Review Article

Review on Pasteurellosis: Causes, Pathogenesis, Diagnosis and Current Status in Ethiopia

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Abstract

Infectious diseases are one of the key constraints like pneumonic pasteurellosis is most recurrent respiratory infections that affect ruminants. This disease is caused by transportation stress, bacteria, viruses and climatic changes. A variety of etiologic agent form this multi-factorial disease such as Pasteurella multocida (*P. multocida*) (*P. multocida gallicida, P. multocida multocida)* and *P. multocida septica*. may also be divided into five capsular serogroups (A-E) and sixteen somatic serotypes [1-16]. *Mannheimia haemolytica* (*M. haemolytica)* formerly named *P. haemolytica* has two biotypes A and T depending on arabinose and trehalose fermentation. The colonies produced by *M. haemolytica* are odorless, moist, smooth, grayish, and translucent measuring approximately 1-3mm in diameter on blood agar plates while the colonies of *P. multocida* are round, grayish, shiny and non-haemolytic. Pneumonic pasteurellosis diagnosis is based on the clinical symptoms, necropsy, and bacteria isolation, Biolog, molecular and by the recent developed bacterial diagnostic technique called Matrix-Assisted-Laser-Desorption/Ionization-Time-of-Flight Mass Spectrometry (MALDI TOF MS), a fast, reliable and cost-effective method. Pasteurellosis is complex multifactorial disease and difficult to control but good management and prevention is advisable.

Keywords: *Mannheimia haemolytica; Pasteurella multocida;* Pasteurellosis; Diagnosis.

Introduction

Livestock have been domesticated for their meat and milk all over the world. Ethiopia boasts Africa's largest national livestock population [20]. However, due to a various technical, financial and health issues, production of livestock resource is marginalized in Africa. Infectious diseases are one of the health elements that have an impact on animal output [36]. Pneumonic pasteurellosis is one of the most common respiratory diseases that affect ruminant. *Pasteurella sp.* are gram negative rods or coccobacilli, non-motile, non-spore forming, facultative anaerobic, oxidase and catalase positive, bipolar bacteria that belong to the family *Pasteurellaceae* [53]. A variety of etiologic agents create this multi-factorial disease of pasteurellosis which is caused by the bacteria Mannheimia haemolytica *(M. haemolytica) and* Pasteurella multocida *(P. multocida)* [46].

M. haemolytica and *Pasteurella P. multocida* are commensal bacteria found in the tonsils and nasopharynx of healthy animals [1]. Many are identified as opportunistic or primary infections in animals. Transmission of agents occurs by inhalation of infected droplet, coughed up or exhaled from infected animals, carriers in which the infection persists in the upper respiratory tract [35]. The disease is caused by transportation stress, bacteria, viruses and climatic changes. Pneumonic pasteurellosis diagnosis is based on the clinical signs, postmortem lesions, isolation and molecular characterization of the bacteria and by currently emerged bacterial and fungi diagnostic method Matrix-Assisted Laser Desorption/Ionization Time-of-Flight Mass Spectrometry (MALDI TOF MS) is a reliable alternative to detect bacteria and fungi Protein [69].

The method is based on analysis of bacterial proteins, mainly ribosomal which are particularly abundant in the bacterial cells [19]. MALDI-TOF MS represents a universal, fast and cost-effective and it is an open system that can be complemented with own reference data. A various genera and species of *Pasteurellaceae* was analyzed by MALDI-TOF MS [38]. Pasteurellosis is complex multifactorial disease and difficult to control but good management, control and preventive measures are desirable [63].

In recent years MALDI-TOF MS has revolutionized routine identification of bacteria diagnosis in many countries. However, in Ethiopia this Rapid and reliable machine (MALDI TOF) was

not available before 2020 years and up to date, there is no report on the use of MALDI TOF mass spectrometry diagnosis of Pasteurellosis.

Therefore, this review is aimed to make inclusive overview of causes, pathogenesis, and diagnosis of *Pasteurellosis,* disease with MALDI-TOF MS and other methods and its status in Ethiopia.

