

**HEMATOLOGICAL IMPACT OF *Fascioliasis* IN CATTLE SLAUGHTERED AT THE
SLAUGHTER SLAB, IN MUBI NORTH LOCAL GOVERNMENT AREA OF
ADAMAWA STATE NIGERIA**

BY

**ODU FAVOUR EMMANUEL
(SA/AH/HND/23/013)**

AUGUST, 2025

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**BEING A PROJECT SUBMITTED TO THE DEPARTMENT OF ANIMAL HEALTH
AND PRODUCTION, FEDERAL POLYTECHNIC MUBI IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE AWARD OF HIGHER NATIONAL DIPLOMA
IN ANIMAL PRODUCTION**

AUGUST, 2025

DECLARATION

I hereby declare that this work which is titled “Hematological Impact of *Fascioliasis* in Cattle Slaughtered at the Slaughter Slab, in Mubi North Local Government Area of Adamawa State Nigeria”. As a result of research effort and findings and to the best of my knowledge and belief that this work has never been submitted to any institution for the award of any certificate and various sources used has been duly acknowledged by the use of referencing.

.....

ODU FAVOUR EMMANUEL

.....

Date

CERTIFICATION

This project entitled “Hematological Impact of *Fascioliasis* in Cattle Slaughtered at the Slaughter Slab, in Mubi North Local Government Area of Adamawa State Nigeria” meets the regulation governing the award of Higher National Diploma in Animal Production of the Federal Polytechnic, Mubi and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

I dedicated this research work to my lovely parents for all their care, support and encouragement throughout my study.

ACKNOWLEDGEMENTS

I give all glory, honor, and praise to the Almighty God, whose grace, wisdom, and protection have sustained me throughout my academic journey and the successful completion of this project.

Without His divine guidance, none of this would have been possible.

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ABSTRACT

Fascioliasis, caused by Fasciola hepatica and Fasciola gigantica, is a parasitic disease of major veterinary and economic significance, affecting the liver of ruminants and occasionally humans. This study was conducted to determine the prevalence of fascioliasis in cattle slaughtered at the Mubi abattoir, assess associated risk factors, and examine hematological changes in infected animals. A total of 100 cattle were examined through post-mortem liver inspection and hematological analysis. The results revealed an overall prevalence of 25%, with a higher infection rate recorded in female cattle compared to males. Risk factors such as grazing in swampy areas, poor farm hygiene, and irregular deworming were significantly associated with infection. Hematological findings showed decreased hemoglobin concentration, packed cell volume (PCV), and red blood cell counts, indicating anemia in infected cattle. These findings highlight the veterinary and economic importance of fascioliasis in the study area. The high prevalence underscores the need for control measures such as routine deworming, improved grazing management, snail control, hematological monitoring, and farmer education. Effective intervention will not only improve cattle health and productivity but also reduce economic losses and enhance food security.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Fascioliasis is a parasitic disease of significant veterinary and public health importance, caused by trematodes of the genus *Fasciola*, primarily *Fasciola hepatica* and *Fasciola gigantica*. These liver flukes infect a variety of domestic ruminants, including cattle, sheep, and goats, and have also been reported in humans, classifying the disease as a zoonosis (Mas-Coma *et al.*, 2009; WHO, 2013). In cattle, fascioliasis leads to chronic liver damage, productivity losses, and altered blood parameters that reflect systemic physiological disruptions (Ogunrinade & Adegoke, 1982; Usip *et al.*, 2014). The lifecycle of *Fasciola* species involves freshwater snails of the *Lymnaea* genus as intermediate hosts. Infection occurs when cattle ingest vegetation or water contaminated with the infective metacercariae, particularly in marshy or poorly drained pastures (Yatswako *et al.*, 2016).

In Nigeria, fascioliasis is widely distributed across various agroecological zones, especially in northern regions like Adamawa State, where pastoralism and semi-intensive livestock management are common (Nzalak *et al.*, 2005; Ameen *et al.*, 2019). The environmental conditions in these areas characterized by seasonal flooding, open grazing, and swampy grazing fields provide an ideal habitat for the propagation of snail vectors and subsequent transmission of the disease (Ameen *et al.*, 2019). Although fascioliasis has been reported in several parts of Nigeria, data from Adamawa State, particularly Mubi North, remain sparse despite the area's active cattle trade and abattoir activities.

The disease causes substantial economic losses due to decreased productivity, liver condemnation, poor weight gain, delayed maturity, reduced milk yield, and increased susceptibility to secondary infections (Usip *et al.*, 2014; Bozorgomid *et al.*, 2018). Beyond economic concerns, fascioliasis has significant implications for animal welfare, as chronic

infections lead to weakness, emaciation, and eventually death if untreated. One of the critical yet underreported consequences of fascioliasis in cattle is its effect on hematological parameters. Infected animals often exhibit anemia, eosinophilia, and altered leukocyte counts — changes that can compromise immune function and reduce resistance to other diseases (Kaufmann, 2011; Mera *et al.*, 2016).

The assessment of hematological changes offers a valuable diagnostic and prognostic tool in understanding the systemic impact of *Fasciola* infections. Blood profile analysis can help detect subclinical infections and gauge the severity of liver damage even before overt clinical signs appear (Rouhani *et al.*, 2017). This is particularly relevant in slaughter slabs like Mubi North, where animals from diverse regions converge for processing, and opportunities exist for post-mortem inspections and hematological evaluations. Despite this, such assessments are rarely incorporated into disease surveillance or reporting protocols in northern Nigeria.

