .....	5
2.2. Skin and hides as commodities .....	7
2.3. Contribution of skin and hides to the Ethiopian economy .....	8
2.4. Diagnosis of Parasitic skin diseases .....	9
2.4.1 <i>History</i> .....	10
2.4.2. <i>Clinical examination</i> .....	10
2.4.3. <i>Skin scraping examinations</i> .....	11
2.4.4. <i>Collection of free living ectoparasites</i> .....	12
2.4.5. <i>Histopathology</i> .....	12
2.5. Status of ectoparasites of small ruminants in Ethiopia .....	13
2.5.1. <i>Ectoparasites damage</i> .....	13
2.5.2. <i>Mange mites</i> .....	14
2.5.3. <i>Pediculosis</i> .....	15
2.5.4. <i>Sheep keds (Melophagus ovinus)</i> .....	15
2.5.5. <i>Ticks</i> .....	16

## TABLE OF CONTENTS(CONTINUED)

2.6. <i>Sheep and goat pox</i> .....	17
2.6.1. <i>Causes and factors affecting skin defects in sheep and goats in Ethiopia</i> .....	18
2.6.2. <i>Microbial causes</i> .....	21
2.6.3. <i>Description of major skin lesions and defects</i> .....	22
2.6.4. <i>Defects caused during life</i> .....	22
2.6.5. <i>Damages caused after death</i> .....	23
<b>3. METHODOLOGY</b> .....	<b>25</b>
3.1. Study area.....	25
3.2. Study design .....	27
3.2.1. <i>Sample size determination</i> .....	27
3.2.2. <i>Study population and sampling technique</i> .....	27
3.2.3. <i>Histopathological technique</i> .....	28
3.3. Data Analysis and management .....	28
<b>4. RESULTS</b> .....	<b>29</b>
4.1. Gross pathological lesion characterization.....	29
4.1.1. <i>Gross lesions due to lice infestation</i> .....	29
4.1.2. <i>Gross lesion due sheep ked infestation</i> .....	30
4.1.3. <i>Gross lesion due to tick and fleas infestation</i> .....	30
4.1.4. <i>Gross lesion due to pox infection</i> .....	32
4.2. Microscopic lesions.....	36
4.2.1. <i>Microscopic lesion due to lice infestation</i> .....	36
4.2.2. <i>Microscopic lesion due to sheep ked infestation</i> .....	37
4.2.3. <i>Microscopic lesion due to tick and flea infestation</i> .....	38
4.2.4. <i>Microscopic lesion due to pox infection</i> .....	40

TABLE OF CONTENTS(CONTINUED)

4.3. Quality grading and skin defect analysis.....	43
<b>5. DISCUSSION .....</b>	<b>45</b>
<b>6. CONCLUSION AND RECOMMENDATIONS.....</b>	<b>48</b>
<b>7. REFERENCES.....</b>	<b>49</b>
<b>8. ANNEXES .....</b>	<b>60</b>

## STATEMENT OF AUTHOR

First, I declare that this thesis is my *bonafide* work and that all sources of material used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for an advanced (MSc) degree at Addis Ababa University, College of Veterinary Medicine and Agriculture and is deposited at the University/College library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

Name: Nigussu Fail                      Signature: \_\_\_\_\_

College of Veterinary Medicine and Agriculture, Debrezeit

Date of Submission: 9/6/2014

## **ACKNOWLEDGMENTS**

Before all, I praise the living God through Jesus Chris for his protection, divine miracles and wonderful guidance throughout this study period!

I am greatly indebted to my Advisors, Dr.Getachew Terefe and Dr.Tilaye Demissie for their technical guidance, insight understanding of my condition and time devotion to correct this paper. My appreciation also goes to the of the Vice president for Reasesch and Technology Transfer of the Addis Ababa University for funding the project under the “Hide and skin quality improvement” thematic research project.

I would like to acknowledge Dr. Asegdech Sirak, Dr.Getenet Abie and Dr.Selemon Gebre of Sebeta National Animal Disease Investigation Center for their valuable technical support and encouragement

My deep appreciation goes to Ato Behailu Wolde owner and General Manager of Genesis farms Ethiopia plc. For his ignitable courage, hospitality and financial support.

I would like to acknowledge my wife Emebet Bekele and my son Alpha Nigussu for the cost they paid and priceless sacrifation during the period of this study.

Thanks are also due to all family specially my mother Mastawet Birhanu and my brother Tedrows Fasil for their encouragement and true love. Finally, I would like to say thank you all my relatives who has the dream of my success.

## LIST OF FIGURES

Figure 1: Map of Oromia showing study zone .....	26
Figure 2: The same goat of fig 1 at wet blue stage with its circular rough defect .....	31
Figure 3: The same goat of fig 1 at wet blue stage with its circular rough defect .....	31
Figure 4: Young goat dead of characteristic pox lesion .....	32
Figure 5: Adult sheep with generalized pox lesions of diffused nodule.....	33
Figure 6: Lesions of pox of at Fig.4 sheep from flash side after flaying with nodules visible.....	33
Figure 7: Processed skin at crust stage with defect due to pox (skin of sheep at fig.5)....	34
Figure 8: Sheep skin infested by flea, with alopecia and with acute hemorrhagic lesion at the periphery of alopetic lesion.....	34
Figure 9: Defects on processed skin at crust stage due to flea infestation (from fig.8)....	35
Figure 10: Apparently normal skin as in controlled group .....	35
Figure 11: Defect called “cockle” at wet blue stage caused by mixed infestation by sheep ked and lice .....	36
Figure 12a: Perivascular infiltration of dermis×10 from positive lice lesion.....	37
Figure 12b: lymphocytes surrounding blood vessels×40 .....	37
Figure 13a: Eosinophilic infiltration of dermisfrom sheep ked positive lesion .....	37
Figure 13b: Perivascular infiltration (Lymphocyte and eosinophiles) .....	37
Figure 14a: necrosis of corium with pickle Degeneration from tick positive lesion.....	38
Figure 14b: necrosos of sratum corium×40 from tick positive lesion.....	39

Figure 14c: lymphocytic infiltration×40 from flea positive lesion.....	39
Figure 15a: acanthosis and fibrosis from pox positive lesion.....	40
Figure 15b: congestion and perivascular infiltration with Lymphocytes from pox positive lesion.....	41
Figure 15c: hyperkeratosis and tissue proliferation from Pox positive lesion×40.....	41
Figure 15d: abscessed epidermis from pox positive lesion×40.....	42

## **LIST OF APPENDICES**

Annex 1: Histopathological Technique: .....	60
Annex 2: Leather manufacturing process .....	62
Annex 3: quality grades characteristics .....	66
Annex 4: skin scraping techniques for mange mites .....	67

## LIST OF ABBREVIATIONS

CACC	Central Agricultural Census Commission
CS	Corium Stratum
D	Dermis
DP	Dermal Papillae
FAO	Food and Agricultural organization
GDP	Gross Domestic Product
M.A.S.L	Meter above sea level
MOAR	Ministry of Agriculture and Rural Development
OIE	World Organization for Animal Health
PD	Papillary Dermis
RD	Reticular layer of the Dermis
SG	Stratum Germinativum
SGR	Stratum Granulosum
SS	Stratum Spinosum
PMN	polymorphic nuclear cells

## **ABSTRACT**

*The objectives of this study were to determine the type and extent of damage and to characterize gross and microscopic lesions as well as quality grading of processed skin to crust stage. In this study 500 animals (350 sheep and sheep and 150 goats) were examined for any skin problem from both ectoparasites controlled and non controlled areas. Nine goats and 11 sheep with skin diseases were conveniently selected for characterization of pathological lesions and evaluation of defect in the tannery and quality grading. Ten goats and 10 sheep skins which apparently look normal were also taken to tannery as controls. Out of the 500 animals examined for skin abnormalities 42 % were infested by lice, 15.7% by fleas, 18.57% by sheep ked, 2.5% ticks, 2% mange, and 25% were infected by pox virus. Generally, the predominant gross pathologic lesions were crusts, scabs, pit depression, alopecia nodules, lichenification, fissuring and erythema. In pox infection lesions were macules, papules with central depression which finally became gray (necrotic) lesion and developed to scabs. Histopathologically pox lesions include acanthosis, parakeratosis and hyperkeratosis in the epidermis and the dermis showed vasculitis, infiltration of inflammatory cells such as macrophages, fibroblasts and histiocytes. Generally microscopic lesions induced by ectoparasites were similar with little variation and includes parakeratotic, hyperkeratosis, and infiltration with eosinophils. Perivascular with eosinophils, plasma cells, and lymphocytes infiltrations. Different downgrades to leather quality due to various agents were observed at tannery and this includes aesthetic appeal, poor grading and rejection of which 50% were rejected, 15.4% categorized as grade 6, 19.2% as grade 5, and 11.5% as grades 1-4 category (annex.2). Ectoparasites were the major causes of down grading and rejection followed by sheep and goat pox.*

**Key words:** *Ectoparasite, Crust, Goat, Inflammatory cells, Lesions, Sheep, Pox*

## 1. INTRODUCTION

In Ethiopia, livestock is second major source of foreign currency through export of live animals, meat, skins and hides. Skins from goats and sheep are important economic products contributing for the largest share to the total and agricultural export commodities (Ayele *et al.*, 2003, FAO, 2005) followed by live animals. However in recent years, this rank has been relegated to fifth level mainly because of rejection and down grading by defects mainly due to infestation by external parasites (Bayou, 2005). As farm damage is the greatest cause of downgrading, the farmer is the only person in a position to make the change. Skin problems caused by ectoparasites such as mange mites, lice, keds and ticks result in serious economic loss to smallholder farmers, the tanning industry and the country as a whole. Similarly, other skin diseases such as *dermatophilosis*, ring worm and lumpy skin disease significantly affect the general health and the quality of hides and skin in these animals. They can result in mortality, decreased production and reproduction, down grading and rejection of skins (Ayele *et al.*, 2003, Yacob *et al.*, 2008, Part I). According to Kassa (1998), skin problems due to ectoparasites cause 35% of sheep skin and 56% of goat skin rejection (Amsalu *et al.*, 2000).

Even though small ruminants are important components of Ethiopian farming system, their contribution to food production and export income are far below the expected potential. This is because small ruminant production in Ethiopia is constrained by the compound effects of diseases, poor feeding and poor managements (Getachew, 1995). The existence of various skin disease affecting small ruminants are frequently reported from different parts of Ethiopia to cause substantial economic losses by reducing the productivity and reproduction performance and degrading skin quality (Zewdu,1995). Ethiopian small ruminant skins, especially sheep and goat skins traditionally have a very good reputation for quality in the world leather market due to their fine grain and compact structure. They were also very important to the country's economy as sheep and goat skins rank among the largest export commodities. Skin diseases, scratches, scabs,

flay cuts and holes, putrefactions and heat and poor substances are the main problems related to skin and hide quality that the tanners are facing (Abadi, 2000). Skin diseases are known to affect the quality of skin. As many as one-quarter to one third of all skins processed at tanneries have various defects and are unsuitable for export purposes (Bayou *et al.*, 1998). Up to 65% of these defects occur in the pre-slaughter stage of production while the animals are alive. Considerably large portions of these pre-slaughter defects are directly related to parasitic and /or to other skin diseases and secondary self-inflicted damages (Ermias, 2000). Ethiopian tanneries have put the numbers of reject skins, at certain times of the year at as high as 50-60%. Of these rejects, 80-90% is attributed to “*ekkek*”. (Haffize, 2001). Dermal lesions, in particular are responsible for much of the defects that are visible after skins are processed, and these include hardened grains, patches of putrefaction, pinpoint depressions and disappearance of the grains (Lehman, 1993). Hence, one of the major problems affecting the leather and especially tanning industry is related to the decreasing quality of skins. The profitability of sheep goat and is often affected due to occurrence of diseases, especially the infectious diseases (Senthilkumar, 2006). Among these infectious diseases affecting sheep, sheep pox is considered to be economically the most important in the tanning sector due to its slow and permanent scar formation (Ozmen, 2009). Heavy economic losses in sheep pox outbreaks are due to mortality, abortions and loss of market value of the affected animals (Babiuk, 2009).

Ectoparasites such as mange mites, lice, keds and ticks are widely distributed in all agro-ecological zones in Ethiopia, causing serious economic loss in small holder farms (Kumsa *et al.*, 2012). They are also one of the most important causes of loss in production and mortality of animals in various part of the country through decrease in production and down grading and rejection of skins. It was reported that 35% of sheep and 56% of goat skin rejections in Ethiopia are attributed to ectoparasites (Kassa, 2006). All these established facts imply that ectoparasites pose serious economic losses to the farmer, the tanning industry and the country as a whole. Skins from goats and sheep are important economic products contributing for the largest share to the total and agricultural export commodities (Food and Agriculture Organization (FAO), 2005)

followed by live animals (Ayele *et al.*, 2003). The current utilization of hides and skins in Ethiopia is estimated to be 45% for cattle hide, 75% goat skin and 97% sheep skin with expected off take of 33, 35 and 7% for sheep, goats and cattle, respectively (Mohammed, 2000). However in recent years, this rank has been relegated to fifth level mainly because of rejection and down grading inflicted on hides and skin defects mainly due to infestation by external parasites (Kassa, 2006).

The small ruminants skin diseases often caused by bacteria, viruses, fungi, and ectoparasites like lice, fleas and ticks show various types of lesions (Gbolagunte and Hambolu 2006). The appearance of skin lesions, however, may change with medication, self-inflicted trauma and secondary infections. Primary lesion varies slightly from its initial appearance to its full development. Later, through regression, degeneration and traumatization, it changes in appearance and in its new altered form becomes a secondary lesion (Muller and Kirk 1969). In the course of a disease like dermatophilosis for instance, infection is not established unless the immediate skin environment becomes unfavorable revealing in most cases, altered lesions. Classical structural lesions observed on the dermatophilosis infected bovine hide surface were exudation and scabbiness. The microscopic pathological changes were hyperkeratosis, edematous epidermal strata denoted by widening of intercellular spaces with loss of cellular contacts, total degeneration and necrosis of epidermal cells, detachment of basal epidermal cells from underlining basal laminae, breakages in continuities of basal laminae, collagen fibrillar destruction with spatial disorientation in the grain, and dislodgement of collagen bundles by excessive cellular infiltrates within the corium (Isitor and Gbolagunte 1987). Such pathological diagnosis should then prove valuable in ascertaining the level of damage done to the various structures of Ethiopian small ruminant skins by diseases. Knowledge of the pathogenesis of the various diseases afflicting small ruminant skins which adversely affect their leathers, is vital for effective control of the conditions of many of the various dermatosis. It is therefore necessary to investigate the effects of the afflicting diseases on the surface and microscopic structures of these small ruminant skins as well as on the gross leather surfaces, as was investigated for bovine dermatophilosis afflicted

hide where blemishes in form of pittings and wrinklins on the grain enamel were observed (Isitor and Gbolagunte 1987).

This study has thus set out:

1. To characterize gross and histopathologic lesions of sheep and goats skins in relations to causative agents and
2. To characterize lesion on processed skin in tanneries and evaluate leather grades in relation to causative agents.