Etiology of Pasteurellosis

The *Mannheimia* and *Pasteurella* are small, non-motile, non-spore forming, gram- negative rods or coccobacilli and facultative anaerobic bacteria that belong to the family *Pasteurellaceae.* They are oxidase and catalase positive and reduce nitrates and carbohydrates fermentatively and Bipolarity of *Pasteurella* and *Mannheimia* can be seen in Giemsa-stained smears [47]. There are several species of *P. multocida* and *M. haemolytica are* most clinically relevant to animals. *P.multocida* is divided into three different subspecies: P.multocida gallicida, P. multocida multocida, and P. multocida septica. *P.multocida* subspecies may also be divided into five capsular serogroups (A-E) and sixteen somatic serotypes [1-16]. B2 and E2 cause hemorrhagic septicemia in addition to the possible pneumonia, enteritis, or septicemia caused by the remainder of the capsular serogroups and somatic serotypes [48]. *M. haemolytica* formerly named (*P. haemolytica)* has two biotypes A and T depending on arabinose and trehalose fermentation. Biotype A is further subdivided into 13 serotypes *(A1, A2, A5, A6, A7, A8, A9, A11, A12, A13, A14, A16 and A17)* that cause pneumonic pasteurellosis (shiping fever) in cattle, sheep and goats (Table 1). *P. haemolytica* is carried in the nasopharynx and tonsils of apparently healthy sheep and goat. Lambs acquire infection soon after birth, presumably by contact [34]. The carriage rate is low in normal healthy flocks and an assortment of serotypes is present. In flocks suffering by outbreaks, the carriage rate is high, and a few specific serotypes dominate. Thus, a high carriage rate is indicative of prevalent infection in the vicinity. This carriage status has been found to display seasonal variations [10].

Taxonomy and Classification

The *Mannheimia* and *Pasteurella* are grouped taxonomically under

Super kingdom	*Bacteria*
Phylum	*Proteobacteria*
Class	*Gammaproteobacteria*
Order	*Pasteurellales*
Family	*Pasteurellaceae*
Genera	*Mannheimia* and *Pasteurella*
Species	*M. hemmolytica* and *Pasteurella multicoca*

Source.

Based on number of characteristics including pathogenicity, antigenic nature and biochemical activity, *P. haemolytica* can be differentiated into two biotypes, biotype A and T. Biotype A ferments arabinose whereas biotype T ferments trehalose; however, based on molecular, biological techniques and analysis of phenotypic data, biotype T was reclassified as *P. trehalosi* and biotype A as *M. haemolytica* and *M. glucosida.*

Based on quantitative evaluation of phenotypic and genomic characteristics. They are classified trehalose-negative *P. haemolytica* multipart into five new species *M.haemolytica, M.glucosidal, M.ruminalis*, *M.granulomatis* and *M.varigena.* Based on extractable surface antigens, 17 serotypes of *M.haemolytica* and *P. trehalosi* are recognized. Serotype 3, 4, 10, and 15 are classified as *P. trehalosi [61]*.

Microbiological Properties

Morphology and staining characteristics: *Pasteurella and Mannheimia* appear as short ovoid rods measuring 1μm in length and 0.5-0.8μm in width and most of them are capsulated. The organisms tend to bipolar staining when stained with Giemsa staining. Old culture usually revealed Gram-negative rods of various sizes. Cells are arranged in chains and filamentous forms are occasionally observed. The bipolarity feature is lost due to continuous culturing [62]. *Mannheimia* are gram-negative rods or coccobacilli, nonmotile, non-spore-forming, facultatively anaerobic, oxidase-positive, and fermentative, and they naturally inhabit in the domestic and wild animals upper respiratory and digestive tract mucous membrane [70]. These organisms grow best on blood agar and produce a narrow zone of hemolysis, and they also grow on MacConkey agar [62].

Growth requirements: The organisms are aerobic or facultative anaerobic. The optimum temperature for growth is 37°C at pH 7.2 to 7.4. Although non enriched media support their growth, the *Pasteurella and Mannheimia* species grow best in the presence of blood. Sheep blood is used for the demonstration of hemolysis. These microorganisms grow well in medium containing amino acids, a mixture of salts, vitamins, sugars like galactose and glucose. *Mannheimia* species requires a higher concentration of iron for production of cytotoxin than is needed for growth [64].