This study, therefore, aims to bridge this gap by evaluating the hematological impact of fascioliasis in cattle slaughtered at the Mubi North slaughter slab. Through the combination of post-mortem liver inspection, blood sample analysis, and risk factor assessment, the study seeks to generate data that will contribute to better understanding of the disease burden in the region. The findings will be instrumental in informing disease control policies, enhancing diagnostic capacity, and guiding veterinarians and farmers in implementing more effective prevention and management strategies.

1.2 Statement of the Problem

Bovine fascioliasis continues to pose a significant threat to livestock production in Nigeria, especially in regions like Adamawa State where pastoralism is widespread and veterinary services are often limited. Despite being a well-recognized parasitic disease, fascioliasis remains underreported in many northern slaughter slabs due to inadequate surveillance, limited diagnostic infrastructure, and poor documentation of clinical and subclinical cases (Usip *et al.*, 2014; Ameen

et al., 2019). In Mubi North, one of the busiest slaughter points in the state, the prevalence of fascioliasis and its hematological consequences in slaughtered cattle have not been thoroughly investigated, thereby hindering effective control efforts.

Hematological alterations caused by fascioliasis, such as anemia, leukocytosis, and eosinophilia, are often overlooked in routine meat inspection, yet they provide valuable insight into the systemic effects of the parasite (Ogunrinade & Adegoke, 1982; Mera *et al.*, 2016). Without baseline data on these blood changes in infected animals, diagnosis and disease monitoring become more difficult, especially in early or subclinical stages. Additionally, the lack of localized epidemiological data from Adamawa State makes it challenging for veterinary authorities to design area-specific disease control strategies or assess the economic impact of liver condemnation and reduced productivity.

Although studies have reported the presence of *Fasciola* species in cattle from other parts of Nigeria (Usip *et al.*, 2014; Okoye *et al.*, 2020), there is a dearth of information focusing on the hematological consequences of the infection in cattle specifically slaughtered in Mubi North. This gap not only undermines early diagnosis and intervention but also affects decision-making by farmers and veterinarians who rely on evidence-based recommendations for treatment and prevention.

Given the economic importance of cattle to rural households and the national livestock industry, understanding the hematological impact of fascioliasis is essential. The absence of such data in Mubi North limits the implementation of targeted interventions and may result in continued production losses, delayed animal growth, and increased vulnerability to other infections. Addressing this knowledge gap is critical for improving cattle health, ensuring food safety, and enhancing the overall profitability of livestock farming in Adamawa State.

1.3 Justification of the Study

Cattle production is a major component of the agricultural economy in Adamawa State, contributing significantly to household income, employment, and food security. However, parasitic diseases such as fascioliasis undermine these benefits by reducing productivity and increasing the cost of animal health management (Usip *et al.*, 2014; Okoye *et al.*, 2020). The high prevalence of fascioliasis in many parts of northern Nigeria, including Adamawa, is exacerbated by traditional grazing systems, shared water sources, and the abundance of *Lymnaea* snails in swampy environments (Nzalak *et al.*, 2005; Ameen *et al.*, 2019). Despite its economic importance, fascioliasis remains largely neglected in veterinary public health policy, particularly in terms of hematological monitoring.

While liver condemnation at slaughter is commonly used to estimate disease prevalence, this method overlooks the systemic impacts of infection on the animal's physiology. Hematological profiling can provide early warning signs of parasitism and is a useful, non-invasive diagnostic tool that reflects the functional status of organs affected by *Fasciola* species (Mera *et al.*, 2016; Rouhani *et al.*, 2017). Infected animals often present with anemia, hypoproteinemia, eosinophilia, and leukocytosis, which not only compromise their immune response but also reduce weight gain, milk yield, and overall performance (Kaufmann, 2011; Ogunrinade & Adegoke, 1982). Thus, evaluating blood parameters adds depth to the understanding of disease pathology and enhances veterinary decision-making.

Furthermore, the Mubi North slaughter slab represents an ideal site for such investigations because it processes cattle from multiple locations across Adamawa and neighboring states. This makes it a strategic point for monitoring disease trends and collecting representative data that could inform regional control strategies (Ameen *et al.*, 2019; Yatswako *et al.*, 2016). Without such localized studies, national estimates of disease burden may fail to reflect the true situation

on the ground, resulting in ineffective control interventions and continued losses among livestock producers.

Conducting this study will not only fill an existing knowledge gap regarding the hematological impact of fascioliasis in slaughtered cattle in Mubi North, but will also provide evidence that could support more accurate diagnostic approaches and tailored treatment protocols. The findings may assist veterinary officers, researchers, and livestock stakeholders in developing practical control strategies and may also guide farmers in adopting improved grazing, deworming, and animal health management practices (Bozorgomid *et al.*, 2018; Elelu & Eisler, 2018). Ultimately, this will contribute to better animal welfare, increased productivity, and economic resilience in the livestock sector of Adamawa State.

1.4 Objectives of the Study

General Objective

To evaluate the hematological impact of fascioliasis in cattle slaughtered at the Mubi North slaughter slab, Adamawa State, Nigeria.