## **2. LITERATURE REVIEW**

### **2.1. Skin anatomy and histology**

The skin is considered the largest organ of the body and has many different functions. The skin functions in thermoregulation, protection, metabolic functions and sensation. The skin is divided into two main regions, the epidermis, and the dermis, each providing a distinct role in the overall function of the skin. The dermis is attached to an underlying hypodermis, also called subcutaneous connective tissue, which stores adipose tissue and is recognized as the superficial fascia of gross anatomy. The epidermis is the most superficial layer of the skin and provides the first barrier of protection from the invasion of foreign substances into the body. The principal cell of the epidermis is called a keratinocyte. The epidermis is subdivided into five layers or strata, the stratum germinativum (SG), the stratum spinosum(SS), the stratum granulosum(SGR), and the stratum corneum(SC) in which a keratinocyte gradually migrates to the surface and is sloughed off in a process called desquamation (Janson and Swanson,1996).

The stratum germinatum provides the germinal cells necessary for the regeneration of the layers of the epidermis. These germinal cells are separated from the dermis by a thin layer of basement membrane. After a mitotic division a newly formed cell will undergo a progressive maturation called keratinization as it migrates to the surface. The cells that divide in the stratum germinativum soon begin to accumulate many desmosomes on their outer surface which provide the characteristic ‘prickles’ (seen on the close-up view) of the stratum spinosum, which is often called the prickle-cell layer. The progressive maturation of a keratinocyte is characterized by the accumulation of keratin, called keratinization. The cells of the stratum granulosum (SGR) accumulate dense basophilic keratohyalin granules (seen on the close-up view). These granules contain lipids, which along with the desmosomal connections help to form a waterproof barrier that functions to prevent fluid loss from the body. Epidermis varies in thickness throughout the body

depending mainly on frictional forces and is thickest on the palms of the hands and soles of the feet. The stratum lucidum is normally only well seen in thick epidermis and represents a transition from the stratum granulosum to the stratum corneum. As a cell accumulates keratinohyalin granules, it is thought that rupture of lysosomal membranes release lysosomal enzymes that eventually cause cell death. The dead and dying cells filled with mature keratin form the stratum conium. The deeper cells of the stratum corneum retain their desmosomal junctions, but as they are pushed to the surface by newly forming cells of the stratum germinativum, the dead cells gradually break apart and are lost, a process called desquamation.

The dermis (D) assumes the important functions of thermoregulation and supports the vascular network to supply the avascular epidermis with nutrients. The dermis is typically subdivided into two zones, a papillary dermis and a reticular layer. The dermis contains mostly fibroblasts which are responsible for secreting collagen, elastin and ground substance that give the support and elasticity of the skin. Also present are immune cells that are involved in defense against foreign invaders passing through the epidermis. The papillary dermis (PD) contains vascular networks that have two important functions. The first being to support the avascular epidermis with vital nutrients and secondly to provide a network for thermoregulation. The vasculature is organized so that by increasing or decreasing blood flow, heat can either be conserved or dissipated. The vasculature interdigitates in areas called dermal papillae (DP) (Janson and Swanson, 1996). The papillary dermis also contains the free sensory nerve endings and structures called Meissners corpuscles in highly sensitive areas. The reticular layer of the dermis (RD) consists of dense irregular connective tissue, which differs from the papillary layer, which is made up of mainly loose connective tissue (note the difference in the number of cells). The reticular layer of the dermis is important in giving the skin its overall strength and elasticity, as well as housing other important epithelial derived structures such as glands and hair follicles. The skin also contains a variety of appendages, mainly hair follicles; sweat glands, and sebaceous glands, which are all embryologically epidermal in origin (Janson and Swanson, 1996).

## **2.2. Skin and hides as commodities**

The global leather supply chain grew tremendously over the period 1981 to 2006, for example its exports, which included raw hides and skins, tanned leather and footwear, expanded by 329.19 percent in nominal terms from an average annual figure of USD13,4 billion in the 1981-3 period to USD59.8 billion in 2005-6 period. The three main segments namely hides and skins, tanning and footwear contributed 12.06 percent, 30.09 percent and 57.85 percent respectively to the total global export bill. Growth was propelled by rapid expansion in the exports of light bovine leather, which increased by 700 percent from USD2.0 billion in the base period to USD16.2 billion average per annum by 2005-6. Footwear rose by 363.89 percent, from USD7.7 billion to USD35.9 billion per annum in the same period. All categories registered growth of above 90 percent, except for the exports of goatskins, which declined by 76.97 percent in the same period; however its retreat was hardly felt in the chain because its share in the exports basket was less than one percent (FAO, 2008). The main feed stock of the leather supply chain, hides and skins are a byproduct of the meat and dairy market chains. Therefore the production of hides and skins is virtually inelastic to changes in their price, but is influenced by factors that drive the meat and dairy markets. On the other hand the consumption of footwear with leather uppers<sup>1</sup> and other leather products is positively related to changes in the purchasing power of consumers, as reflected by the fact that high income countries import proportionately more footwear than poor countries, as shall be illustrated in the relevant sections of this report. The dynamics in the leather chain are therefore to a significant extent dependent on the level of performance in the meat and dairy markets and growth trends in the global economy (FAO, 2008).

From 2004 to 2007 the global bovine head averaged 1,566.3 million, which yielded approximately 6.2 million tonnes of raw hides per annum on a wet salted basis. The average unit weight per hide was 18.3 kg. Heavy leather production totaled 500,200 tonnes, while 13,832 million square feet of light leather, including split leather, were produced. Some 48 percent of the light leather was converted into 4,487 million pairs of footwear with leather uppers, utilizing roughly 6,730 million square feet. The remaining

52 percent of light bovine leather was absorbed by other diverse end-uses, largely garments, furniture and travel goods, including handbags. A global sheep and goat flock of 1,893 million generated 657,000 tonnes of raw skins on a dry basis<sup>3</sup>. This raw material was converted into leather measuring 4,689 million square feet. i.e. some 7.1 square feet per kg of raw skin. While some of the sheep leather was used in shoe linings and some goat leather in shoe uppers, the bulk found its way into a vast variety of leather articles ranging from leather clothing to wristwatch bands (FAO, 2008)

### **2.3. Contribution of skin and hides to the Ethiopian economy**

Archaeological studies have shown that hides and skins have been used since antiquity as clothes, vessels, bedding and possibly structurally in ancient dwelling places. These are renewable resources. Materials for the tanning industry are renewable and easily perishable resources (Arugna, 1995). Their production is dependent on the rearing, management and disposal of the livestock population. The availability of hides and skins through slaughtering or death of livestock is of particular importance to the leather industry. Hides and skins could be obtained from fish, birds, and reptiles as well as wild and domesticated animals. The most important sources are cattle, sheep and goats. Based on annual off take rates of 7% for cattle, 33% for sheep and 35% for goats, the potential production is estimated at 2.38 million cattle hides, 10.07 million sheep skins and 7.38 million Goatskins in 1998/99. This raw material of the leather industry is mainly derived from local areas of the country where basic amenities for slaughtering and subsequent marketing are either not in existence or lacking. Additional sources of hides and skins include slaughter slabs, municipal slaughterhouses, the limited number of export abattoirs, and meat and meat product processing plants (Mahmud, 2000). The leather industry sector is one of the forth growing economic sectors in Ethiopia (MoARD, 2009). Skins represent a major source of foreign exchange earnings with a share of 14-16% of Ethiopia's total export revenue. Its share has dropped to nearly 7% in 1998/1999 due to a decreased price for leather in the international market and the deterioration of the raw material quality. The major suppliers of sheepskins for the Ethiopian central market are Amhara, Oromiya and Southern Nations, Nationalities and People Regional states

accounting for 34.5, 32.9 and 16.6%, according to their order. On the other hand, 45.4, 26.4, 11.7 and 11.6% of the total goatskins supplied to tanneries are collected from Amhara, Oromiya, Southern Nations, Nationalities and People regional State and Tigray, respectively (Adamu, 1997).

Ethiopian highland sheepskins in particular, remain highly competitive in international markets for some natural characteristics of clarity, thickness, flexibility, strength and compact texture which make them especially suitable for making of high quality gloves, sport equipments and garments. Goatskins, originating from Wollo in Ethiopia and classified as *Bati-genuine* and *Bati-type* are characterized by thick, highly flexible and clean inner surfaces and are in high demand for the production of fashion leathers (Raga, 2003). Annually, 16.6 million pieces of skins are produced in the country, based on the off take rates of 33% and 32.5% for sheep and goats (Tadesse, 2005). Considering the development potential and economic importance of hides and skins, in the last few decades the government has launched different development programs aimed at increasing the supply and improving the quality of the raw material. Despite these development interventions, hides, skins and the leather industry are still constrained by the poor quality of raw materials, lack of an efficient market structure, a weak extension service, competition from local/rural tanning industries, and a lack of price incentive for production of good quality raw material (Mahmud, 2000). The problem has adversely affected all aspects of the industry including the income derived from exports. Improvement of the quality of raw material is vital in expanding trade in the sector. Better-quality skins fetch better prices. Eliminating or at least reducing defects that because the down-grading and consequent rejection of the raw material will improve price received (ESGPIP, 2009).

#### **2.4. Diagnosis of Parasitic skin diseases**

In making a diagnosis of ectoparasitic infestation or an ectoparasite associated dermatosis it is Important to have an idea of the parasite involved and its life cycle. Some parasites live in intimate relationship with the host's skin, however, visiting parasites, may be on

the skin only for a short period of time and a diagnosis is often made by implication. Hence a working knowledge of the clinical sign of the skin diseases is usually also required (Wall and Shearer, 1997). The ideal approach to diagnosis of skin diseases is a logical progression from history to an overall clinical examination, to a detailed examination of the skin, and finally to confirmatory testing or diagnosis by response to treatment (Jackson, 1991; Smith and Sherman, 1994).

#### *2.4.1 History*

According to Jackson (1991), the main points to be noted during history taking includes Date when symptoms first appeared, symptom observed by the owner, contact with other flock, spread within the flock, previous health history of affected animals, other disease problems within the flock past and present, response to treatment (including home remedies) so far and detailed management including feeding worming, etc.

#### *2.4.2. Clinical examination*

Simple observation allows identification of most external parasite infestations and clinical signs of skin diseases, thus many conditions can be diagnosed with reasonable certainty (Smith and Sherman, 1994). The entire skin surface of the patient should be examined for parasites and lesions and the elasticity of the skin, its temperature, thickness, color and consistency should be noted and response of the animal to palpation of affected area should be observed (Jackson, 1991). The appearance and location of lesions are the bases for diagnosis.

The primary lesions include papules, vesicles, pustules and nodules. Secondary lesions such as scales, crusts and alopecia are the result of self trauma or superimposed bacterial infections (Smith and Sherman, 1994). During clinical examination unidentified external parasites or their eggs are collected, fixed and stored in 70% alcohol or 10% formalin and identification can be made with the help of an identification key (Soulsby, 1982). Many of the larger ectoparasites, such as blowfly larvae and ticks, may be collected directly of

the host using appropriately sized forceps. Small specimens may be pickled up with the end of moistened paintbrush. Unattached mites and ticks can be removed by combing or brushing of the host animal over a white enamel tray or sheet of paper. Brushing over moistened white blotting paper or paper towel may help to identify flea infestations (Wall and Shearer, 1997). Hairs collected by coat brushing and plucking should be mounted in a mineral oil, such as liquid paraffin, and examined microscopically for evidence of ectoparasites. Eggs of some parasites, such as lice may be found attached to the hair shaft and adult ectoparasites, such as lice and various mites, may be also found by this method. The hair bulb and lower third of the shaft should be examined for evidence of follicular mite *Demodex*. In cases of alopecia it may be useful to examine the upper portion of the hair for evidence of fracture, which occurs with self-induced alopecia due to pruritus (Wall and Shearer, 1997).<sup>18</sup> To insure that the mouth parts are not left behind, embedded living ticks may be removed most effectively by dabbing the ticks and the surrounding skin with alcohol. This relaxes the tick, allowing it to be pulled out intact. Alternatively, the tick can be covered with a layer of petroleum jelly, which prevent respiration and, after about 30 minutes, the tick will drop off (Wall and Shearer, 1997).

#### 2.4.3. Skin scraping examinations

Examination of skin scrapings is essential in the diagnosis of mange. In longstanding cases mites are often very few in number and extremely difficult to find and their absence from the skin scraping doesn't negate a diagnosis (Jackson, 1991). Multiple sites should be scrapped to increase the likelihood of ectoparasite detection. Superficial skin scraping (epidermal surface examination) after removing coat hair by gentle clipping can be used to identify surface mites while deep skin scraping (deep epidermal examination) until capillary ooze occurs is useful in the diagnosis of burrowing and follicular mites such as *Sarcoptes scabiei* and *Demodex spp.* (Wall and Shearer, 1997). A few drop of 10% potassium hydroxide solution or liquid paraffin are added to the sample, a cover slip applied and cleansing of debris allowed to proceed for 15-30 minutes before microscopic examination. Large samples may be processed by boiling 10 minute in 10% potassium

hydroxide solution, centrifuging and performing sugar flotation on the sediment (Smith and Sherman, 1994).

#### *2.4.4. Collection of free living ectoparasites*

Mobile free living mites, ticks and fleas can be extracted from bedding, nests and fecal material by careful search or by shaking the material through a tier of sieves of decreasing mesh-size. They may be swept from vegetation using a hand net. Most commonly used for collecting ticks, however, is a blanket drag. This is a woolen blanket or cotton towel, about 1m square, attached to a bar at one side. The drag is pulled across low-lying vegetation and questing ticks attached to the cloth (Wall and Shearer, 1997). Adult flies can be collected using hand nets, usually consisting of a deep bag of fine mesh netting with a circular, wire stiffened, and opening on a pole. Flies may be picked off as they visit their host or baits of rotting carrion or feces, using either a hand net or, more simply, by inverting a glass tube over them as they feed or rest (Wall and Shearer, 1997).

#### *2.4.5. Histopathology*

Although these indirect techniques are not as useful as direct identification for the diagnosis of ectoparasite dermatosis, they may be valuable in some circumstances, such as insect and arthropod bite lesions (Wall and Shearer, 1997). Small whole thickness strips of skin 25mm\*5mm are taken from normal and abnormal area and the skin strip should be fixed in formol saline (Jackson, 1991). According to Wall and Shearer (1997), histological changes often associated with ectoparasites include an eosinophil-rich dermal infiltrate collagen degeneration usually associated with dermal eosinophil infiltration focal dermal necrosis, which occur in tick bite lesions eosinophilic pustule formation, which occur in cases of flea bite dermatitis.

## **2.5. Status of ectoparasites of small ruminants in Ethiopia**

Ectoparasites are the major causes of skin diseases that hamper small ruminant production in many areas of Ethiopia. Studies conducted in different parts of the country in the past three decades have revealed that the occurrence and spread of skin diseases have been shown to correlate with feed scarcity host, poor husbandry, climatic factors and inadequate veterinary services including absence of national control strategies (Kassa, 1998; Teshome, 2002; Yacob *et al.*, 2008a). According to report by Serste and Cosine (2007), ectoparasites, particularly sarcoptic mites along with other affects on the body is blamed to cause losses due to death of sheep and goats in north Amhara region in Ethiopia. Ectoparasites also have transmission ability for many infections due to blood sucking habit. Skin damage is the most important cause of losses in livestock industry (Tadesse *et al.*, 2011).