Cultural characteristics and Biochemical characteristics: The colonies produced by *M. haemolytica* are odorless, moist, smooth, grayish, and translucent measuring approximately 1-3mm in diameter on blood agar plates while the colonies of *P. multocida* are round, grayish, shiny and non-hemolytic. Some colonies of pathogenic strains of *P. multocida* are mucoid due to the production of thick hyaluronic acid capsules. The colonies have a subtle but characteristic odor. The *M. haemolytica* grow on blood agar in the form of smaller colonies with slight thickening in the center and circular surrounded by a narrow zone of β-hemolysis. *M. haemolytica* is very distinct from *P. multocida* by their growth on MacConkey agar as pink to red colonies [31].

Table 1: Summary of common diseases caused by *Pasteurella* serotypes in animals.

Hosts	Name of the Disease	Serotypes
Cattle	Hemorrhagic septicemia (HS) Occasionally, HS like septicemia disease Bovine pneumonic pasteurellosis	*P. multocida* serotypes B2 and E2 *P. multocida* serotype B3, 4 *M. haemolytica* A1; *P multocida* A
Buffalo	HS	*P. multocida* serotypes B2 and E2
Shoats	Pneumonic pasteurellosis Septicemia pasteurellosis	*M. haemolytica* A; *B. trehalosi*
Pigs	Sporadic outbreaks of HS Atrophic rhinitis Pneumonia	*P. multocida* serotype B2 Toxigenic strains of *P multocida* type D, occasionally, type A; *P. multocida* type A
Poultry	Fowl cholera	*P. multocida* type A (type F in turkeys) and type D are less common.

Biochemical characterization of *P. multocida* strains were catalase and oxidase positive, did not have hemolytic properties, lysed in bile, did not form hydrogen sulfide, reduced nitrates to nitrites, and Voges-Proskauer reaction negative. Urea, sorbitol-positive and dulcitol-negative [49]. Although *Mannheimia* spp. have limited fermentative ability of carbohydrates, they utilize number of carbohydrates with acid production but not gas [1].

Chemical and physical properties: *Pasteurella* is not resistant to adverse agents and can easily be killed with common chemical and physical agents. Exposure of suspension to disinfectants such as to 0.5% phenol for 15 minutes, to heat at 55°C, to ultraviolet light and colonies on solid media to sun light are lethal, and are susceptible to commonly used antibiotics [9].

Virulence

Pathogenic bacteria produce virulence factors that enhance their ability to escape host defense mechanisms and increase the ability of the organisms to colonize and invade deeper tissues. Members of *Mannheimia* and *Pasteurella* spp produce several substances that are associated with the pathogenicity of these groups of microorganisms. These include the capsule that plays a great role in adherence and invasion, Outer Membrane Proteins (OMP) that are important in eliciting the protective immune response, adhesins implicated in colonization, the neuraminidase that reduces the viscosity of respiratory mucus and allows closer bacterial apposition to the cell surface [25].

Lipopolysaccharide causes immune-mediated hypersensitivity that can exacerbate inflammation and tissue damage [29] and the Leukotoxin that produces a lot of biological effects: at higher concentrations, the toxin creates pores in the cell membrane that leads to swelling and lyses [33]. The virulence factors are responsible for promoting adhesion, colonization, and proliferation of the organism which play vital role in pathogenesis [45], the alteration of the organism from commensal into a pathogenic [28].

Transmission and Pathogenesis

P. multocida and *M. haemolytica* species are highly vulnerable to environmental influences and a close contact is a main factor in the spread of the disease Particularly, when animals are closely confined in inadequately ventilated trains or held for long periods in holding pens and feed lots, the disease may spread very quickly and affect high proportion of the herd within short hours [42]. It also acquired infection through inhalation of infected nasal secretions, droplet, coughed up or exhaled from infected animals or recovered carriers in which the infection persists in the upper respiratory tract. Animals at pasture are able to move freely and the rate of spread may be slower. *P.multocida* have public health importance, humans infection is often transmitted by animal bites, scratches or licks from cats or dogs [53].