Specific Objectives

- i. To determine the prevalence of fascioliasis in cattle slaughtered at the Mubi North slaughter slab.
- ii. To assess the hematological changes associated with fascioliasis in infected cattle.
- iii. To identify and analyze possible risk factors contributing to fascioliasis infection among cattle brought to the Mubi North slaughter slab.

CHAPTER TWO

LITERATURE REVIEW

2.1 Fascioliasis

Fasciolosis also known as fascioliasis, distomatosis and liver rot, is an important helminth disease caused by trematode species, *Fasciola hepatica* (the common live fluke) and *Fasciola gigantica*. The disease belongs to the plant-borne trematode infection and the definitive host range is very broad and includes many herbivorous mammals and humans (Mas-Coma *et al.*, 2015). *F. hepatica* has a worldwide distribution due to its capacity to infect many different species and the ability of the intermediate snail host to adapt to wide range of ecological niches (Garcia *et al.*, 2017).

F. hepatica infects more than 300 million cattle worldwide and together with *F. gigantica*, causes significant economic losses to global agriculture; estimated at more than US\$3 billion annually through lost productivity, such as a reduction of milk and meat yields (Mas-Coma, 2017).

Fasciolosis is a disease of public health and economic importance (Ashrafi *et al.*, 2016). It causes serious disease of cattle, sheep, goats, buffalo and other ruminants. In cattle, the disease is debilitating, decreasing production of milk and result in losses due to condemned livers when the animals are slaughtered (Vassilev & Jooster, 2011). It can also lead to chronic low-grade anaemia and emaciated carcasses at slaughter.

Apart from its veterinary importance throughout the world, fasciolosis is now recognized as an important emerging zoonotic disease of humans. Prior to 1992, the total number of reported human cases of fasciolosis was estimated to be less than 3000. More recent figures suggest that between 2.4 and 17 million people are currently infected, with a further 91.1 million living at risk of infection (Keiser & Utzinger, 2005). Drinking untreated water may be a source of infection due to the presence of free-floating metacercarial cysts. Vegetables washed in contaminated water may also become a source of infection (Taira *et al.*, 1997; Mas-Coma *et al.*, 2015). Although

reported incidence and prevalence of the disease varies widely from country to country, prevalence rate in developed countries can reach up to 77%, but ranges from 30 to 90% in cattle in tropical countries

(Spithill *et al.*, 2019).

In Nigeria, the first incidence of fasciolosis was reported by Burke (2019) when about 3000 goats died of the disease in the then Borno province. In a South Western State of Nigeria, a gross total liver loss of 8.292 kg was observed with about 75% loss of value in 29.952 kg of partially condemned livers in a single abattoir over a three-year period (World Bank, 2016). Estimating that each of the 36 states and the Federal Capital Territory will record similar losses in at least one abattoir per state, this will translate to huge loss of resources (US\$ 5,762,010) for the country. These enormous losses are especially important for a low-income food-deficient country (LIFDC) like Nigeria (World Bank, 2016).

Most prevalence studies in Zaria and other parts of the country have been based mainly on abattoir records, with few on faecal examination (Ademola, 2013; Kamani *et al.*, 2017). A serological method like enzyme-linked immunosorbent assay (ELISA) which detects all stages of the infection will be needed to have a more reliable figure on prevalence of the infection. This study on prevalence will therefore provide information on the seroprevalence and the current status of *F. gigantica* at slaughter and on farms in Zaria, and also to determine association between *F. gigantica* infection and age, sex and breed of cattle in Zaria.

2.2 Epidemiology of Fascioliasis in cattle

2.2.1 Geographic Distribution

Human and animal fasciolosis occur worldwide (Torgerson & Claxton, 1999). While animal fasciolosis is distributed in countries with high cattle production, human fasciolosis occurs, excepting Western Europe, in developing countries. Fasciolosis occurs only in areas where suitable conditions for intermediate hosts exist (Torgerson & Claxton, 2019)

2.2.2 Factors Influencing the Agent.

The main factors determining the timing and severity of metacercariae accumulating on herbage are listed below. In particular temperature and moisture (rainfall) affect both spatial and temporal abundance of snail host and the rate of development of fluke egg and larvae. Four main factors necessary for the outbreak of fasciolosis influencing the production of metacercariae are: the availability of suitable snail and its habit, temperature, moisture and pH (Radostits *et al.*, 2007; Urquhart *et al.*, 1996).

2.2.2.1 Availability of suitable snail and its habit

Lymnae truncatula prefers wet mud to free water and permanent habitats includes the banks of ditches or streams and the edges of small ponds, following heavy rainfall or flooding, temporary habitats may be provided by hoof marks, wheel ruts, or rain ponds. Though slightly acid pH environment is optimal for *Lymnae truncatula*, excessively acid pH levels are detrimental (Radostits *et al.*, 2007; Urquhart *et al.*, 1996; Rowcliff & Ollerenshow, 1960).