### **2.5.1. Ectoparasites damage**

As a result of their activity, arthropod ectoparasites may have a variety of direct and indirect effects on their hosts. The effect of skin parasitism usually depends on the size of invading population, on the manner on which the parasite ekes out its existence and the state of nutrition of the host animal when infected (Peter, 1995). The damage ectoparasite inflict may be mechanical, but the situation is complicated also by host reactions to the presence of the particular parasite, their secretion and excretion (Peter, 1995). Young animals are generally more susceptible to ectoparasites because of higher ratio of accessible surface to the body volume and poor grooming behavior (Lehmann, 1993). According to Wall and Shearer (1997), the direct and indirect harm caused by ectoparasites on the host includes; blood loss: although each individual ectoparasite only removes a small volume of Blood from a host, in large numbers the blood removed by feeding may be directly debilitating and anemia is common in heavily infested hosts. In one study in USA over 90 kg of blood was estimated to have been removed by ticks from a cow over a single season. Myiasis the infestation of the living tissues with fly larvae causes direct damage to carcasses or skin.

The presence of ectoparasite on or in burrowing into the skin can stimulate inflammation. Toxic and allergic responses: caused by antigen and anticoagulant in the saliva of blood feeding arthropod. The irritation caused, particularly by flies as they attempt to feed or oviposit, commonly result in a varieties of behaviors such as head shaking, stamping, skin twitching, tail switching or scratching. These activities may result in reduced growth and loss of conditions because the time spent in avoidance behaviors is lost from grazing or resting self wounding: the activities of particular ectoparasites, such as warble flies, may cause dramatic avoidance responses in the intended host, known as gadding. The madly panicking animals may cause serious self injuries following collision with fence and other objects. Social nuisance large number of flies may breed in animal dung, particularly in and around intensive husbandry units. The activities of flies may cause considerable social problems. Adult flies and their feces may also decrease the esthetic appearance and values of farm facilities and produce, such as hens' eggs, and cause irritation and annoyance to employees. In addition to these effects, one of the most important roles of ectoparasites is in their action as vector of pathogens acting as either mechanical or / and biological vectors (Bay and Harris, 1988; Wall and shearer, 1997). The direct damage caused by most ectoparasites is directly proportional to their abundance. This is not the case, however, for disease vectors, where even very low numbers of infected vectors may cause considerable economic and welfare problems. In the case of *Ctenocephalides felis-felis*, both the male *and* female adult fleas are present on the host animal's skin, living, feeding and breeding there. Of the two sexes, however, it is the *female* flea that is the bigger blood-sucker, drinking far more of the host's blood than any of the male fleas that climb on board. Flea Allergy Dermatitis (FAD) when a flea bites sheep and goat, it deposits a small amount of saliva in the skin. Then the animal develops FAD in reaction to this saliva, which causes severe itching. In addition the animal scratching or biting excessively around the tail, groin or backside, scabs or bumps may also appear on neck or back (Muller and Kirk, 2001).

#### 2.5.2. Mange mites

Mange mites are common in Ethiopia and therefore are reported from many regions and different agro climates. Based on the reports so far, mange mites are most prevalent in four national regional states of Ethiopia namely, the Amhara Oromia Tigray and Southern Nation and Nationalities regional states (Yacob *et al.*, 2008a; Mulugeta *et al.*, 2010; Asnake *et al.*, 2013). In all reports, three genera of mites namely, *Sarcoptes*, *Psoroptes* and *Demodex* were reported to affect small ruminants in Ethiopia. Demodectic mange has been reported in sheep (*Demodex ovis*) and goats (*Demodex caprae*). It is one of the major skin diseases of sheep and goats Demodectic mange is distributed in different agro- agro-ecological zones in Ethiopia as reported by Yacob *et al.*

### 2.5.3. Pediculosis

Lice infestation in Ethiopia is the most frequently reported and the most important skin disease of small ruminants this is because lice are found to be the cause of cackle. According to Tefera and Abebe (2007), *Bovicola ovis* and *Linognathus* spp. are the two species with prevalences in sheep of 38.5 and 2.4%, respectively while in goats *Linognathus* species has prevalence of 28.3%. Nowadays, pediculosis is a serious health problem of small ruminants in Ethiopia. The highest prevalence was recently reported in sheep from Assela by Hailu (2010), who identified *Linognathus* spp (75.5%), *B. ovis* (67.1%), *Linognathus ovillus* (14.6%) and *B. ovis* (36.1%), this last one was reported by Asnake *et al.* (2013). Other reports were *B. ovis* in sheep 15.3 and 27.9% in goats, *L. ovillus* (27.9%) from Tigray by Mulugeta *et al.* (2010) and *B. ovis* (26.64%) in sheep from Wolayta Sodo (Yacob *et al.*, 2008a). The louse species identified in many studies conducted so far in Ethiopia were *B. ovis* and *L. stenopsis*. Results obtained by Ermias (2000) from examination of fresh sheep pelts also showed a much higher infestation rate of 89.55%. In Ethiopia, most lice populations on animals vary seasonally, depending on the condition of the host. Lice populations on animals are greater during the rainy months (Hailu, 2010).

### 2.5.4. Sheep keds (*Melophagus ovinus*)

In Ethiopia, few works are available on ecological distribution of sheep ked. Recent reports on sheep ked of small ruminants indicated that the parasite is most common in sheep mainly in cooler high altitudes. Other reports were in sheep. 65% from Assela highlands (Hailu, 2010) (Oromyia region); 19.1% from Mekele midlands (Mulugeta *et al.*, 2010); 14.2% from central highlands of Oromyia regional state (Kumsa *et al.*, 2012) and 20.14% from Gondar highlands (Tewodros *et al.*, 2012). In all cases, the identified species was *Melophagus ovinus*. Infestation of sheep with *M. ovinus* leads to the development of cockle and those results in downgrading and rejection of skins. The prevalence of cockle lesion in *M. ovinus* infested groups of sheep skin g to Enquebaher and Etsay (2010), the prevalence varies from 1.84 to 19.48% in Tigray regiona was found to be 100 and 95%, respectively (Tefera and Abebe, 2007). Examination of fresh sheep pelts also indicated the prevalence rate of 32.7% infection rates (Ermias, 2000). Both lice and keds are considered as cause of cockle in Ethiopian sheep pelts (Kassa, 1998). According to Serste and Wossene (2007), about 70.8% of the pickled sheep pelt and 42.3% of the wet blue goat pelt were downgraded and rejected due to cockle caused by both lice and sheep ked.

#### 2.5.5. Ticks

Ticks are one of the most serious ectoparasites in Ethiopia. They cause the greatest economic losses in livestock production. Their effects are various including reduced growth, milk and meat production, damaged hides and skins, transmission of tick-borne diseases of various types and predispose animals to secondary attacks from other parasites such as screw worm flies and infection by pathogens such as *Dermatophilus congolensis*, the causative agent of streptothricosis (Ethiopia Sheep and Goat Productivity Improvement Program (ESGPIP), 2010). Reports from different areas of Ethiopia indicated that highest overall prevalence of ticks infestation are, 23.8% in sheep and 10% in goats (Teshome, 2002) from Sidama zone; 31.78% in sheep and 18.63% in goats from Wolayta Sodo (Yacob *et al.*, 2008b); 16% in sheep and 29.7% in goats from Tigray region (Mulugeta *et al.*, 2010) and 57.6% in goats from three agro-ecological zones of southern rangeland of Ethiopia (Asnake *et al.*, 2013). In all these studies, it was

observed that about four genera namely, *Amblyomma*, *Hyalomma*, *Boophilus* and *Rhipicephalus* were known to affect sheep and goats in different agro-ecological zones in the country. The high prevalence of ticks in different areas seems to be related to absence of national campaign for strategic control of these ectoparasites.

## **2.6. Sheep and goat pox**

The profitability of sheep and goat is often affected due to occurrence of diseases, especially the infectious diseases (Senthilkumar, 2006). Among these infectious diseases affecting sheep and goat pox is considered to be economically the most important in the tanning sector due to its slow and permanent scar formation (Ozmen, 2009). Heavy economic losses in sheep pox outbreaks are due to mortality, abortions and loss of market value of the affected animals (OIE, 2008). Morbidity and mortality vary with the breed of the animal, its immunity to Capri pox viruses, and the strain of the viruses. It is an OIE list A disease. Pox infections can limit trade, export, and development of intensive livestock production. It also prevents the import of new breeds. Mortality may be up to 50% in a fully susceptible flock and as high as 100% in young animals (OIE, 2008). Mild infections are common in indigenous breeds. However, symptoms may be more severe in lambs, stressed animals, animals that have concurrent infections or animals that come from areas where pox has not occurred for sometime (Beard, 2009). Incubation period of the disease is 8 to 13 days following contact between an infected and susceptible animal. It may be as short as 4 days following experimental infection by intradermal inoculation or mechanical transmission by insects. Transmission of sheep pox among flocks and transfer between countries occur from the movement of sheep. All age groups can be affected; however the disease is more severe in young animals than adults. (OIE, 2008). The systemic signs include fever (104-107F), conjunctivitis, rhinitis, lymphadenopathy, anorexia and depression (Balinsky, 2007). The mucous membranes can become necrotic and animals may develop a mucopurulent nasal or ocular discharge (Ozmen, 2009). In Ethiopia, Sheep pox is a serious problem and has been reported from different regions of the country (MORAD, 2010). Generally, sheep pox is a disease of considerable economic importance for Ethiopian sheep farming. However, little information is available

regarding transmission and vaccination of naturally occurring sheep pox in extensive production systems. The present study analyses the clinical and histopathological findings of sheep pox in indigenous sheep in Ethiopia.

#### *2.6.1. Causes and factors affecting skin defects in sheep and goats in Ethiopia*

Up to 65% of the defect that lead to decline of the quality occur in the pre-slaughter stage of production while the animal is still alive and a considerable portion of these pre-slaughter defects are directly associated to skin disease initiated by external parasites (Kassa et al., 1998). Ectoparasitic skin diseases of domestic ruminants caused by lice, sheep keds, ticks and mites are among the major diseases that result serious economic loss to smallholder farmers, tanning industries and to the country at large. In 1996/97, six tanneries in and around Addis Ababa had rejected 2,037,745 pieces of skins which caused a loss of USD 6.3 million and in 1998/99 three tanneries that are found in Amhara Regional State have reported 443,602 pieces of skin rejection per annum which worth USD 1.4 million loss. Ectoparasitic skin diseases due to ticks, lice, sheep kades and mange mites cause 35% of sheep skin and 56% of goat skin rejections (Tadesse, 2005; Ayele *et al.*, 2003). As a result of their activity ectoparasites may have a variety of direct and indirect effects on their hosts ectoparasites commonly tick, mite (*Sarcoptes*, *Psoroptes*, and *Demodex*), keds and lice affect the host species by the inflammation and the infection they inflict on the skin (Taylor, *et al.*, 2007) by their effect on the physiology of the animals as well as through transmission of different diseases. Infestations by ectoparasites significantly affect the quality of hide there by affecting the economy of Ethiopian farmers as well as international market. Currently Ethiopia is accountable for considerable economic losses particularly to the skin and hides export due to various defects. According to Tanneries report, skin diseases due to external parasites causes' 35% sheep skin and 56% goat skin rejection in Ethiopia (Yeshehak, 2000). The prevalence of cockle lesion on *D. ovis* and *M. ovinus* infested group of sheep pelts in Wukro Sheba tannery Tigray Region was 100 % and 92.5 %, respectively. On the other hand, the prevalence of cockle lesion on sarcoptic mange infested goat pelts was

100 %. Beside this other defects such as scratches, scars, ld age and technical defects due to flaying were observed in each group of pelts This report also indicated existence of strong positive correlation between the severity of ectoparasites infestations (light, moderate and severe) (Yeshehak, 2000). On raw pelts and the severity of cockle (clean, light, moderate and severe) on pickled skins. There are also other causes of skin damage in the preslaughter stage. These include fungal, bacterial and viral skin infections Hides and skins are the basic raw materials for the leather industry. Currently there are about 27 tanneries in the country and have an average capacity of 4,000 pieces of hides and 30,000 pieces of skins per day However they are working under capacity even if the country has a potential to supply around 20 million pieces of hides and skins per annum. The potential supply of hide and skins depend on the scale of meat production, not on the size of livestock population. Thus, the product, i.e. hides and skins, becomes available when meat is needed, not when it is appropriate for leather processing and so it is not primary agricultural commodity. This means that hide and skin supply does not respond to price change As a result, the industry in the country has tremendous potential for domestic and foreign exchange earnings and the capacity to attract profitable foreign investment. (ESGPIP, 2008).

Though Ethiopia has very good potential to produce substantial quantities of skins over the last 10 years, there are indications that quality of raw hide and skins supplied are indications that quality of raw hide and skins supplied has deteriorated with an increasing number of poor grades. The reason behind is the appearance of skin disease called ‘ekek’ due to external parasites, shortage of supply of hides and skins to meet the demand of tanneries and absence of effective market demand, absence of credit, high marketing cost, inappropriate management of animals, faults during slaughtering and improper handling of skin and hide before it reached at tannery This has resulted in an ever increasing number of complaints about the quality of skins and hides available to market. In combination it has adversely affected all aspects of the combination it has adversely affected all aspects of the industry. Ethiopia offers a wide range of processed and semi processed sheep and goatskins to the world market. Some of the skin and the skin products such as the high land sheepskin wing to its quality and natural characteristics

have gained international reputations. Based on the off take rates of 33% for sheep and 32.5% for goats the annual production of skin is estimated at 16.6 million pieces. The total earnings of the country from 1998 to 2004 ranged between \$405 and \$590 millions with annual average of \$450 million for both hides and skins (Tadesse, 2005; Ayele *et al.*, 2003). Therefore, small ruminants are important components of the Ethiopian farming system. However, contribution of sheep and goats to food production, rural and export income are far below the expected potential. This is because small ruminant production in Ethiopia is constrained by the compound effects of diseases, poor feeding and poor management (Kassa, 2005; Ayele *et al.*, 2003). Losses from these skin diseases are due to downgrading and rejections of skins, unthriftness, loss of body condition, mortality and decreased in production. This is reflected in tanning industries of the world in general and in Ethiopia in particular Kassa and his colleagues in 1998 showed that skin diseases due to external parasites causes 35% of sheep skins and 56% of goat skin rejections in some Ethiopian tanneries. Studies and reports from different parts of the country showed that skin quality deterioration is very evident mainly due ectoparasites (Tefera, 2004; Numery, 2001; Ermias, 2000; Asegedech *et al.*, 1999; Kassa, 2005). Lice, keds, mange mites and ticks are the major ectoparasites of small ruminants in Ethiopia.