Mannheimia and *Pasteurella* play a major role as a secondary pathogen in the final progression of severe pleuropneumonias in animals. Their pathogenesis involves many predisposing agents such as bacteria, viruses, lungworms, environment changes (excessive temperature, sudden change of feed, dust) or stress associated during weaning, dehorning and shipping [47]. These factors seems to alter the upper respiratory tract epithelium allowing *M. haemolytica and Pasteurella* to colonize, escaping clearance, and to move from the nasopharynx to the lungs, leading to a broncho-alveolar type of pneumonia which is accompanied by high morbidity and mortality [13].

Mannheimia species are common commensals of the naso-pharynx in many domestic and wild animals [56]. These species can cause infection when the animals' immunity becomes compromised [6]. *M.haemolytica* induces most severe fibrinous pleuropneumonia characterized by extensive leukocyte infiltration in alveoli, intra-alveolar hemorrhage, deposition of fibrin, and consolidation of the lungs [7] (Figure 1). Pasteurellosis caused by *Mannheimia haemolytica* are transmitted from sick to healthy animals by direct contact and aerosol. Particularly, when animals are closely confined in inadequately ventilated held for long periods. These infectious disease are transferred by direct contact with body fluids (such as saliva and nasal secretions, coughed up or exhaled from infected animals or recovered carriers), contaminated feeders and troughs [70].

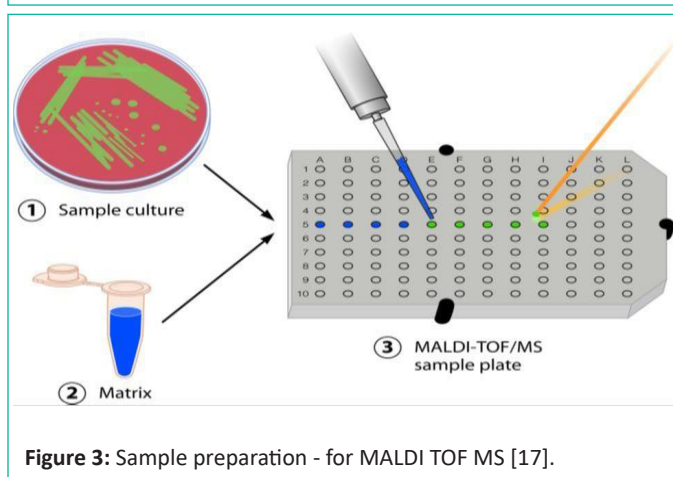### Symptomatology and Diagnostic of Pasteurellosis

Clinical Signs: Pneumonia pasteurellosis is an important disease that affect animal often appear depressed, with a muco-
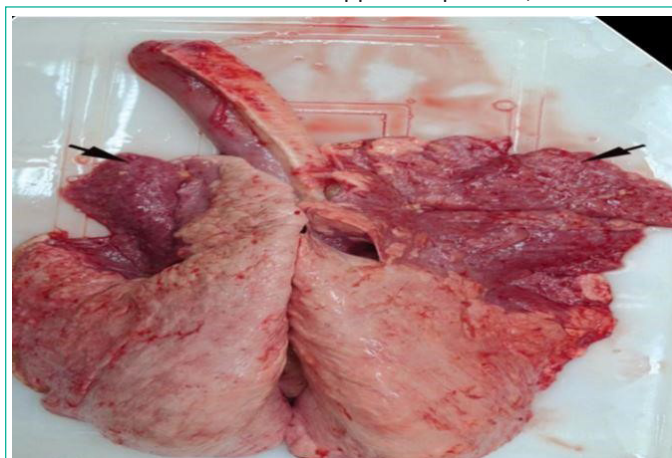
Figure 1: Dark red consolidation of cranio-ventral lobes (arrows) [8].
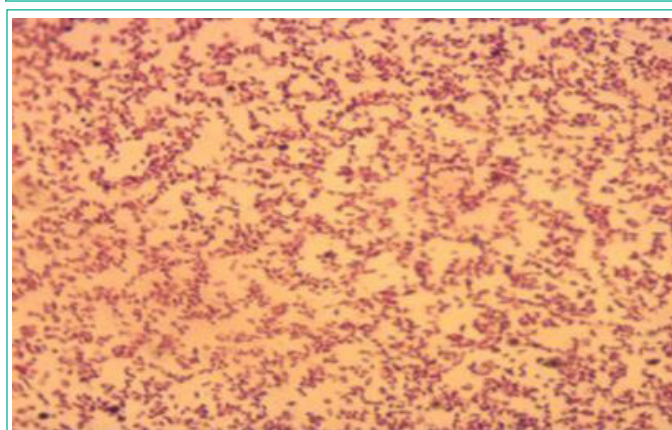
Figure 2: Gram stained isolate of *P.multocida*.