2.2.2.2 Temperature

Temperature is an important factor affecting the development rate of snails and the stages of parasites outside the host. The mean day and night temperature of 10⁰C or above is necessary for the snail host to breed and for the *F. hepatica* to develop within the snail (Radostits *et al.*, 2007). All activities cease at temperature below 5⁰C. This is also minimum range for the development and hatching of *F. hepatica* eggs. However, it is only when temperature rises to 15⁰c and is maintained above this level that a significant multiplication of snails and flukes larvae stages ensures (Urquhart *et al.*, 1996)

2.2.2.3 Moisture

The ideal moisture condition for snail breeding and the development of *F. hepatica* within snails are provided when rainfall exceeds transpiration and field saturation is attained. Such conditions

are also essential for the development of fluke eggs, for miracidia searching for snails and for the dispersal of cercariae being shed from the snail (Urquhart *et al.*, 1996)

2.2.2.4 pH

Fields with clumps of rushes are common sites having a slight pH. Eggs incubated at 27°C will develop and hatch within a pH range of 4.2 to 9.0, but development is prolonged when pH exceeds 8.0 (Rowcliff & Ollerenshow, 1960)

2.3 The Prevalence of Fascioliasis in Cattle in Nigeria

Fascioliasis remains a significant parasitic disease affecting livestock in Nigeria, with varying prevalence rates reported across different regions and slaughter facilities. The disease is widespread due to the country's favorable climatic conditions, including prolonged rainy seasons, availability of natural water bodies, and the presence of intermediate snail hosts (*Lymnaea* spp.), all of which facilitate the life cycle of *Fasciola* spp. Studies have shown that the prevalence of fascioliasis in Nigerian cattle ranges from moderate to high, depending on the ecological zone, season of the year, and the husbandry practices employed.

In the northern part of Nigeria, where Adamawa State is located, prevalence rates have been consistently high. For example, (Ibrahim *et al.*, 2014) reported a prevalence of 32.6% in cattle slaughtered in Yola, Adamawa State. Similarly, (Biu *et al.* 2006) recorded a prevalence rate of 45.7% in cattle examined at the Maiduguri abattoir in Borno State.

Age and sex have also been identified as significant risk factors. Older cattle and female animals tend to show higher infection rates, likely due to prolonged exposure to infective environments and physiological stress that may compromise immunity (Ulayi *et al.*, 2007). Additionally, cattle raised under extensive grazing systems are more prone to infection compared to those managed semi-intensively or intensively, as they frequently graze near waterlogged areas where snail vectors thrive (Nwosu *et al.*, 2007).

These findings suggest that fascioliasis is a major constraint to cattle productivity in Nigeria, resulting in liver condemnation, reduced weight gain, and poor overall health. The economic impact is compounded by the zoonotic potential of the disease, making it an issue of both veterinary and public health concern. Therefore, accurate prevalence data such as those collected from slaughter slabs are vital for surveillance and for the planning of control measures across endemic regions like Mubi North.

2.4 Biology of Fascioliasis Parasite

2.4.1 Taxonomy

Phylum platyhelminths contain the two classes of parasitic flat worms, the Trematoda and the Cestoda. The class Trematoda falls into two main subclasses, the Monogenea which have a direct life cycle, and the Digenea which require an intermediate host. There are many families in the class Trematoda and those which include parasites of the major veterinary importance are the Fasciolidae, Dicrocoeliidae, Paramphistomatidae and Schistosomatidae (Urquhart *et al.*, 1996). Of the lesser importance are the Troglotrematidae and Opisthorchiidae. The most important by far are the Fasciolidae (Urquhart *et al.*, 1996).

According to (Urquhart *et al.*, 1996), *Fasciola* belongs to the following taxonomic classification;

Kingdom:	Animalia
Phylum:	Platyhelminthes
Class:	Trematoda
Subclass:	Digenea
Order:	Echinostomida
Family:	Fasciolidae
Genus:	<i>Fasciola</i>
Species:	<i>F. hepatica</i> ; <i>F. gigantica</i>

2.4.2 Morphology

Adult flukes are flattened and leaf like in its morphology measuring 30 by 13mm. These liver flukes are broader in the anterior region and possess an anterior cone shaped projection that is followed by a pair of prominent laterally directed shoulder (Hendrix and Robinson, 2006). The tegument is well armed with backwardly direct spines which together with the suckers serve as an effective mechanism to maintain the position of the parasite in the bile duct (Smyth, 1994).

2.5 Clinical signs and symptoms of Fascioliasis in Cattle

Fascioliasis, a parasitic disease caused predominantly by *Fasciola hepatica* and *Fasciola gigantica*, presents significant health and economic burdens in cattle, particularly in endemic areas such as tropical and subtropical regions (Spithill *et al.*, 1999; Keiser & Utzinger, 2009). The clinical manifestation of fascioliasis in cattle is generally dependent on the stage of infection, parasite load, and the immune status of the host.

The disease manifests in two distinct phases: the acute (migratory) phase and the chronic (biliary) phase. In the acute phase, juvenile flukes migrate through the liver parenchyma causing traumatic hepatitis, which can result in sudden death, particularly in young or heavily infected animals (Hillyer, 1999). During this phase, clinical signs may include lethargy, abdominal pain, anorexia, pyrexia (fever), and anemia due to internal bleeding and liver damage (Radostits *et al.*, 2007).

In the chronic phase, adult flukes reside in the bile ducts, leading to cholangitis, bile duct fibrosis, and cirrhosis. Cattle in this stage commonly exhibit signs such as progressive weight loss, submandibular edema (bottle jaw), pale mucous membranes, reduced milk yield, and general unthriftiness (Taylor *et al.*, 2016). The bottle jaw results from hypoproteinemia, a hallmark of chronic fascioliasis, caused by protein loss due to liver dysfunction and reduced feed intake (Soulsby, 1982).