Sheep and goats contribute about 12% of the value of livestock products consumed at the farm level, 48% of the cash income generated but only 6.6% of the capital invested in this livestock sector by farmers. They provide 46% of the value of national meat production and 58% of the value of hide and skin production thus they play an integral part of the production (Tembely, 1998). External parasites are the major causes of skin diseases that hamper small ruminant production in many areas of Ethiopia. Studies conducted in different parts of the country in the last 20 years have revealed the prevalent nature of ectoparasitism. The studies have indicated that the occurrence and spread of skin diseases have been shown to correlate with host factors, poor management, climatic factors, feed scarcity and inadequate veterinary services (Kedir, 2002)

Up until 1996, hides, skins, leather and leather products provided for the second largest amount of foreign exchange earnings following coffee and accounted for 14 to 16% of

the country's total foreign trade revenue. Recently, its share has dropped to nearly 7% in 1998/1999 due to a decreased price for leather in the international market and the deterioration of the raw material quality. Considering the development potential and economic importance of hides and skins, in the last 2 to 3 decades the government has launched different development programs aimed at increasing the supply and improving the quality of the raw material. Despite these development interventions, hides, skins and the leather industry are still constrained by the poor quality of raw materials, lack of an efficient market structure, a weak extension service, competition from local/rural tanning industries, and a lack of price incentive for production of good quality raw material. (Teshome, 2002).

### **2.6.2. Microbial causes**

Ringworm is a fungal infection of the skin that is common in many animal species. It occurs in sheep and goats but not with great frequency. Lesions are most commonly seen on the head, ears, neck and shoulders. The lesion is often circular with hairless areas and the development of a thickened and crusty skin. Dermatitis is a disease condition characterized as an exudative dermatitis. Lesions usually begin on the animals back. Early signs include matting of the hair or wool into clumps due to sticky secretions exuding from the affected skin. Dermatitis can be very destructive of the skin and lead to extensive rejection of skins for tanning. Streptothricosis is a common disease causing supportive lesions which break out spontaneously or become hardened. These cause blemishes on the superficial grain tissues. Dermatophilosis Bacterial disease such as *Dermatophilus congolensis* the main disease in lambs, lumpy skin disease or lumpy wool disease, affecting the dorsal part of the body is also called 'strawberry foot rot' Goat and sheep pox. It is a viral disease of sheep and goats which is highly contagious. Healing of the skin affected by pox is slow and permanent scars can be left. This causes huge economic losses in the tanning sector. Despite the reports about the deterioration of the quality of leather raw material with an increasing number of reject grades and the appearance of skin disease called cockle that is mainly due to lice, keds, and mange infestations (Abadi, 2000), Ethiopian small ruminant skins especially sheep skins have

good reputation for quality in the world leather market due to their fine grain and compact structure (Zelege, 2009; Mohamed, 2000).

### *2.6.3. Description of major skin lesions and defects*

Imperfections in the grain surface or structure of a hide or skin result in unsightly appearance and/ or weakness of the resultant the leather. Such defects may have arisen during the life of the animal or may have developed in the flaying and/or preparation of the stock. Defects exist on natural leather surfaces and they usually cannot be eliminated during processing. No international criterion specifies the compensatory counting for calf leather surface defects, so complicated negotiation causes additional cost and argument between suppliers and purchasers (Abadi, 2000).

### *2.6.4. Defects caused during life*

Scars are resulting from scratches or cuts. (When the cut is healing, the fibers grow densely packed together, and the healed skin is often hard, raised, and lacking hair follicles. Scar damage is also caused by branding the animal for ownership purposes, usually in the butt area, which is the best part of the hide). Parasitic infestations such as warble flies, and mange and ticks pierce the skin to suck blood, leaving holes that look either like pin pricks or minor scars in the grain of the leather. This defect occurs mainly in the belly areas of the skin. Sarcoptic mange mites enter the epidermis and tunnel around, causing the cells to multiply and the hair to fall out. The grain surface becomes roughened, and the animal generally compounds the damage by rubbing to relieve the itching. In demodectic, or follicular, mange, the mites penetrate into the dermis itself, where a wall of fibers is formed to surround and "encyst" them. The cysts generally are seen on the grain of unhaired skins as small swollen nodules. Tanning and drying processes shrink the contents of the cysts, causing the grain surface to sink over the cavity so that the defects are seen as shallow depressions, though the grain surface itself is not generally damaged; Microbial infections. (If ringworm, which is a fungus, heals it

leaves no scars, but if the animal is slaughtered while still infected, the grain appears coarse at the site of the infection); Cockle which occurs in woolled sheep immediately before shearing (This defect appears as boil-like hard spots, of varying size, which occur in rows at right angles to the spine from the shoulder to the butt, and, while the defect disappears rapidly after shearing, it cannot be eliminated during manufacture of the leather). Keds can produce an allergic hypersensitivity reaction in the skin of sheep, leading to lesions known as cockle in processed skins. In Ethiopia, keds are considered a major cause of “*EKEK*”/cockle and are visible on the skin surface of affected animals (ESGPIP, 2009).

#### 2.6.5. Damages caused after death

Flay cuts and gouges: which cut into the fibers of the dermis. (In thin leathers they show through and thereby spoil the grain. Some flay cuts go completely through the hide or skin, ruining it completely. These kinds of cuts are usually the result of careless or improper flaying); Putrefaction which is the result of bacterial growth which starts almost immediately once the animal is dead, unless the skin is properly cured, especially on the exposed flesh side putrefactive damage. Vainness in which branching lines of blood vessels can be seen on the flesh side. (If, because of poor curing or old age, for example, the structure around them becomes loose, the skin is said to be veiny, and the branching pattern of the veins usually shows through on the grain side. Veininess can actually at times be attractive in some skins, such as Vellum. Damage from heat: which may occur on hides and skins in tropical areas it is a common fault with ground-dried skins. Sun damage that occurs to a hide or skin when it becomes heated above a certain critical temperature while it is still moist and is laid out in the sun to dry (cure). A completely dry skin can become very hot and still not be affected under normal conditions of cure, but prior to this a skin is very susceptible to damage. Also, the drying of a salted skin proceeds so uniformly throughout its entire thickness that the cooling effect produced by evaporation off its surfaces maintains the temperature of the entire skin below the danger point until it is uniformly dry. Without salt, however, a skin tends to dry unevenly when laid out in the usual manner, which is flesh side up. This can happen because the flesh

side can dry out completely and begin generating heat, while the underside remains moist, and, being shielded from evaporation, also begins to generate heat. This is especially the case when pieces of flesh, generally of a fatty nature, are present on the flesh side, and further retard the drying of areas beneath them (ESGPIP,2009).

### **3. METHODOLOGY**

#### **3.1. Study Area**

The study on small ruminant skin lesion characterizations and impact on their grade at tannery was conducted in two woredas, Aris zone of Oromia regional state, south east of Adiss Ababa 170km away from Addis Ababa, considering Asella a focal point. The areas have altitudes ranging from 1700 to 4130 m.a.s.l, experiencing binomial rainfall occurring from July to October and April to May, with an average annual temperature of 15-25°C. The production system of the area is mixed crop-livestock in all agro ecological zones. The livestock reared in the area consists of cattle, sheep, goats, horses, donkeys, and mules. Arsi indigenous sheep are one of the known highest populations of sheep species in the country (CACC, 2003). Mainly sheep and goats are drawn from these areas for export slaughter houses. Similarly large number of skin and hides are produced from the proposed study site and those animals taken for slaughter at export abattoirs.

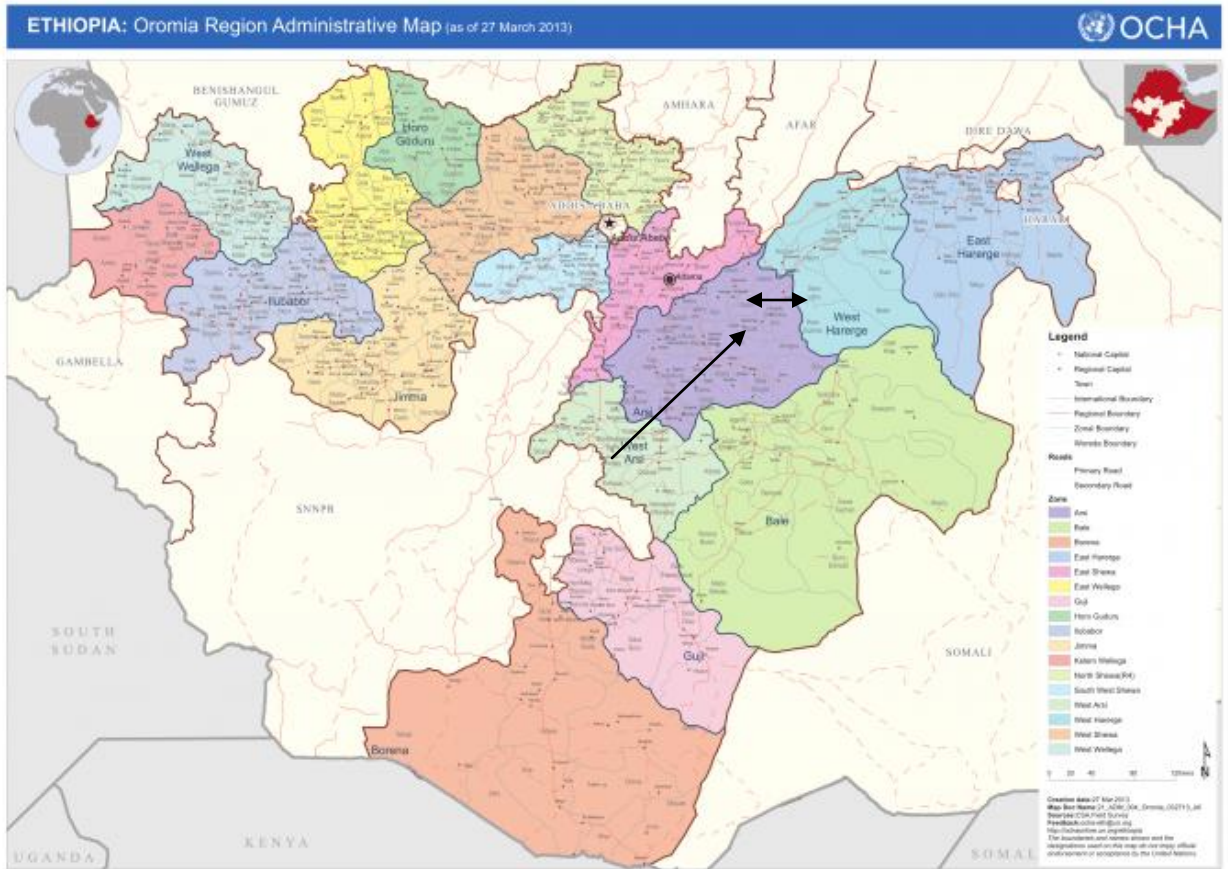


Figure 1: Map of Oromia showing study zone [www.maplandia.com/ethiopia/oromiya](http://www.maplandia.com/ethiopia/oromiya)

## **3.2. Study Design**

Cross-sectional study design was employed to study the type and prevalence of skin diseases and skin lesions both on live animals and freshly collected skins at collection sites.

### *3.2.1. Sample size determination*

The sample size for this study was determined using Thrustfield (2005) formula by taking 50% expected prevalence and 5% precision and 384 animals to be surveyed for skin lesions and concurrently for their causes. For examination of tannery processed skin product total of 40 skins of from sheep and goat including positive groups and apparently normal looking skins were studied. Skins of 9 goats and 11 sheep with lesions, as well as 10 goats and 10 sheep without observable gross lesions were included.

### *3.2.2. Study population and sampling technique*

The study populations included in this investigation are live sheep and goats raised in various areas of Arsi zone and processed skin product obtained from sheep and goats originated from the same area. Multistage technique was employed in such a way that Weredas and Kebeles were selected purposively according to accessibility, small ruminant population and presence or absence of ectoparasites control programs. One wereda from ectoparasites control area around Asella town and another from non-control area Zuway dugda Abura were included. Five to six Peasans't Kebeles were selected from each woredas and 12-15 households were randomly selected and all sheep and goats belonged to selected households were examined for any skin diseases and if any the causative agents were identified, gross lesions were characterized and Tissue samples was taken and fixed in 10% buffered formalin for histopathological analysis. Animals with specific lesion were bought, slaughtered and skin taken to tannery. At the same times skins at collection centers at Assela town were assessed for lesions and those with lesion were bought and take to tannery.

### *3.2.3. Histopathological technique*

Histopathology techniques done through fixation, dehydration, cleaning, embedding, cutting and staining as mentioned in the annex (Lowe, 1998).

### **3.3. Data analysis and management**

Data obtained from both gross lesion, histopathological findings and processed skins examination were stored in Microsoft excel spreadsheet. These data were analyzed by descriptive statistic using SPSS 11.5 for window and analytical statistics using incorporated STATA 11.0 software's (Stata Corporation, Texas, USA, 2001) programs. To determine the type and the extent of damage and to characterize different gross and microscopic lesions and quality grading of crust stage skins product. Then recording positive association and comparison were made for prioritization which skin lesions have great contributions for potential economic losses, skin rejection and quality down grading.

## 4. RESULTS

The Major causes of skin lesions and skin defects in this study were associated with the infestation and distribution of ectoparasites. Based on the examination of 500 animals from controlled and non controlled area 350 sheep and 150 goats observed out these 42 % lice, 18.5% sheep ked, 15.5% fleas, 2.5% tick, 2% mange infestation, and 25% of pox infection were recorded. Among the major ectoparasites *Bovicola ovis*, *Melophagus ovinus*, *Amblyomma variegatum*, *Linognathus Aricanus* and *A. variegatum*, *Ctenocephalidis fealis* and other tick species were identified.

### 4.1. Gross pathological lesion characterization

The results of gross pathological observation are given in animals encountered in this study had mixed type of parasitic infestation with predominant condition stated as allergic type dermatitis. The predominant gross lesions due to different parasitic and pox infection causes were redness, erythema, alopecia, scaly crust, matted coat, roughness, Dermatitis, Wheals, rough, erosion and fissuring commonly observed. According to this findings most of skin lesions were caused by lice and ked infestation followed by pox infection.

#### 4.1.1. Gross lesions due to lice infestation

The site of attachment of lice was red and slightly elevated. In some cases, pinpoint hemorrhages were noticed. The most characteristic skin lesions in sheep and goats infested by lice were the presence of erythema and excoriative lesions on the skin. The wool of sheep infested with *B. ovis* appeared ragged and shaggy in appearance. *B. ovis* eggs (nits) were glued to the wool. Besides, *B. ovis* was also associated with alopecia and yellowish crusts on skins in the area of attachment.

#### *4.1.2. Gross lesion due sheep ked infestation*

*M. ovinus* (Sheep ked) infestation were mainly detected on the neck, breast, shoulder, flank, and on the rump. The hair of affected sheep was ragged and stained with the excreta of sheep ked. Grossly; skin lesions caused by sheep keds were characterized by scaly crust. The excreta from sheep keds stained the wool and reduced wool quality. Initially, skin lesions caused by sheep keds were characterized by the presence of wheals and papules centered up on a puncture wound, which were then covered by scales and crusts. Sheep keds spent their entire life on the host; hence could cause severe skin lesions including a wide spread pruritis, exacerbated by scratching and biting. Sheep ked and lice causes a rash called cockle on the skin, which is the principal cause of skin rejection at tanneries (Figure 11).