① Sample culture
② Matrix
③ MALDI-TOF/MS sample plate

Figure 3: Sample preparation - for MALDI TOF MS [17].

purulent nasal and ocular, exhibit inappetance, weight loss and temperatures rises to 40.4°C to 42°C. Most cases happen within two weeks after transportation and the development of disease can be rapid with death without showing above clinical signs of disease [66]. The most common manifestation of *P. multicoda* in humans is a local wound infection, usually following an animal bite or scratch which can develop into a serious soft tissue infection that can be further complicated by abscesses, septic arthritis and osteomyelitis also cause meningitis, ocular infections [54]. The early clinical signs are anorexia, high fever, and frothing, coughing and rapid shallow breathing accompanied by profuse mucopurulent nasal and ocular discharges. In the later stage of infection severe cough predominates where dyspnea with an exhalation grunt [18].

Differential Diagnosis: The differentiation of pasteurellosis from other respiratory diseases is based on the high mortality and rapid progression to death and in pneumonic pasteurellosis is dark red/purple areas, firm to the touch, are evident mainly in the anterior and cardiac lobes of the lung [10] and respiratory diseases which are confused with pneumonic pasteurellosis caused by *Mycoplasma* species, *Bordetella parapertussis,* and *Streptococcus zooepidemicus,* lung abscesses caused by *Staphylococcus aureus*. The differential diagnosis should also be done with the viral pneumonia caused by ovine adenovirus, and Peste des Petits Ruminants (PPR), parasitic pneumonia caused by lung worms like *Dictyocaulus filarial* , mycotic pneumonia caused by *Aspergillus* species, upper respiratory tract disease [10].

Isolation and Identification: *Pasteurella* can be isolated by culturing different sample (lung tissue or nasal swab, blood) in pre-enriched in 5ml of tryptose Soya broth specimen incubated for 24 hours at 37°C. The collected culture is streaked on to blood agar base containing 5% sheep blood and incubated aerobically at 37°C for 24 hours. Then typical colonies subjected to gram' s staining and cellular morphology under light microscope and gram negative, coccobacilli bacteria will further sub cultured on blood agar containing 5% sheep blood and MacConkey agar for isolation and characterization. Existence of hemolysis, the kind of haemolysis, the general appearance of colonies will be examined and followed by biochemical, MALDI TOF MS and molecular tests for identification and characterization of bacteria [45].

Postmortem: *P. multicoda* causes fibrino-purulent bronchopneumonia without the multifocal coagulation hemolytic necrosis, *M.haemolytica* were also characteristics of fibrinous lobar pneumonia. Pasteurellosis is manifested by the association involving the lungs, catarrhal bronchitis, bronchiolitis a fibrinous pleurisy the cut surface consists of several colors due to hemorrhage, necrosis and red and grey consolidation, coagulation necrosis of pneumonic lungs [4].

Serological Diagnosis: The presence of *P.multocida and M. haemolytica* is carried out using different serological methods. These methods consist of a rapid slide agglutination test, an (IHA) immune hemagglutination test for capsular typing, Indirect Enzyme Linked Immunosorbent Assay (I-ELISA) [2].

Molecular methods: Conventional and real time Polymerase Chain Reaction (PCR): Molecular methods of bacterial identification have been proved valuable to overcoming some limitations of the conventional biochemical and serological methods and has better sensitivity and rapidity [40]. Molecular identification is further advance accuracy of characterization in pure and/or mixed cultures, speed of detection, determination of taxonomic position, and indulgent of intra-species genetic relationships [12].