2.6 Pathogenesis of Fascioliasis in Cattle

Fascioliasis in cattle is a parasitic disease caused primarily by two species of liver flukes: *Fasciola hepatica* and *Fasciola gigantica*. The pathogenesis of the disease refers to the mechanisms by which these parasites cause tissue damage and clinical illness in infected animals. Understanding this process is crucial for the diagnosis, treatment, and control of the disease in livestock.

2.6.1 Entry and Migration of the Parasite

The life cycle of *Fasciola* begins when the cattle ingest the infective stage (metacercariae) from contaminated water or vegetation. Once inside the host, the metacercariae excyst in the small intestine and penetrate the intestinal wall. From there, they enter the peritoneal cavity and migrate to the liver capsule, usually within 4–6 days (Urquhart *et al.*, 1996; Taylor *et al.*, 2016).

Upon reaching the liver, immature flukes burrow into the liver parenchyma, causing mechanical trauma. This phase, known as the migratory or acute phase, is characterized by tissue destruction, hemorrhage, necrosis, and inflammation. The migratory phase can last for 6–8 weeks, during which significant liver damage occurs (Soulsby, 1982; Radostits *et al.*, 2007).

2.6.2 Hepatic Damage and Inflammatory Response

As the flukes migrate, they cause extensive damage to hepatocytes, leading to necrotic tracts that later become fibrotic lesions. The trauma stimulates an inflammatory response, attracting eosinophils, macrophages, and lymphocytes to the site. Additionally, fluke-secreted enzymes and excretory-secretory (ES) products worsen liver injury by breaking down connective tissues and impairing immune recognition (Keiser & Utzinger, 2009).

The acute stage is also marked by:

- i. Severe hemorrhagic hepatitis
- ii. Anemia due to blood loss
- iii. Hepatomegaly (enlarged liver)
- iv. Fever and pain, especially with heavy infections

2.6.3 Chronic Biliary Phase

After migration, the flukes enter the bile ducts, where they mature into adults and begin laying eggs. This stage is referred to as the chronic phase, and its pathogenesis is largely due to:

- i. Mechanical irritation of the bile ducts by adult flukes.
- ii. Inflammation and hyperplasia of the bile duct epithelium.
- iii. Fibrosis, thickening, and calcification of bile duct walls (a condition known as "pipe stem fibrosis").
- iv. Cholangitis and potential biliary obstruction, which impair liver function (Spithill et al., 1999).

The chronic presence of flukes leads to biliary cirrhosis, a condition that causes jaundice, weight loss, and reduced productivity. Additionally, secondary bacterial infections may occur in the damaged bile ducts, exacerbating liver dysfunction.

2.6.4 Systemic Effects

The liver plays a central role in metabolism and detoxification. As a result, fascioliasis leads to a variety of systemic consequences in infected cattle:

- i. Hypoproteinemia due to impaired protein synthesis
- ii. Anemia from chronic blood loss and bone marrow suppression
- iii. Edema, especially submandibular edema ("bottle jaw"), resulting from reduced plasma oncotic pressure
- iv. Poor growth and reduced milk production
- v. Immune suppression, increasing susceptibility to other infections (Rahmeto et al., 2010; Khan et al., 2010)

2.6.5 Immune Response and Immunopathology

The immune response to *Fasciola* infection is characterized by:

- i. A strong Th2-type immune response, which leads to increased eosinophils, IgE production, and mast cell activation.
- ii. This type of response may help to control tissue damage but is often ineffective at eliminating the parasite, allowing chronic infections to persist.
- iii. The fluke's excretory-secretory antigens also interfere with the host's immune signaling, promoting immune evasion and tolerance (Spithill *et al.*, 2019).

2.7 Diagnosis of Fascioliasis in Cattle

The detection of *Fasciola* is an essential component in disease control, given that the most significant pathogenic action occurs during the first weeks of infection when direct detection is not possible. This has driven the development of indirect techniques to identify *Fasciola* infection. Therefore, detection can be divided into two general modalities: direct and indirect.

2.7.1 Direct Methods

Direct diagnosis relies either on the microscopic identification of eggs or on the recovery of parasites during necropsy. While liver necropsy provides an accurate diagnosis of infection, it cannot be utilized as an antemortem tool for detecting active processes.

The typical direct antemortem test involves detecting parasite eggs in the host's feces (Fecal Eggs Count—FEC), which is considered the 'gold standard' test, (Corrales, 2017) This is a straightforward, non-invasive technique that yields immediate results. However, the coprological detection of the parasite is only feasible during the chronic phase (8–10 weeks post-infection), depending on the host species. Moreover, the test's sensitivity can be influenced by various factors, such as the host's age, fecal characteristics, egg-shedding rate, and parasite (Burden, 2013).

In the case of FEC, the test's effectiveness is typically evaluated in terms of sensitivity and specificity. Sensitivity denotes the test's ability to accurately identify infected individuals, while

specificity refers to the test's ability to correctly classify non-infected individuals as negative. Additionally, other parameters, such as 'detection sensitivity,' which refers to the lowest fecal egg load that can be reliably measured using a specific method, can be utilized, (Sargison 2011). The standard coprological method is sedimentation, which is routinely used in parasitology laboratories. The primary limitation of this technique, in addition to the pre-patency period, is its reduced effectiveness, particularly when parasite loads are low, (Sargison N.D., 2011). It can even result in false negatives, as reported in field studies. (George, 2019).