#### *4.1.3. Gross lesion due to tick and fleas infestation*

Lesions or defects associated with ticks include red papules, circular erythematous areas up to 2 cm in diameter, focal necrosis, erosions, ulcers, crusts, and in some animals, nodules. Lesions heal with scarring and alopecia. Skin lesions caused by ticks, tick bites left bleeding points to which the mouthparts of the ticks were attached. Skin lesions due to tick bites were characterized by papules and wheals. Hyperemic and edematous lesions were also detected at the site of tick attachment. In the subcutis of the skin, Rough and reddened skin, loss of hair, slightly elevated and skin damage due to rubbing were recorded. There were dermatitis, pruritis, and alopecia. Ticks and lice bite animals, suck blood and cause mechanical irritation. The other common defect of skin detected was unspecified infection caused multiple circular alopecia and white dry crusts covering the whole body in skin of affected goats (live animal, Figure 2 and processed, Figure 3). In the case of flea infestation discrete crust and intense pruritis provoke self scratch which produces area of alopecia and hypersensitive type pyotraumatic dermatitis (live animal, Figure 8, and processed, Figure 9)



Figure 2: The same goat of fig 1 at wet blue stage with its circular rough defect

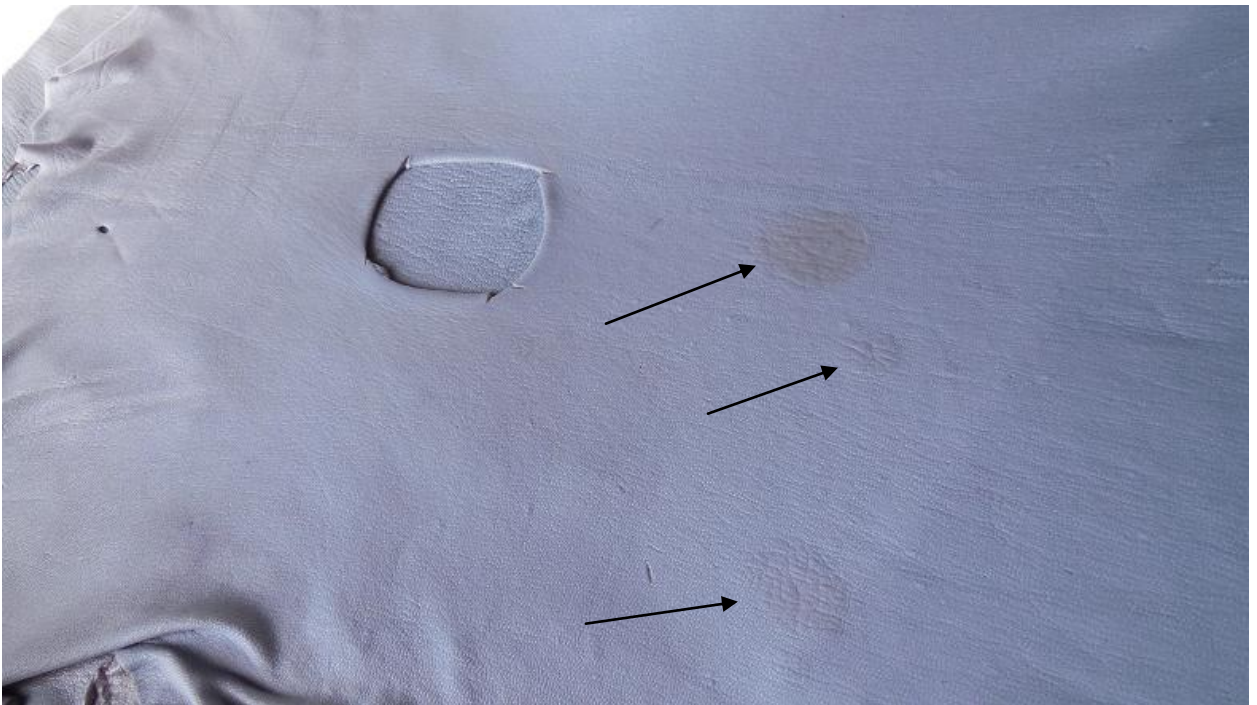


Figure 3: The same goat of fig 1 at wet blue stage with its circular rough defect

#### *4.1.4. Gross lesion due to pox infection*

Important non- parasitic disease of skin recorded in the present study was sheep and goat pox. At postmortem examination pox lesions are of light brown to dark brown in color. Gross pathological findings showed presence of pox lesions in different stages especially in areas with less wool and hair with clearly changes in the epidermis and the dermis of the skin layers (Figures 4-7). This study characterized the sheep and goat pox according to pathological events in Arise area of different district.



Figure 4: Young goat dead of characteristic pox lesion



Figure 5: Adult sheep with generalized pox lesions of diffused nodule



Figure 6: Lesions of pox of at Fig.4 sheep from flash side after flaying with nodules visible



Figure 7: Processed skin at crust stage with defect due to pox (skin of sheep at fig.6)



Figure 8: Sheep skin infested by flea, with alopecia and with acute hemorrhagic lesion at the periphery of alopetic lesion



Figure 9: Defects on processed skin at crust stage due to flea infestation (from fig.8)



Figure 10: Apparently normal skin as in controlled group

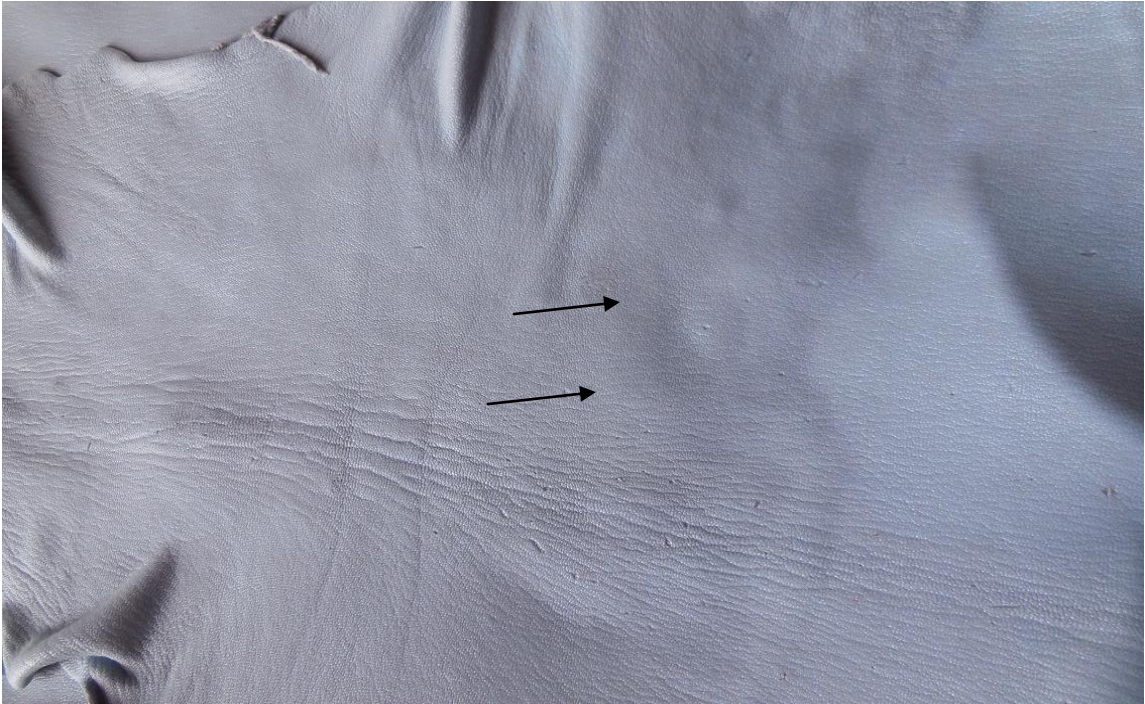


Figure 11: Defect called “cockle” at wet blue stage caused by mixed infestation by sheep ked and lice

## **4.2. Microscopic lesions**

Even though most of the parasitic lesions seen both in dermis and epidermis, 57% of microscopic lesions were related to dermal reaction while 38% of microscopic lesions were found in epidermal layers. The severities of the lesions were directly related to the degree of infestation, the type of parasitic infestation and the nature of inflammatory cells involved.

### *4.2.1. Microscopic lesion due to lice infestation*

Microscopic examination of skin sample from sheep and goats infested by lice showed parakeratotic, hyperkeratosis, and infiltration with eosinophils. Perivascular (Figure, 12a) or diffuse dermatitis with eosinophils, plasma cells, and lymphocytes were encountered

in the dermis. Aggregates of lymphocytes surrounding blood vessels, macrophages, eosinophils, and neutrophils were observed in the dermis (12b).

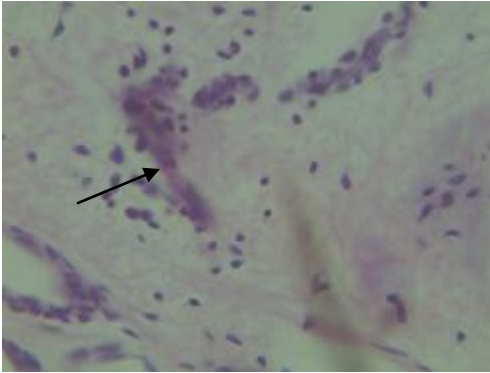


Figure 12a: Perivascular infiltration of dermis×10  
From positive lice lesion

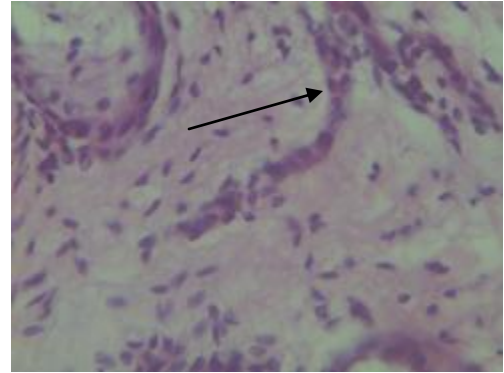


Figure12b:lymphocytes surrounding  
blood vessels×40

#### 4.2.2. Microscopic lesion due to sheep ked infestation

Perifolliculitis and perivasculitis (figure, 12b) were also observed in skin lesions caused *M. ovinus* (sheep ked) infestation. Sheep infested with sheep keds had also many empty capillaries and arteries in the dermis and follicular keratosis were also common. Extensive inflammatory infiltrations consisting of lymphocytes, plasma cells, and eosinophils (Figure, 12a) were observed in the upper dermal layer.

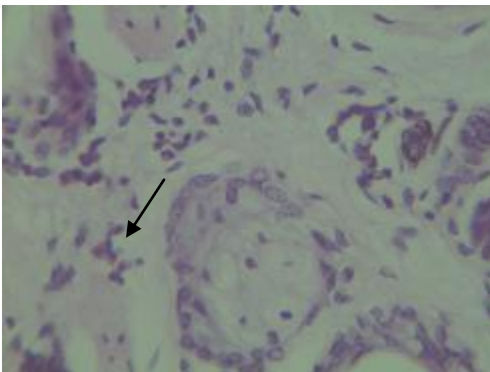


Fig.13a.eosinophilic infiltration of dermis×40  
From sheep ked positive lesion

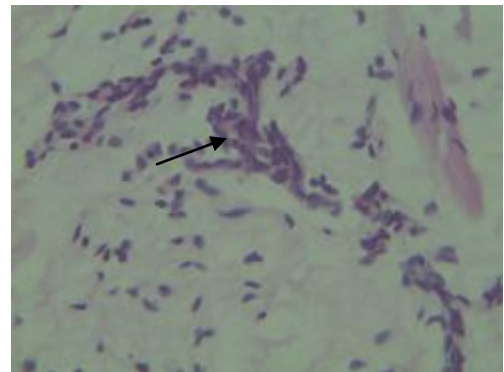


Fig13b. Perivascular infiltration×40  
(Lymphocyte and eosinophiles)

#### 4.2.3. Microscopic lesion due to tick and flea infestation

Microscopically, tick bites have caused necrotic lesions in the epidermis and dermis at the attachment sites. Moreover, perivascular to diffuse dermatitis consisting of eosinophils, macrophages, and lymphocytes were recognized. Epidermal hyperplasia in the epidermal layer and dermal necrosis, perivasculitis (Figure, 14a) to diffuse dermatitis, and perifolliculitis were observed microscopically in skin lesions caused by tick infestation. Excess fibroblast cells proliferation was seen in the papillary layer of the dermis (Figure, 14a). Other histological changes associated with tick infestation include, pickle cell degeneration, eosinophilic, pustule formation, lymphocyte infiltration, folliculitis and eosinophilic rich dermal infiltrate (Figure, 12b). In the condition of **flea** allergic dermatitis, the major lesions were perivascular infiltration, epidermal lymphocytic infiltration (Figure, 14c). Formation of yellow exudates in the epidermal layer and necrosis of the epidermis.

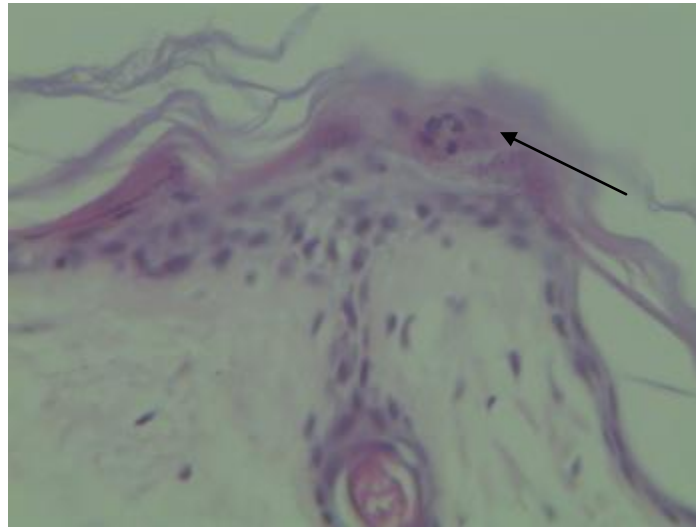


Fig.14a necrosis of corium with pickle Degeneration  $\times 40$   
From tick positive lesion

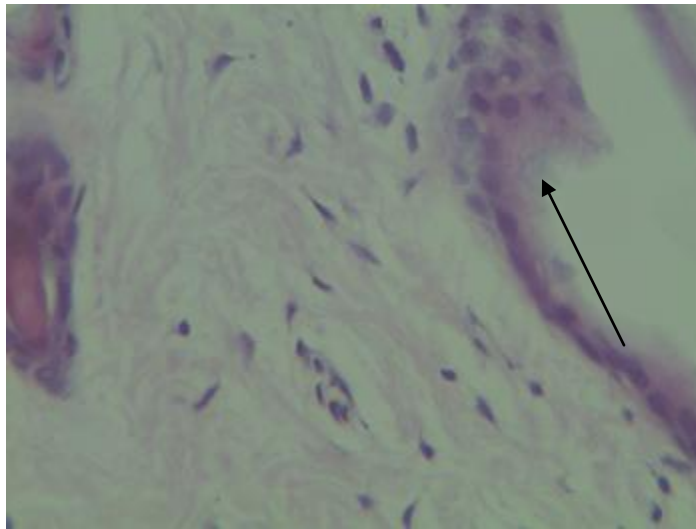


Fig. 14b necrosis of stratum corneum×40 from tick positive lesion

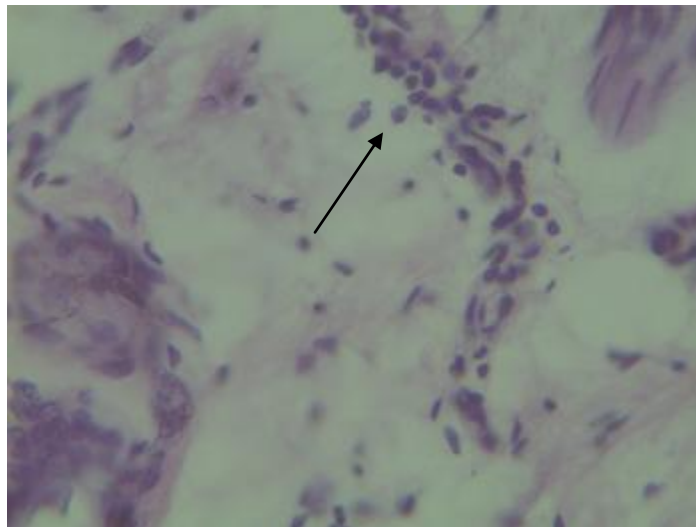


Fig. 14c lymphocytic infiltration×40 from flea positive lesion

#### 4.2.4. Microscopic lesion due to pox infection

Histopathological study in the case of sheep and goat pox revealed changes in epidermal and dermal skin layers that include: acanthosis, parakeratosis and hyperkeratosis (Figures, 15a, 15c) with degeneration of proliferating epithelial cells. The dermis showed congestion (Figure, 15b) and vasculitis, infiltration of inflammatory cells such as macrophages, fibroblasts and histiocytes, Initial epithelial hyperplasia (Figures, 15c) was followed by coagulation necrosis as thrombi developed in the blood vessels supplying some papular lesions. The dermis showed infiltration of macrophages, fibroblasts, necrosis, and debris and micro pus formation (Figures, 15d).