MALDI TOF mass spectrometry: based isolation method

Matrix-Assisted Laser Desorption/Ionization Time-of-Flight Mass Spectrometry (MALDI-TOF MS) has recently emerged as a powerful technique for identification of bacteria altering the workflow of well-established diagnostics laboratory [15]. MALDI-TOF MS is a useful, fast, cost-effective and accurate tool for routine laboratory diagnostic and has been used to identify bacteria. A typical consists of growth of the bacteria, pure colony and placement on a target plate, addition of matrix, and analysis with MALDI-TOF MS [26]. Matrix is a small organic molecule used to facilitate ionization process by absorption of UV light. Moreover, it is an open system that can be complemented with own reference data. The Biotyper 3.0 database from the Bruker MALDI-TOF MS system contains a few, selected representatives of the family Pasteurellaceae.

Pasteurella and M.haemolytica rapid and accurate identification from ruminants these bacteria are essential for effective prevention and treatment of infected animals. Phenotypic tests are commonly used in diagnostic laboratory to identify *P.multicoda and M.haemolytica* based on biochemical methods [32]. The protein spectrum obtained for the strain analyzed is compared with reference spectra, and then, the bacterium is automatically identified. Mass spectrometry is currently used successfully for rapid identification of a variety of Pasteurella species [14]. Recent study shows that, 100% identification agreement between MALDI TOF and the biochemical method. However, in comparison with conventional phenotyping methods, MALDI-TOF MS is much faster, and labor and reagent costs are lower [5]. The suitability of MALDI-TOF MS for rapid identification of many species of bacteria isolated from animals, including *M. haemolytica,* has only been confirmed in a few publications [52]. The identification of Pasteurella by MALDI-TOF MS using the [27] and the growth is isolated where from plated culture media and applied directly onto the MALDI test plate including Bacterial Test standard (BTS) as a control. Pasteurella samples are then overlaid with matrix dried **and Load the MAL-**DI target plate into the mass spectrometer [38].

The plate is subsequently loaded into the MALDI-TOF MS instrument and analyzed by software associated with the respective system, allowing rapid identification of the *Pasteurella* bacteria [17]. The identification criteria of MALDI Biotyper™ system log (score values) higher than 2.0 indicates species identification, while log (score values) between 1.7 and 2.0 are sufficient for identification of the genus. For values below 1.7, no isolate identification is possible [43].

A substantial cost savings can be achieved by implementing MALDI-TOF MS as the primary method of identification in the diagnostic laboratory. While the initial cost of the instrument is high, the cost savings on reagents and labor can offset the expenditure [68]. Significantly decreases the turnaround time. The sample preparation is simple and the sample requirement is minimal. A single colony is sufficient to generate spectra of sufficient quality. Cost effective, automated, robust, interlaboratory reproducibility, broad applicability (all types of bacteria including anaerobes, fungi) [50].

MALDI-TOF MS in the diagnostic laboratory can accurately identify most closely related species. However, there are some exceptions. The inability to discriminate between related spe-

cies can be due to the inherent similarity of the bacteria themselves. For example, MALDI-TOF MS is currently unable to differentiate *E. coli* from *Shigella* [57]. This is likely because these may not be two species, but one, as has been suggested by taxonomists. In the future, the addition of proteomic based approaches to the typical MALDI-TOF MS system may improve the discriminatory power of this method and make it possible to identify organisms at the strain or serotype level. Another reason why similar species may be incorrectly identified is a lack of sufficient spectra in the database [65].

Identification of new isolates is possible only if the spectral database contains peptide mass fingerprints of the type strains of specific genera/species/subspecies/strain. No susceptibility information is provided, not useful for direct testing of samples (except urine). Some organisms require repeat analysis and additional processing (extraction). The acceptable score cutoffs vary between studies and some closely related organisms are not differentiated [61]. The important challenges in species identification arise from incomplete databases, close relatedness of species of interest, and spectral quality, which is currently vaguely defined [21].