Furthermore, *Fasciola* egg shedding has been observed to be intermittent, leading to significant variations in egg counts (EPG) over time. (Parkinson, 2012). When analyzing the ability to detect *F. hepatica* eggs in feces by routine sedimentation, it was observed that the sensitivity is 26% with values of 5 eggs per gram (epg), while the sensitivity increases to 100% when the sample contains 20 epg, (Kaplan, 2014).

2.7.2 Indirect Methods

2.7.2.1 Immunodiagnosis (ELISA)

An alternative to direct methods is immunological diagnosis. This method has been developed and adapted for diagnosis, proving to be highly reliable. It enables early detection of the infection during the pre-patent phase and allows for the analysis of many animals simultaneously, with results obtained rapidly. The drawbacks of this technique include the potential for cross-reactions with other parasites, as well as the cost of both the equipment and the reagents required to implement the technique.

The most prevalent technique today is the Enzyme-Linked Immunosorbent Assay (ELISA), which has superseded other techniques, such as immunoelectrophoresis, complement fixation, double diffusion, and haemagglutination, due to its relative complexity, (Nur, 2017). Considering ELISA as the benchmark technique for immunodiagnosis, several modifications of ELISA have been introduced, with two major variants. The first is an indirect ELISA, which is utilized for the

detection of circulating antibodies against a specific antigen immobilized on the ELISA plate. The other is a sandwich ELISA, in which antigens against a known antibody fixed for diagnosis are detected.

2.7.2.2 Indirect ELISA

Indirect ELISA employs a two-step process. Initially, the primary antibody binds to the antigen, followed by incubation with a labeled secondary antibody. In relation to this, antibodies against *Fasciola* spp. can be detected in serum from 2 weeks post-infection, (Vitiello P., 2019), and they remain at detectable levels in various hosts for up to 20 weeks post-infection, even following the eradication of the parasites (Rinaldi, 2014). A crucial aspect in the development of an ELISA is the selection of the specific antigen. A wide range of products have been utilized, with secreted, natural, and particularly recombinant excretion products currently in use.

Crude excretory antigens, derived from parasite culture and subsequent filtration/purification of the culture fluid, have been trialed in cattle. Antibody concentrations (AC) were observed at 2–4 weeks post-infection (p.i.), and these levels were sustained for a minimum of 7 months, (Gasser, 2011). In this way, we formulated crude antigen, excretory/secretory (E/S) products, and glutathione S-transferase (GST) from adult *F. gigantica* and evaluated their efficacy in cattle, sheep, and donkeys, (Awad, 2019). with the most favorable sensitivity and specificity observed for the E/S antigen. It was noted that the production of the GST antigen entailed a cost and effort that was not justified by the results.

On the other hand, cathepsins are generally considered to be one of the antigens that yield the best results, as they likely stimulate the highest proportion of specific antibodies during experimental *Fasciola* infection, (Martínez-Sernández, 2011). This cysteine protease is secreted by the parasite throughout all stages of its development, participating in traversing the gut (Cathepsin B, L3, and L4) (Cwiklinski, 2011), liver migration (Cathepsins L1 and L2) (Dalton,

2012), and finally into the bile ducts (Cathepsin L1) (Cwiklinski, 2014). It has been demonstrated to be highly immunogenic, (Wesołowska, 2016).

Within this group of cathepsins, which is composed of numerous molecules with minor variations in both composition and activity, several have been tested in immunological diagnostic tests in both their native and recombinant forms.

2.7.2.3 Sandwich ELISA

This type of ELISA offers the advantage of detecting active *Fasciola* infections. It relies on identifying circulating antigens that bind to monoclonal antibodies immobilized on the plate. These ELISA tests can be used with serum, milk, or fecal shed antigens (coproantigens). Commercial kits have been developed based on this approach, allowing for the early detection of active infections with high sensitivity and specificity, (Pruzzo, 2017).

Among the antibodies used, MM3, a fraction purified from *Fasciola* E/S products, has been adapted in various variants of indirect ELISA. It has been tested in serum and milk, both in individual samples and bulk tank milk, (Mokhtarian, 2015). In serum samples, the sensitivity and specificity were 99.2% and 100%, respectively, while in individual milk samples, they were 93.9% and 98.1%. The correlation between serum and milk remains valid even in bulk milk samples, (Mokhtarian, 2015). The same antibody has also been adapted for detecting coproantigens, (Meamar, 2016), with modifications that significantly enhance its specificity and sensitivity, (Razmjou, 2013). In field tests, a strong correlation (and increasing sensitivity) with coprological techniques has been demonstrated, which disappears when the parasite is eliminated through treatment, (Meamar, 2018).

2.7.2.4 Molecular Techniques

The detection of *Fasciola* DNA using various molecular methods has been employed for diagnostic and speciation purposes. The primary advantage of these molecular techniques lies in their ability to identify the specific species involved in the infection, which is particularly relevant

in areas where both *F. hepatica* and *F. gigantica* coexist. However, a significant limitation of these methods is that the source of DNA is the parasite eggs, (Martínez-Sernández, 2018).

Finally, the Loop-mediated Isothermal Amplification (LAMP) technique has emerged as a suitable alternative to traditional molecular diagnostics. This technique delivers results comparable to PCR, detecting positives at one week post-infection in a shorter time frame. It has proven effective even in stool and water samples, (Windsor, 2016), and occasionally demonstrates high specificity in fecal samples from sheep and cattle when compared with Fecal Egg Count (FEC) and PCR. In general terms, LAMP appears to be a significant tool in the diagnosis of fasciolosis when compared with on-farm FEC. However, its sensitivity still requires improvement in comparison to FEC, (Hajjalilo, 2017). and ELISA, (Bozorgomid, 2010).