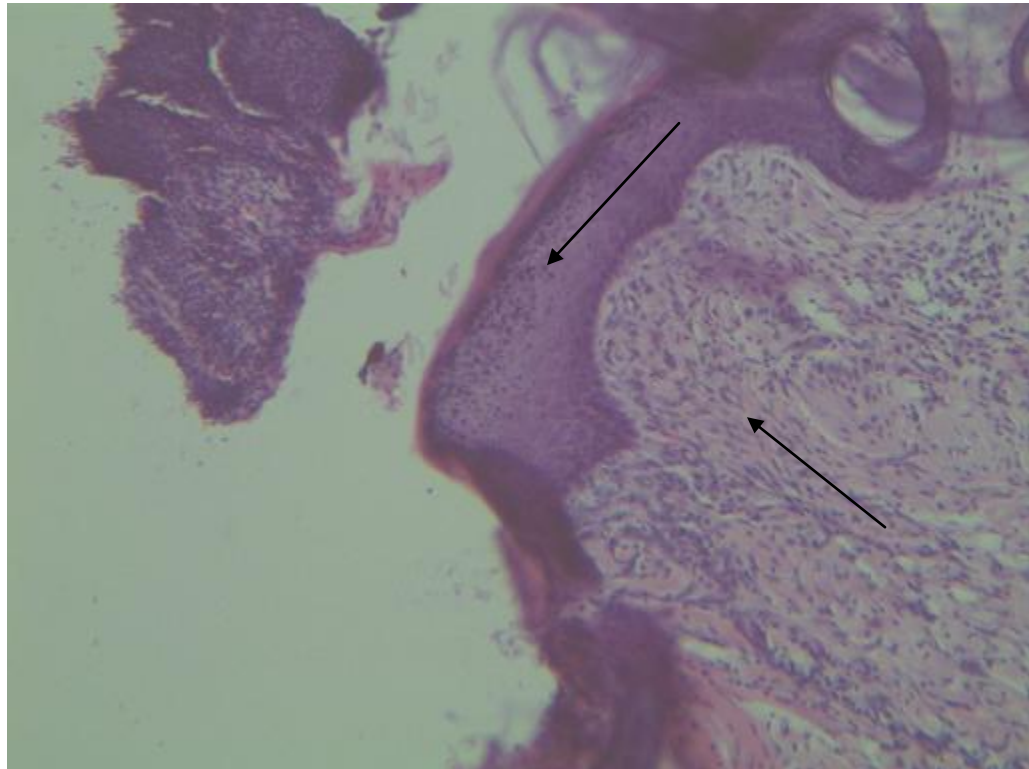


Fig.15a acanthosis and fibrosis from pox positive lesion

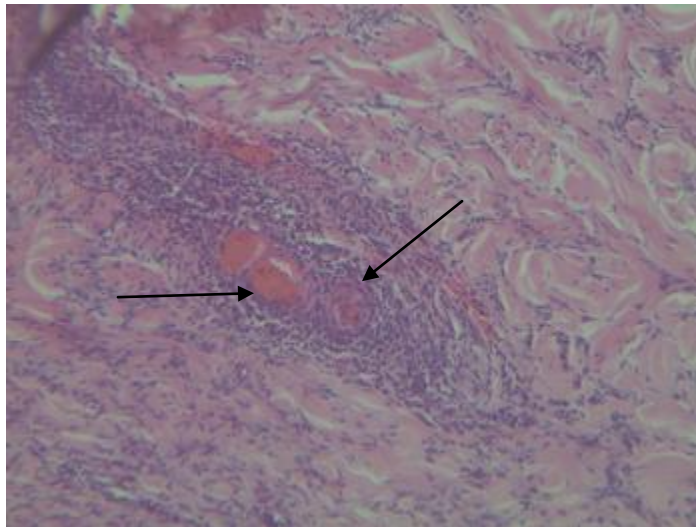
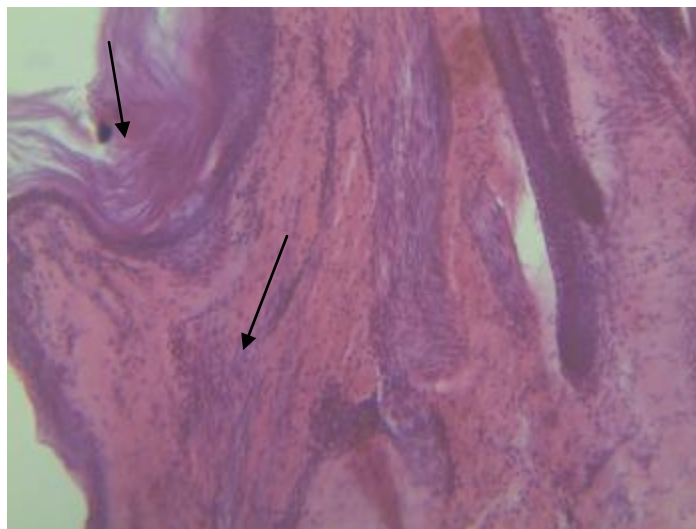
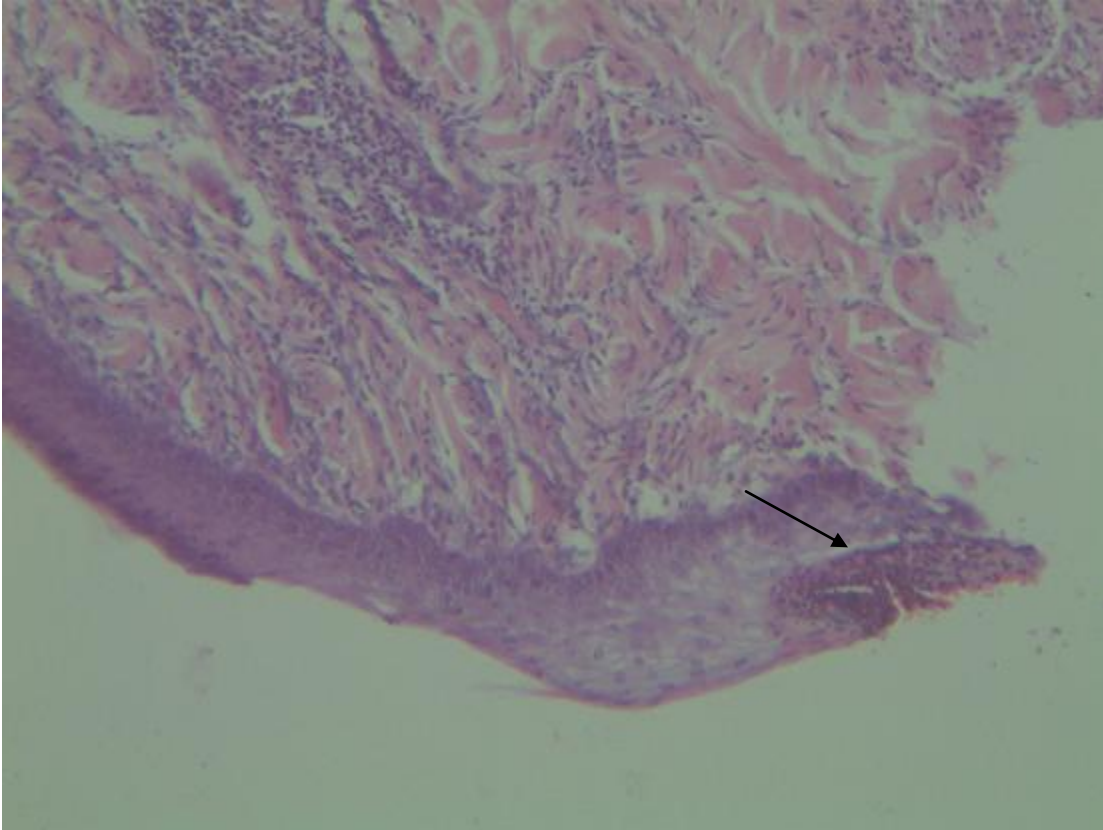


Fig. 15b congestion and perivascular infiltration with Lymphocytes from pox positive lesion



**Fig, 15c hyperkeratosis and tissue proliferation from Pox positive lesion**



**Fig.15d abscessed epidermis from pox positive lesion**

### **4.3. Quality grading and skin defect analysis**

In the present study 40 skins of sheep and goats from both positive and apparently negative group were processed until crust stage to observe all possible defects according to Ethiopian Quality and Standard Authority. Accordingly all skins were subjected to complete visual examination on the crust stage and 50% of them were categorized rejected, 15.4% categorized as grade 6, 19.2% grade 5, and 11.5% as grades 1-4 category. The causes of defect were diagnosed as skin diseases such as sheep and goat pox. Skin defect caused by lice, keds, ticks and mange mites; are also among the major diseases of small ruminants responsible for skin rejections.

Leather grain appearance of most of the various skins with diseases indicated roughness, unsightliness, depressions, fibrosis, pin point diffuse mass and holes. These leathers were graded mostly as rejected. Ultimately, the smoothness of the grain surface is especially required in the case of leather made from skins goats. Leather grain appearance of most of the various skins with diseases indicated roughness, unsightliness, depressions and holes and these leathers were graded as rejects. The aesthetic quality of leather depends to a great extent on the fine, smooth, outer or grain surface, which is exposed once the tanner removes the epidermis and hairs by means of chemicals during the early stages of processing. The most common defect observed was associated with lice and sheep ked parasitic infestation. In relation with sheep and goats pox lesion when scabs are removed, a star shaped scar, free of hair or wool remains. After tanning process, the lesions become more prominent in form of white spots on the skin. Tick bites directly damage to the skin at the site of attachment. This affected the quality of leather produced (its grain and suede). After wet blue, these areas stand raised and rough against the uniformly smooth areas reflecting the normal skin. In finished leather these lesions appear as dull patches on the shiny normal skin which is characterized by circular patches on the leather. The damage is permanent even if the infection is clinically cured on animal. If the infection is still active when the animal was slaughtered, then the damage was very pronounced with severe distortion of the grain surface and follicle mouths. Once the infection has cleared, the damage is less severe, but still very noticeable on the surface of the leather. Because

of the alteration in the skin surface, the damage appears as shiny patches on dull leather or dull patches on shiny leather.

## 5. DISCUSSION

The objective of the present study was to characterize both gross and microscopic lesions as well as to appreciate the magnitude of sheep and goat skin damage at tanneries and the impact of defect on their grades. The distribution of gross lesion varies in wide ranges and categories of grades and manner of the rejection were associated. The lesions of the various skin diseases described in this investigation had adverse aesthetic and physical effects on their leathers and similar result was observed by Gbolagunte and Hambolu (2006), Tancous *et al.* (1959), who asserted that a number of skin diseases in small ruminants are characterized by skin conditions that would persist in the finished leather and then lower its value. The combined effect sheep ked and tick infestation for instance, induces hyperkeratosis, necrosis of stratum corium and prickle cells degeneration usually, leaves behind pitted grain appearance in the leather despite the fact that much of the keratinous materials are removed during processing. In severe cases with ulceration, there would be holes in the skin. Healing of such lesions is often by scar formation which may be visible in the leather (Tancous *et al.* 1993).

It was identified that the dermis in very cases is infiltrated with inflammatory cells mainly lymphocytes and eosinophils. These could be enough to separate the collagen of the dermis thereby resulting in fiber disorganization (Njoku and Alafiatayo 1984) and similar lesion was observed in this study. Oduye (1976), also made similar observations in cattle, characterized by hyperkeratosis, parakeratosis and neutrophilic infiltrations. In the sheep where pediculosis was diagnosed, the observed layer of scab and dermal inflammation, were characteristic of allergic type dermatitis reactions resulting from salivary secretions of allergens and/or toxins (Schwartzman and Kral 1967). The purulent exudates within the hair follicles in this study agreed with the description by Nesbitt and Schmitz (1977). Generally, the crust leathers from infested skins in this investigation, were unsightly, hard and fibrosed, with many tunnellings. The grain surfaces were coarse and rough. Numerous holes appeared on them. These observations were in agreement with

those of previous workers (Knew 1952; Dempsey 1954; Green 1956, 1957, 1959; Ibrahim and Abu-Samra 1988).

The leather from skin infested with ectoparasites in this study was characterized by spots (either circular or dented, pin point, rough, nodule, fissuring) as well as with hardness of the surfaces especially the areas of the rims around the spots. The leathers of animals with alopecia shared these characteristics with special nature of large circular area of hard surface and cracked skin too and this was in agreement with the work of Tancous (1993) who referred such lesions as "pits" generally, however, according to Haines (1978), On histological sections, epidermal lesion such as hyperkeratosis, parakeratosis, congestion and diffuse dermatitis characterize skin lesions caused by lice. The damages done by biting and sucking lice are often eliminated by grain correction during the process of leather manufacture. The leather whose depressions looked like scratches was a consequence of the animal's effort to get relief from irritations by frequent rubbing of the body against an object as also explained by Tancous (1993).

Parasitic infestation resulting in alopecia, a description similar to our observation. On histological sections, epidermal lesion such as hyperkeratosis and diffuse dermatitis characterize skin lesions caused by lice and was agreed with Halligan and Johnstone (1992) who described excess collagen fiber deposition in the dermis due to lice infestation similar with the present findings the puparial and adult sheep keds were detected on the chest, forequarters, and rib region with few on the back or abdomen of sheep. Sheep keds were observed to cause severe skin lesions in this study which was agreed with Wall and Shearer (1997). Various types of dermal pathologies varied from follicular lesions to perivascular and/or diffuse dermatitis was described in other studies.