Control and Prevention

Management

Pasteurellosis represents diseases, amongst which is influenced by a wide variety of environmental and management risk factors. Thus, the reduction or even elimination of such predisposing factors is of major importance [51]. Most cases are acute or per acute, resulting in death within 8-24 hours after the onset of disease. Management factors such climatic changes and avoiding crowding stress, mixing of different flocks, movement, and deprivation of feed and water, exposure to aerosol infection from other sheep and goats providing shelter especially during extreme weather condition reduce the outbreaks of the disease [42].

Treatment

Antimicrobials are still the tools of choice for control of infections due to *Pasteurella* and *Mannheimia* spp. [22]. The priority of treatment against pasteurellosis is directed towards saving the lives of animals and depends on early detection of the disease and administration of appropriate and effective antibiotics. The antibiotics such as Oxytetracycline, trimethoprim, sulfonamides, penicillin, timilcosin, streptomycin and florfenicol are the most commonly used drugs to treat pasteurellosis [37]. It is well known that these organisms are having the tendency of becoming resistance to antibiotics the antimicrobial sensitivity of the *Pasteurella* and *Mannheimia* isolates should be tested and a suitable antibiotic should be chosen on the basis of the *in vitro* sensitivity test. The use of long-acting antibiotics in the face of an outbreak is common approach to prevent pasteurellosis in small ruminants [53].

Vaccines and Vaccination

The development of effective vaccine used for the *P. multocida* and *M. haemolytica* is very important in control strategy to reduce the incidence and burden of the disease and to minimize antimicrobial use. Currently, several vaccine types exist against pasteurellosis globally. Problems with vaccination arise where there is more than one serotype circulating, due to the lack of cross-protection [3]. At present, only a monovalent *P. multocida* serotype A vaccine is commercially available in Ethio-

Table 2: Biochemical characteristics of *M. haemolytica* and *P. multocida* [32].

Reaction	M. haemolytica	P. multocida
Haemolysis	+	-
Motility	-	-
Indole formation	-	+
Litmus milk	Acid	Neutral
Lactose	+	-
Oxidase	+	+
Catalase	+	+
MacConkey agar	+	-

+=indicates present, -=indicates not present.

pia, although *P. multocida* serotypes A and D and 11 serotypes belonging to *M. haemolytica* have long been detected [23]. Consequently, repeated outbreaks are reported in Ethiopia even among vaccinated sheep and goats, which practitioners and communities ascribe to vaccine failure [10]. Serotypes have different levels of virulence, host-species adaptability with possible inter-species transmissibility, antigenicity, immunogenicity, drug resistance and a lack of inter-serotype cross-reactivity [71]. Routine serotyping is not practised in Ethiopia due to the lack of detailed information, time, expense involved, and the lack of commercially available antisera, so that the serotypes of the circulating and outbreak-causing isolates remain unknown [10]. Many predisposing factors are normal environmental changes or routine management practices that cannot be avoided. Outbreaks are sporadic and unpredictable. Thus vaccines should seek to achieve round the year protection in areas with a high prevalence [30].

Vaccines against pneumonic pasteurellosis involved will help to reduce the severity of the disease, since it is the secondary bacterial phase of the disease that contributes to both its severity and fatality (Sarah *et al.*, 2011). Killed vaccines from locally isolated *P. multocida* types A and D and *M. haemolytica* in oil adjuvant are widely used for prevention of pneumonic pasteurellosis of ruminants. Such vaccines were found to be effective in prevention of the natural disease caused by homologous strains [44]. A trial at National Veterinary Institute (NVI), showed that vaccination with a formalin killed vaccine prepared from combined A2 and A7 *M. haemolytica* serotypes grown under iron restriction, deliberated relatively good protective efficacy in sheep than either of *M. haemolytica* A7 or A2 monovalent vaccines [44].

Status of Pasteurellosis in Ethiopia

Epidemiology of Pasteurellosis

Pasteurellosis caused by *M. hemolytica* is one of the most economically substantial infectious diseases affecting small ruminants, with an international distribution (Table 3). However, Iceland was the first country to report it, followed by Australia, the United Kingdom, Ethiopia, Norway, South Africa, Somalia, and the United States [10]. The disease is reported most frequently in Asia and Africa countries where sheep or goat breeding is widespread. It is also prevalent in USA and Canada where cattle breeding is common. In Europe, pasteurellosis widespread in many countries where sheep and cattle are present such as the Netherlands, Germany, Italy and France [35].