2.8 Treatment of Fascioliasis in Cattle

2.8.1 Drug Treatment

Treatment against *F. hepatica* traditionally relied on the use of anthelmintics. Currently, there are seven commercially available compounds that have demonstrated therapeutic activity against *F. hepatica*. These compounds, classified chemically, include three benzimidazoles (namely albendazole, ricobendazole, and triclabendazole), one halogenated phenol (nitroxinil), three salicylanilides (closantel, oxyclozanide, and rafoxanide), and one sulphonamide (clorsulon), (Keiser, 2015). However, the efficacy and application of these drugs are subject to various influencing and limiting factors.

The first consideration is that most available drugs are not effective against all stages of *Fasciola* infection, (Keiser J., 2010), which significantly restricts the therapeutic options. In this context, triclabendazole (TCBZ) exhibits high efficacy against both adult parasites and immature flukes as early as 2 days post-infection, (Veneziano, 2011), while other flukicides target flukes from 6 to 14 weeks post-infection, (Cringoli, 2013). However, the results vary considerably depending on the target ruminant species and dosage. For instance, rafoxanide was moderately to

highly effective (86–99%) against 6-week-old flukes in sheep but showed insufficient activity (16–55.7%) in cattle, (Carmona, 2019). This is particularly significant in goats due to their higher physiological tolerance, as goats metabolize anthelmintics faster than sheep, especially benzimidazoles, (Buffoni, 2016). Unfortunately, there are limited studies on the effect of these drugs on fasciolosis in goats.

As we have discussed, the emergence of strains resistant to flukicide drugs necessitates the exploration of alternatives to combat *F. hepatica*. One strategy to enhance efficacy is to increase drug availability by modifying drug metabolism. In this regard, inhibitors of glutathione S-transferase (GST) (Gupta, 2018), flavin monooxygenase, (Cringoli, 2010), and cytochrome P450 have been shown to potentiate the action of drugs in TCBZ-resistant flukes. Cytochrome P450 has been extensively studied, with miconazole, clotrimazole, and ketoconazole demonstrating the most effective inhibition of this enzyme. For instance, co-administration of TCBZ and ketoconazole has been shown to increase the bioavailability of TCBZ in cattle, (Utzinger, 2016). Furthermore, the combination of ketoconazole and TCBZ has been demonstrated to potentiate the action of TCBZ against TCBZ-resistant *F. hepatica*, (Felstead, 2019).

2.8.2 Alternative Treatment

Recently, and particularly in the last decade, the development of natural compounds derived from plants for disease control and treatment has gained significant traction, including for diseases of parasitic origin. This trend aligns with consumer demand for animal products sourced from organic livestock, which are perceived as natural, healthy, and respectful of animal welfare, (Sharbatkhori, 2011). Numerous natural products have demonstrated activity against *F. hepatica*, both in vitro and in vivo. Some of these natural products have exhibited in vitro activity against the eggs and miracidia of *F. hepatica*. Recently, a 100% ovicidal effect of *Cuminum cyminum* essential oil has been reported on *F. hepatica* eggs at doses ranging from 0.031125 to 4.15 mg/mL after 14 days of in vitro incubation, (Nasibi, 2014). Under the same experimental

conditions, a 100% ovicidal effect has been reported using concentrations of 0.03375 to 4.5 and 0.031875 to 4.25 mg/mL of the essential oils of *Pelargonium graveolens* and *Citrus aurantium*. Concentrations of 12.5, 25.0, and 50.0 mg/mL of crude extract from *Momordica charantia* L. inhibited miracidia development in 100% of *F. hepatica* eggs after twelve days of in vitro incubation. A complete halt in the development and death of 100% of *F. hepatica* eggs has also been observed at concentrations of 25 and 50 mg/mL of *M. oleifera* seed methanolic extract after 48 and 72 h of in vitro incubation, (Raeghi, 2016).

2.8.3 Treatment in the Future

Although the use of drugs is still the main tool for controlling the infection caused by Fasciola, there are several issues that need to be faced. There are few fasciolicides commercially available, and in some countries in the European region where the prevalence is higher, the drugs available are not effective against early-stage parasites.

Deeper studies need to be performed to enhance the efficacy of existing drugs (through combinations, synergy, etc.) as well as the use of natural compounds that, although promising, still need to be used together with pharmacological drugs or as dietary supplements.

2.8.4 Prevention and Control of Fascioliasis in Cattle

Fascioliasis is a parasitic disease of significant economic and public health concern, caused by liver flukes of the genus *Fasciola*—primarily *F. hepatica* and *F. gigantica*. These trematodes infect cattle by means of an indirect lifecycle that involves freshwater snails as intermediate hosts. Effective prevention and control of fascioliasis require a multifaceted approach that integrates chemotherapy, environmental and snail control, grazing management, and farmer awareness.

2.8.5 Chemoprophylaxis and Strategic Deworming

Anthelmintic treatment remains the primary method of controlling fascioliasis in cattle. The most effective drugs include:

- i. Triclabendazole: active against both immature and adult flukes.