Microscopically; tick bites have caused necrotic lesions in the epidermis and dermis at the attachment sites and parakeratosis and hyperkeratosis with prickle cell degeneration. Moreover, perivascular to diffuse dermatitis consisting of

eosinophils, macrophages, and lymphocytes were recognized in which the inflammatory cells were interspersed between collagen fibers and lymphoid follicles formed in the dermis. Sheep keds and lice causes a rash called cockle on the skin, which is the principal cause of skin rejection at tanneries and this was in agreement with work of Sertse and Wossene (2007). Animals exhibited grain surfaces described pitted by Haines (1983) in this study. There was marked reduction in the aesthetic appeal and cutting areas of the prepared leathers. They were unsightly and fibrosed in the same manner as observed by Abu-Samra and Ibrahim (1989). The presence of nodules with holes on the crust from a goat in this study was typical of pox infected (OIE 2008).

## 6. CONCLUSION AND RECOMMENDATIONS

This study has revealed that among the skins studied and available for tanning, various forms of skin lesions caused by ectoparasites and other diseases reduced grade of leathers and led to rejection. Effects of the disease and defects were seen on the grain of the afflicted leathers and this caused economic losses. The costs of processing skins that would be rejected later added extra costs to tanneries.

Based on the above conclusions the following recommendations were forwarded:

- Effective and modern animal husbandry (with adequate prophylactic measures) will be the panacea to the nagging problem of Ethiopian declining hides and skins quality in the world market.
- Effective parasitic control should be implemented considering the prevalence of lesion and important parasites.
- Skill and knowledge in the area of raw skin selection and detection of defect in processed skin in relation with causal factors should be capacitated.
- Appropriate and well organized data gathering concerning gross and microscopic alterations of skin in relation with defect analysis and
- A consequence of quality deterioration of defective skins and its rejection as well as adverse cumulative effect on the national export income should be assessed.

## 7. REFERENCES

- Abadi Y, Merkel, R.C., Abebe G. and Goetsch A.L. (2000): Current problems of the leather industry; In: (Eds.): The Opportunities and Challenges of Enhancing Goat Production in East Africa: Proceedings of a conference held at Debub University, Awassa, Ethiopia from November 10 to 12, 2000. E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK pp. 139- 143.
- Abu-Samra, M.T. and Ibrahim, K.E.E. (1989): Bovine cutaneous Streptothricosis and demodecosis: Studies on the defects and economic losses on crust leather resulting from damage caused by these diseases. *Journal of the Society of Leather Technologists and Chemists* **73**: 74-87.
- Adamu S. (1997): Regional supply and tannery purchase of raw hide and skins: Ministry of Agriculture (MOA), Department of Animal Production Team, and 1997 Annual Report. Addis Ababa, Ethiopia.
- Amsalu D., Bewket S., Kassa T., Tefera T., Gezahgne M., Dagne M., Shihun S. (2000): Mange: A disease of growing threat for the production of small ruminants in Amhara National Regional State. The opportunities and challenges of enhancing goat production in Ethiopia, November 10–12
- Arunga R. (1995): The role of hide skins, leather and leather products for sustainable economic growth: Proceedings of a Regional Workshop, July 28-30, 2010, Addis Ababa, Ethiopia.
- Asnake F., Yacob Hailu Tolossa., Hagos A. (2013): Ectoparasites of Small Ruminants in Three Agro-Ecological Districts of Southern Ethiopia: *Afr. J. Basic Appl. Sci.* **5(1)**:47-54.

- Asp J., Tauni M. (1988): Skin diseases on Ethiopian sheep and their effect on the pickled skin. Swedish University of Agricultural Association, **87**, 39–51.
- Ayele SW., Assegid MA., Jabbar MM., Belachew H. (2003): Livestock marketing in Ethiopia: A review of structure, performance and developing initiatives, working paper No. **52**, Addis Ababa, Ethiopia, pp: 1-4.
- Ayele S., Asegid., W., Abera., M.A., Ahmed., M.M., and Belachew, H. (2003): Livestock marketing in Ethiopia. A review of structure, performance and development initiatives. Socio economic and policy research work paper. Nairobi Kenya, 52:121.
- Babiuk ST., Bowden R., Parkyn G., Dalman B, and Hoa, Boyle DB. (2009): Yemen and Vietnam capripoxviruses demonstrate a distinct host preference for goats compared with sheep. *J.Gen. Virol.* **90(1)**: 105-114.
- Balinsky CA., Delhon G., Afonso CL., Risatti., Borca GR., MV French., RA Tulman., ER Geary., SJ and Rock DL. (2007): Sheep pox virus kelch-like gene SPPV-019 affects virus virulence. *J. Gen. Virol.* **81(20)**: 11392-11401.
- Bayou K. (1998): Overview of Sheep and Goat Skin Diseases, Treatment Trial for Improved Quality of Hides and Skins. Addis Ababa, Ethiopia. (Phase II), pp: 13-20.
- Beard PM., Sugar S., Bazarragcha E., Gerelmaa U., Tserendorj S., and Tuppurainen E. (2009): A description of two outbreaks of Capri poxvirus disease in Mongolia. *Vet. Microbiol.* **142(3-4)**:427-431.
- Belachew H. (2004): Livestock marketing and animal health in Ethiopia. Paper presented at the 18 annual conference of the Ethiopian Veterinary Association. 9-10 June (2004). Addis Ababa, Ethiopia.

- Berhanu G., Hoekstra D., Samson J. (2007): Heading towards commercialization. Blackwell scientific publication, Oxford, pp: 1-3.
- Berhanu W., Negussie H., Alemu S., and Mazengia H. (2011): Assessment on major factors that cause skin rejection at Modjo export tannery, Ethiopia, *Tropical Animal Health and Production* **43 (5)**, 989–993.
- CSA (2008). Central Statistical Authority Sample enumeration report on livestock and farm **7(5): Implement**, Addis Abeba, Ethiopia, **7(5):** pp: 26-136.
- Degume W. (2002): Production and Marketing Problem of AMALGMA. In: Parenti, A. (ed.) *Proceedings of Challenges and Solutions for Ethiopian Leather Industry*; 10 December 2002, UNIDO, Addis Ababa.
- Dessie S., Hailu D., Dereje B. (2010): Epidemiological study of small ruminant mange mites in three agro-ecological zones of Wolaita, Southern Ethiopia. *Ethiop. Vet. J.* **14 (1)**, 31-38.
- Ejila A., Dashe, B.B., Gbolagunte, G.D, and Mshelwala A.S. (1992): The potential of the development of the hides and skins industry in Nigeria: *Proceedings of the Workshop on Proposed Livestock Sub-Sector Review*. Jos, Plateau State, Nigeria, April, pp.132-45.
- Enquebaher K., Etsay K. (2010): Epidemiological study on manage mite, lice and sheep keds of small ruminants in tigray region, northern Ethiopia. *Vet. J.* **14 (2)**, 51-65.
- Ermias Y. (2000): A study on ectoparasites of fresh poor Sheep pelts and assessment of pickled skin defects processed at Sebeta tannery, DVM thesis, Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia.
- ESGPIP (2010): [The Ethiopia Sheep and Goat Productivity Improvement Program]; Control of external parasite of sheep and goat Ethiopian Society of Animal Production (ESAP). Technical bulletin, **41: 2- 11**

- ESGPIP (2009): Common defects of sheep and Goat skins in Ethiopia and their causes in Ethiopian Sheep and Goat Productivity Improvement Program. Technical Bulletin, **19**: 100-129.
- Etagegnehu D. (1992): Constraints to sheep production: A case control study of the Cheffey State farm, South Wollo, northeastern Ethiopia: DVM Thesis, Addis Ababa University, and FVM. Debre Zeit, Ethiopia.
- FAO (2008): Constraints and opportunities in the hides and skins value chain in pastoral areas of northern Kenya F O Wayua and A Kagunyu, Kenya Agricultural Research Institute, National Arid Lands Research Centre, Nairobi, Kenya.
- FAO (1993): The causes of parasitic skin disease in sheep. Ethiopian veterinary researchers and FA technical cooperation project (TCP), Rome, Italy, and pp: 45
- FAO (2005): Ethiopia FAO's Information system on water and agriculture. [Http/ www Fao.org.Rome](http://www.Fao.org.Rome). Italy.
- Gbolagunte G.D. and Hambolu. J.O. (2006): Effects of skin diseases on physical quality of leather from small ruminants in Nigeria: *Peer Reviewed Proceedings of bimonthly Seminars of Materials Science and Engineering Society, Zaria Chapter, Nigeria, ISBN 978-060-609-21*, pp.53-67.
- Getachew T. (1995): Parasites of small Ruminants, In: Gray, G. D. And Uilenberg, G, (eds.) Parasitological Research in Africa.
- Haffize M. (2001): 'Study on skin diseases of small ruminants in central Ethiopia', DVM thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debre Zeit, Ethiopia.

- Hailu W. (2010): Study on the prevalence of major ectoparasites of sheep and assess the major risk factors in Arsi zone of Oromia regional state and evaluate the in vitro and in vivo acaricidal efficacy of seven medicinal plants against lice in naturally infested sheep: MSc thesis, Addis Ababa University, FVM.
- Halligan G., Johnstone, A. C. (1992): Histology of cockle lesions on New Zealand lambskins. *Journal of American Leather Chemistry*.
- Heath A.C.G., Cooper, S.M., Cole, D. J. W. and Bishop, D. M. (1995b): Evidence for the Role of Sheep Biting Lice (*Bovicola ovis*) in producing Cockle, a Sheep pelt Defect. *Veterinary Parasitology*, **59**, 53 – 58.
- Henderson DC. (1991): The Veterinary book for Sheep Farmers. Farming press books, UK.
- HT, Nesanet B, Dinka A (2008a): Prevalence of major skin diseases in cattle, sheep and goats at Adama Veterinary Clinic, Oromia regional state, Ethiopia. *Rev. Med. Vet.* **159**, 455-461.
- Isitor G.N., and Gbolagunte, G. (1987): Fine structural features of dermatophilosis-infected bovine hides, and their implications in the quality of leather. *Journal of the American Leather Chemists Association* 82(11): 351-9.
- Janson R., Swanon. (1996): Histological structure of dermis of the skin, cross sectional view, Pp.45-55.
- Jones T.C., Hunt, R.D., and King, N.W. (1997): *Veterinary pathology*; 6<sup>th</sup> eds. Lippincott Williams and Wilkins, Baltimore, Maryland, (Livestock Insects), Stonefly Publishing, Texas, pp. 111.
- Kassa B. (1998): Control of Sheep and Goat Skin Diseases. In: By Ian, B.C. and Bayou, B. (eds.) *Proceedings of Control of Sheep and Goat Skin Diseases for Improved Quality of Hides and Skin*, 13-14 Feb, 1998, FAO, Addis Ababa.

- Kassa B. (2006): ‘Cockle, mange and pox: Major threats to the leather industry in Ethiopia. Ethiopian leather industry: Perseverance towards value addition, *Proceedings of the National Workshop*, Addis Ababa, Ethiopia, December 14–15, pp. 71–92.
- Kassa B. (2005): Pre-slaughter defects of hides/skin and intervention options in east Africa: Workshop, Addis Ababa, Ethiopia: Harnessing the leather industry to benefit the Regional Workshop Proceedings.
- Kedir M. (2000). Study on mange mite infestations in small ruminants and camel in to selected Agro climatic zones in Tigray, Northern Ethiopia: DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.
- Kumsa B, Beyecha K., Geloye M. (2012): Ectoparasites of sheep in three agro-ecological zones in central Oromia, Ethiopia, *Onderstepoort J. Vet. Res.* **79(1)**; 1-7.
- Lowe J. (1998): Heamatoxyline and eosin techniques.
- Marples J. (1969): The normal flora of the human skin. *British Journal of Dermatology* **81**: Supplement 1, 1.
- Mesfin S. (2005): Standard Veterinary Laboratory Diagnostic Manual, Virology volume I, Ethiopia Agricultural Research Organization National Animal Health Research Centre, Sebeta, Ethiopia.
- Mahmud A. (2000): Development potential and constraints of hides and skins marketing in Ethiopia. In: R.C. Merkel, G. Abebe and A.L. Goetsch (Eds.). The Opportunities and Challenges of Enhancing Goat Production in East Africa. Proceedings of a conference held at Debub University, Awassa, Ethiopia from November 10 to 12, 2000. E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK pp. 127-138.

- MoARD (2008): Ministry of Agriculture and Rural Development; The effect of Hide and skin quality on Domestic and export markets and evaluation of the campaign against Ectoparasites of small ruminants in Amhara, Tigray and Afar Regions, official report to Regions and other sectors, *Tropical Animal Health and Production*, **42**: 1219-Addis Ababa, Ethiopia.
- Mohammed M. (2000): Raw hides and skin improvement in Ethiopia Status and Challenges. In: Proceedings of the opportunities and Challenges of Goat Production in East Africa, A Conference held 10-12 Nov, 2000 at Debu University, Awassa, Ethiopia.
- MORAD (2010): Sheep pox diseases out breaks report; Ministry of Agriculture and Rural Development (MORAD), Addis Ababa, Ethiopia.
- Muller GH, *et al.* Muller. (2001): Parasitic Skin Disease; *Small Animal Dermatology*, 6th ed. USA; Elsevier Health Sciences.
- Muller G.H. and Kirk, R.W. (1969): Small Animal Dermatology: W.B. Saunders Company, Philadelphia, PA, USA, p. 482.
- Mulugeta Y., Yacob HT and Hagos A. (2010): Ectoparasites of small ruminants in three agro-ecological sites of Tigray Region, Ethiopia. *Trop. Anim. Health. Prod.* 42:1219-1224.
- Nesbitt G.H. and Schmitz, J.A. (1977): Chronic bacteria dermatitis an otitis: A review of 195 cases; *Jourrial of American Animal Hospital Association* 13: 442-50.
- Nigatu K. (1992): Preliminary survey of mange mites of sheep and cattle in and around Addis Ababa; DVM Thesis, Addis Ababa University, FVM. Debre Zeit, Ethiopia.