Mannheimia haemolytica are a common commensal bacterium found in the upper respiratory tracts of sheep and goats and they effect of all ages group. Outbreak of pasteurellosis is often associated with climate changes and occur in spring and summer, but can happen sporadically at any time of the year [35]. The worst epidemics occur during the rainy season, in poor

Table 3: Distribution of *M. haemolytica* and *P. multicoda* in different geographical locations.

Country	Region	Host species	*M.h*	*P.m*	Authors
Iraq	Baghdad	Goat	4.46	-	
Morocco		Sheep	42	15	
		Goat	100	0	
Ethiopia	Afar (Mille)	Sheep	-	-	
		Goats	-	-	
	Oromia (Hararghe)	Sheep	87.5	12.5	[45]
	Oromia	Sheep	12	8	[66]
	Amhara	Sheep	32.62	-	

Table 4: Occurrence of *P. multocida* and *M. haemolytica* in Ethiopia [42].

Prevalence of *M. haemolytica* (%)	Prevalence of *P. multocida* (%)	References	Study Area
48.0	2.0		Arsi
20.0	10.0		Debre Berhan
19.0	15.0		Debre Berhan
5.6	25.0		Debre Zeit
11.1	1.8		South Wollo
87.4	12.5	[45]	Haramaya district
46.4	14.3		Bedele district
28.0	2.2		Bishoftu
79.5	20.5		Gonder
11.2	8·85	[10]	Tigray

body condition, stress and wet conditions seem to contribute to the spread of the disease. The majority of *M.haemolytica* infections are mostly endogenous, caused by the normally resident bacteria on the upper respiratory tract, although exogenous infections can also occur by direct contact with sick animals or through infected aerosols [46].

Numerous studies have determined the extent (Table 4) and the relative distribution of *P. multicoda* and *M. haemolytica* species. Different serotypes of *M. haemolytica*, *P. multocida* and *P. trehalosi,* such as *A1, A2, A5, A6, A7, A8, A9, A11, A12, A13, A14, A, D* and *T3, T4, T10* and *T15* which *A1, A2, A8, A7, T3* and *T4* are the dominant serotypes pasteurellosis identify from small ruminants (Jarso *et al.*, 2016). *M. haemolytica* serotype A1 causes pneumonic pasteurellosis in cattle; *M. haemolytica* serotype A2 and causes pneumonic pasteurellosis in sheep and goats and *B. trehalosi* serotypes cause septicemic pasteurellosis in sheep and goats [36].

Conclusion and Recommendations

Livestock plays an important role in the economy and livelihood of community. These animals serve as a foremost source of cash income for household expense as well as domestic consumption. However, efficient utilization of this resource is impaired by different technical and non-technical factors. Infectious diseases are one of the health elements that influence livestock production. Pneumonic pasteurellosis is one of the most significant and recurrent devastating respiratory diseases in ruminants, caused by bacteria, viruses, lung worm, stress, and environmental change. This disease is caused by different etiological agent either by *M. haemolytica* or *P. multocida*, and it causes great economic losses. *M. haemolytica* is the most common cause, whereas *P. multocida* is rare. Young animals are mostly susceptible to pasteurellosis. In diagnosis of bacteria, the implementation of MALDI-TOF MS bacteria, the implementation of MALDI-TOF MS has changed the approach of Pasteurella identification in last 10 years. MALDI TOF MS rapid, accurate and cost-effective diagnostic method for pasteurollosis

and other bacteria. Good husbandry practices are the best ways for prevention and control of *P. multocida* and *M. haemolytica* in reducing stressors and stress associated disease in animals.

Therefore, based on the above conclusion, the following recommendations are forwarded:

➢ Diagnosis of Pasteurella should be adopted to know real cause of pasteurollosis.

➢ MALDI TOF MS Diagnostic technique should be adopted in Ethiopia for isolation and identification of *P. multocida* and *M. haemolytica*

➢ Sustainable pasteurollosis survey should be implemented which is important in disease control and prevention strategy and to reduce respiratory disease.

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