- Njoku C.O. and Alafiatayo, Ruth A. (1984): Comparative pathology of the main bovine skin diseases in Nigeria; Proceedings of the First National Conference on Diseases of Ruminants, Vom, Plateau State, Nigeria. pp. 369-76.
- Numery A. (2001): Prevalence and effect of ectoparasites in goats and fresh goat pelts and assessment of wet-blue skin defects at Kombolcha tannery. South Wollo Northestern Ethiopia, DVM Thesis, AAU, FVM, Debre Zeit.
- OIE (2008): Sheep and goat pox. In: Terrestrial Animal Health Code; World Organization for Animal Health, Paris, France.
- Ozmen O., Kale M., Haligur M and Yavru S. (2009): Pathological, serological, and virological findings in sheep infected simultaneously with Bluetongue, Peste-des-petits-ruminants, and Sheep pox viruses. *Trop. Anim. Health Prod.* **41(6)**: 951-958.
- Pangui L. J. (1994): Mange in Domestic Animals and Methods of Control. *Rev. Sci. Tech.*
- Pascoe, R.R. (1990): A Colour Atlas of Equine Dermatology; Wolfe Publishing Ltd., Ipswich, England, UK.
- Percival G.H.; Montgomery, G.L.; and Dodds, T.C. (1962): Atlas of Histopathology of the Skin. E. & S. Livingstone Ltd., Edinburgh and London, UK, p. 291.
- Peter G. (1995): Parasites and Skin Diseases. J. A. Allen & Company Limited, London.
- Raga T. (2003): Clothing and footwear in the African industrialization; In Theo van der, L. (Ed.), Institute of Social Studies (ISS), Netherlands, 1/2003: The Case of Ethiopia. Addis Ababa, Ethiopia, pp: 1-5.
- Schwartzman R.M. and Kral, F. (1967): Atlas of Canine and Feline Dermatoses; Lea and Ebiger, Philadelphia, PA, USA.

- Senthilkumar V, Thirunavukkarasu M, and Kathiravan G. (2006): Survival time in sheep affected by sheep pox and enterotoxaemia. *J.Anim. Vet. Adv.*, **5(8)**: 647-650.
- Serste T, Wossene A. (2007): ‘A study on ectoparasites of sheep and goats in eastern part of Amhara region, northeast Ethiopia’. *Small Ruminant Research* **69 (1)** 62–67.
- Sewell M. and Brockes D. W. (1990): *Hand Book on Animal Disease in the*  
Shibeshi B, Bogale B, Chanie M (2013): Ectoparasite of Small Ruminants in Guto-Gidda District, East Wollega, Western Ethiopiam, *Acta Parasitologica Globalis* **4 (3)**:86-91.
- Shoshani J. (1994): Skeletal and other basic anatomical features of elephants. In: *Proboscidea: Evolution and paleaeoecology of elephants and their relatives*. Shoshani, J. & Tassy, P. (eds). Oxford University Press.
- Small R.W. (2005): A review of *Melophagus ovinus* (L.): the sheep ked. *Veterinary parasitology*, 130:141–155.
- Smith M. C. and Sherman, D. M. (1994): *Goat Medicine*, Williams and Wilkins, Maryland, pp. 17 – 47.
- Tancous J.J. (1993): Hides and Skins under the microscope; *Leather* 1993: 44-6, May. Tuck, D.H. 1981. *The Manufacture of Upper Leathers*, Tropical Products Institute, London, UK, pp. 34-59.
- Taylor M.A. Coop, R.L. and Wall R.L., (2007): *Veterinary parasitology*, **3rd** edition by Black well publishing Ltd., UK. University, Ethiopia.

- Tefera S, Abebe W. (2007): Effect of ectoparasites on quality of pickled skins and their impact on the tanning industries in Amhara regional state, Ethiopia. *Small Ruminant Research*, 69 (1-3), 55-61.
- Tembely S. (1998): Small ruminant production in Ethiopia: Prospects for improving productivity, in 5th National conference of Ethiopian Society of Animal Production, Addis Ababa, Ethiopia. 82-90.
- Teshome W. (2002): Study on skin diseases of small ruminant in sidama zone, Southern Ethiopia: DVM Thesis, Addis Ababa University, Debre Zeit.
- Tewodros F, Fasil W., Mersha C., Malede B. (2012): Prevalence of Ectoparasites on Small Ruminants in and Around Gondar Town. *American-Eurasian J. Sci. Res.* 7 (3): 106-111, 2012.
- Thrusfield M.V. (2005): *Veterinary Epidemiology*, 3<sup>ed</sup>. Blackwell science, rd oxford, and pp: 234-238.
- Wall, R. and Shearer, D. (1997): *Veterinary Entomology*, 1<sup>ed</sup>. Chapman and Hall, UK, pp.
- Yacob HT, Yalew TA, Dinka AA. (2008b): Ectoparasite prevalence's in sheep and goats in and around Wolita Soddo, Southern Ethiopia. *Rev. Med. Vet.* 159, 450-454.
- Yacob H.T., Netsanet B. and Dinka, A. (2008): Prevalence of major skin disease in cattle, sheep and goat at Adama veterinary cilinic, Oromia regional state, Ethiopia. Addis Ababa University, Ethiopia. *Rev. Méd. Vét.*, **159**: 455-461.
- Yisehak E. (2000): A Study on Ectoparasites of Fresh Sheep Pelts and Assessment of pickled Skin Defects Processed at Sebeta Tannery; DVM thesis, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia. pp. 24.

Zelege T. (2009): Common defects of sheep and goat skins in Ethiopia and their causes. In: Ethiopia sheep and goat productivity improvement program. Technical Bulletin, 19, 1–5.

Zewdu K. (1995): Hide and skins in Ethiopia. Proceeding of the 2nd Annual Conference of the Ethiopian Society of Animal Production (ESAP): Addis Ababa, Ethiopia, May 26-27, pp: 6-14.

## 8. ANNEXES

Annex 1: Histopathological Technique:

1. **Fixation of tissue** by 10% formaldehyde

2. **Trimming tissue** to fit in to standard histological processing tissue cassettes (5mm thickness)

3. **Tissue processing:** dehydration, clearing and impregnating

❖ Dehydrating tissue by using increasing strength of alcohol; e.g. 50%, 70%, 90% and

100%. Dehydration      70% alcohol      1 hour

                                 90% alcohol I      1 hour

                                 90% alcohol II      2 hour

                                 100% alcohol I      1 hour

                                 100% alcohol II      2 hour

                                 100% alcohol III      2 hours

❖ Clearing of tissue by Xylene

                                 Xylene I      2 hours

                                 Xylene II      2 hours

❖ Impregnation tissue with Paraffin wax

                                 Paraffin wax I      1 hour

                                 Paraffin wax II      1 hour

                                 Paraffin wax III      1 hour

4. **Embedding or Blocking:** Impregnated tissues are placed in a mould with their labels and then fresh melted wax (54 - 60C<sup>o</sup>) is poured in it and allowed to settle and solidify.

5. **Section:** sectioning of tissue in to 4- 5 micron thickness and adhere on the surface of clear slide.

6. **Staining:** Automatic or manual staining with Haematoxylin and Eosin to give colour for sectioned tissue.

**Staining procedure:**

❖ Put the sections fixed on slides in xylene for 3 minutes.

- ❖ Then transfer to absolute alcohol for 3 minutes.
- ❖ Transfer to 80% alcohol for 2 minutes.
- ❖ Place in 50% alcohol for 2 minutes.
- ❖ Wash the slide in running tap water for 1 minute and put in Harris's *Haematoxylin* for 5-7 minutes.
- ❖ Wash in running tap water for 30 seconds
- ❖ Wash excess dye in 1% acid alcohol by continuous agitation for 15 seconds.
- ❖ Wash in running tap water for 30 seconds.
- ❖ 2-3 dips in ammonia water solution until tissues attain a blue colour.
- ❖ Wash in running tap water for 30 seconds.
- ❖ Counter stain with *eosin* for 3-5 minutes.
- ❖ Wash in running tap water for 30 seconds.
- ❖ Dehydrate by keeping in increasing concentration of alcohol (2-3 minutes in 50%, 70%, 95% and absolute alcohol).
- ❖ Clear it in xylene and mount with DPX or Canada balsam.

**7. Microscopic examination:** stained slide is examined under microscope.

***And the Lord God made clothes out of animal skins for Adam and his wife, Genesis 4:20***

**1. The Tanning Process**

The majority of leather (almost 90%) is tanned with chromium and is therefore commonly used as the basic format when trying to understand leather production. Other methods of tanning will have significantly different production flow although if the material to be produced is without hair, wool or scales, the preparation and isolation of the collagen in the beam house processes will remain largely similar.

**2. Preparation of the Raw Pelt for Tanning**

Tanning primarily involves the reaction of tanning chemicals with collagen; raw hides contain a number of undesirable components, which are commonly removed prior to tanning. Approximately 75% of the mass purchased as raw material is removed as polluting solid or liquid waste. Preparation of the raw pelt includes the processes from soaking to pickling.

**3. Soaking**

Soaking is usually the first process encountered in the tannery, as the previously dehydrated raw material must be carefully rehydrated before it can be subjected to extended mechanical action. Water is also the vehicle for both chemical penetration and removal, and is a necessary prerequisite for most of the processes to follow.

**4. Unhairing and Liming**

The majority of leathers produced are treated in order to remove the hair or wool to leave the characteristic pattern of the grain surface (analogous to wood grain). Conventionally, the hides or skins are treated with sodium sulphide and hydrated lime to destroy the keratinous material of the epidermis and hair or wool. Fats are hydrolysed due to the

increased pH and the skin structure swells as water is drawn into the fibre network to form a turgid, open-structured, translucent, jelly-like material.

### **5. Deliming and Bating**

Weak acids are used to lower the pH and to reduce swelling which causes the water to flush out any impurities with it. The skin becomes flaccid and is treated with proteolytic bating enzymes to clean the grain and make the pelt smooth and silky.

### **6. Pickling**

The bated pelts are finally treated with acid (commonly sulphuric and/or formic acid) to obtain the desired pH for optimal penetration of the tanning agent, and with salt, to suppress swelling when the acid is added. At this stage, the isolated collagen, termed the pickled pelt, is ready for a pretannage or main tannage.

### **7. Pretanning, Tanning and Retanning**

This includes processes from pretanning and tanning through to retaining via samming, splitting, shaving and neutralisation as a preparation for the dyehouse.

### **8. Pretanning**

The pickled pelt may be lightly tanned prior to the main tannage to improve the penetration and distribution of the tanning chemicals to follow, to add specific properties into the leather or to stabilise it for mechanical operations such as shaving.

### **9. Tanning**

The main tannage has the primary function of producing an utilisable material resistant to microbial attack. The most common chemical used in tanning are chromium tanning salts, vegetable tannins and more recently glutaraldehyde. After the tanning agent has penetrated the collagen structure and distributed satisfactorily, it must be irreversibly bound to the collagen (eg a process called basification, in which the pH is raised, is used to bind chromium and glutaraldehyde tanning agents to the collagen).

## **10. Mechanical Operations**

At some point during production, the leather is split longitudinally to yield an upper grain split and a lower flesh split of desired thickness. In the production of chromium tanned leathers, this process is most commonly performed after basification and samming. The material is then shaved to give a more accurate and even thickness depending on the requirements for the end products eg shoe upper (1.8 mm), garment (0.9 mm) or upholstery leathers (1.1 mm).

## **11. Neutralisation**

The mechanical operations generally squeeze water out of the leather, so prior to further treatment a wetting back and washing process is used to rehydrate the leather and to remove dirt, shavings or grease that may have been picked up. The majority of the chemicals still to be added to the leather are anionic in nature, whereas the tanned collagen at low pH tends to be cationic in nature. Neutralisation is a process in which the pH is raised and chemicals are added to reduce the stringency of the leather to anionic chemicals such as retanning agents, dyes and fatliquors.

## **12. Retanning**

The tanned leather is subjected to additional tannages with similar or new tanning materials. These agents may be used to lighten the colour of the leather, to produce a feeling of fullness and to aid in the penetration of dyes. The choice of pretanning, tanning and retanning chemicals is dependent on the properties desired in the final leather, and therefore, on the properties required in the final leather product.

## **13. Dyeing, Fat liquoring and Drying**

This stage includes preparing the retained material for finishing by processing through to dried crust.

#### **14. Dyeing**

Chromium tanned leather is blue in colour and must be dyed to obtain the desired colour. The dye acts as a base colour for finishing, and the depth of dye penetration and leather colour are of great importance.

#### **15. Fatliquoring**

Chromium tanned material dries out hard and crusty and is unsuitable for most purposes. Small quantities of oil, present as emulsions known as fatliquors, make a significant difference to the handle, ie the fullness, softness and flexibility, among other factors.

#### **16. Drying**

The retaining, dyeing and fatliquoring chemicals are allowed to penetrate and distribute within the collagen fibre structure before the pH is lowered and the astringency causes them to "fix" to the tanned material. The final binding of chemicals is encouraged by the drying process. Batches of leather are commonly toggle dried on frames in heated tunnels for four to six hours or are vacuum dried individually for two to ten minutes.

#### **17. Finishing**

A finish process and finishing chemical must be carefully designed and "married" with the production of the curst to ensure compatibility. The finish may be required to hide defects, to contribute to the leather beauty and properties and to provide fashion effects. Resins, pigments, dyes, handle modifiers, fillers, dullers and other chemicals are added in layers to the surface of the leather by spraying, roller-coating, curtain-coating or by hand. Heated hydraulic or roller presses are used to produce smooth or patterned leathers, depending on customer requirements. Finishing finally completes the leather manufacturing process and the area is then measured and the leather sent for dispatch to a product manufacturer to be turned into shoes, clothing or upholstery. (Halligan, 1992)

### Annex 3: quality grades characteristics

**Grade 1** Skins with good grain appearance and full of substances with two or three minor Defects outside the butt and shoulder areas which do not depreciate the quality of the skin.

**Grade 2** Skins with good grain appearance with closed minor defects possibly along belly and back and two or three similar defects randomly spread on the butt and shoulder area, this skin have a cutting value of about 90%.

**Grade 3** Skins with good grain appearance with closed minor defects possibly along belly and back and two or three similar defects randomly spread on butt and shoulder areas, this skin will have a cutting value of about 80%.

**Grade 4** Skins with a cutting value of at least 70%, major defects visible on neck portion with minor defects on butt and shoulder.

**Grade 5** Skins having at least 60% cutting value with random, minor skin blemishes all over the skin.

**Grade 6** Skins having similar defects as grade 5, but having a cutting vale of about 50%.

**Grade 7** Skins having the same grain characteristics as grade 6, but slightly poorer in substances and having cutting value of not less than 25%.

**Grade 8** Skins with empty substances with major deformation in shape and highly irregular in grain character with 10 – 25% cutting value.

**Rejects Skins:** reject the total products.

#### Annex 4: skin scraping technique for mange mites

Scrapings from mangy skin should be forwarded in dry containers sealed properly to prevent mites from crawling out. The following procedure is recommended for collection of mange scrapings:

1. Select an area where the skin lesions are most marked. In cases of very light infection, the area where the animal likes being scratched is likely to yield the most suitable material for examination
2. Clip the hair from the selected area and moisten it with 10% solution of caustic potash or even plain water.
3. Scrape the area with a blunt knife. A sharp scalpel should not be used, for it may cut the skin.
4. Collect all loose scabs, scurf, hair etc. in a large test-tube. The scraping should be continued until blood oozes from the scraped area as it is only when this stage is reached that the area is likely to yield samples of the different forms of mites harboured by it. Each time a little quantity of blood collects on the scalpel, lightly scrape an adjacent area with it to cover up the blood with scurf and loose hair.
5. Wipe the scalpel against the inner rim of the tube and then detach the adherent mass with the knife to make it drop down into the tube. The blood will thus be prevented from adhering to the knife or to the mouth of the tube.
6. Scrapings at least sufficient in quantity to cover a rupee coin should be collected from all cases suspected for mange. Negative findings are sometimes due to insufficient or only superficial scrapings having been examined for the presence of mites under stereo microscope.