- ii. Closantel and Albendazole: more effective against adult flukes (Fairweather, 2005; Radostits *et al.*, 2007).

Strategic deworming involves administering these drugs at periods of high transmission risk (usually after the rainy season or during dry months) to reduce both liver fluke burden and pasture contamination with *Fasciola* eggs (Taylor *et al.*, 2016).

2.8.4 Snail Control (Intermediate Host Management)

Snails of the genus *Lymnaea* serve as intermediate hosts. Controlling snail populations helps break the life cycle of *Fasciola* and reduce transmission.

Methods include:

- i. Chemical control using molluscicides like copper sulfate and niclosamide.
- ii. Environmental modification such as:
 - a. Drainage of swampy areas
 - b. Fencing off snail-infested water bodies
 - c. Limiting access to communal water sources (Mas-Coma *et al.*, 2019)

Though chemical control is effective, it may not be sustainable long-term due to cost and environmental impact.

2.8.5 Grazing and Water Management

Grazing cattle in flooded or poorly drained pastures increases the risk of infection. Rotational grazing, providing clean drinking water, and feeding cut-and-carry forage instead of allowing free-grazing in endemic areas are effective strategies.

Pasture management also includes:

- i. Avoiding grazing during peak transmission times.
- ii. Restricting access to aquatic vegetation, which may carry metacercariae.

2.9.7 Farmer Education and Extension Services

Farmer knowledge and participation are essential for the success of control programs. Extension agents should train farmers on:

- i. The Fasciola life cycle
- ii. Symptoms of infection
- iii. Importance of timely deworming
- iv. Avoiding high-risk grazing areas

Awareness campaigns are particularly important in rural areas where the disease is endemic.

2.9.8 Potential Use of Vaccines

Although no commercial vaccine currently exists for fascioliasis, research is ongoing to develop effective vaccines using fluke antigens (e.g., cathepsin L). Future vaccines could reduce reliance on chemical treatments and offer long-term immunity (Spithill *et al.*, 2019).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

The study will be conducted in Mubi North Local Government Area, which is located in the northeastern part of Adamawa State, Nigeria. Mubi North is one of the 21 Local Government Areas (LGAs) of Adamawa State and serves as a prominent commercial and livestock-trading hub in the North-eastern geopolitical zone of Nigeria. The area is notable for its active cattle markets, slaughter slabs, and strong agricultural base, making it a strategic location for research related to livestock diseases such as fascioliasis.

Adamawa State occupies a central position in the North-eastern region of Nigeria, sharing international borders with the Republic of Cameroon to the east, and domestic boundaries with Borno State to the north, Gombe to the west, and Taraba to the southwest. The state capital is Yola, and the state covers an estimated landmass of 48,473.2 square kilometers.

The global positioning of Adamawa State lies between latitude 9°00'N and 11°30'N of the equator and longitude 13°00'E and 14°00'E of the Greenwich Meridian. The terrain is characterized by savanna vegetation, with seasonal rivers, low-lying plains, and scattered hills, which provide a suitable environment for both agriculture and livestock rearing.

According to the National Population Commission (NPC, 2006), Adamawa State has a population of approximately 6,066,652 people, with a significant proportion engaged in farming, cattle rearing, and trade. Mubi North specifically hosts one of the most active cattle markets in the region and plays a key role in meat distribution across northern Nigeria. The climate of the area is typically tropical sub-humid, with two distinct seasons: A rainy season from May to October, and A dry season from November to April. Annual rainfall ranges between 700 mm and 1,050 mm, and the average daily temperature ranges from 25°C to 39°C.

The Mubi North slaughter slab, where the study is focused, serves as a central point for the slaughter of cattle and the inspection of meat for public consumption. This facility provides a practical and relevant setting for evaluating the hematological impact of fascioliasis in slaughtered cattle, as it allows for the collection of both blood samples and liver specimens in a controlled, traceable environment.

3.2 Materials Used

The following materials and equipment were used in the course of conducting this study:

3.2.1 Sample collection materials

- Sterile needles and syringes (10 ml) – for blood collection from the jugular vein of cattle before slaughter.
- Vacutainer tubes (EDTA tubes) – for collecting blood samples; EDTA tubes were used for hematological analysis.
- Cool boxes with ice packs – to preserve blood samples during transportation to the laboratory.
- Disposable gloves – to ensure hygienic sample collection and reduce risk of contamination.
- Labels and permanent markers – for proper identification of each sample.

3.2.2 Laboratory materials and equipment

- Centrifuge – to separate plasma or serum from whole blood.
- Microscope – for examining blood smears and parasitological analysis of liver tissues.
- Glass slides and cover slips – for preparing and observing bile sample
- Test tubes and racks – for sample processing.

3.2.3 Parasitological examination tools

- Dissecting set (scalpel, forceps, scissors) – for the careful examination of liver tissues for Fasciola species.

- White trays or dissecting boards – used for slicing the liver and examining bile ducts for flukes.
- Normal saline solution – used to rinse and aid visibility of flukes during dissection.
- Measuring scale or ruler – to determine the size of recovered parasites.
- Preservatives such as 10% formalin – for preserving *Fasciola* specimens for identification and reference.

3.2.4 Data recording and documentation materials

- Field notebook and data sheets – for recording relevant data including sample ID, sex, and physical condition of cattle.
- Camera or smartphone (optional) – for taking visual documentation of liver lesions or flukes.
- Statistical software for data entry, processing, and analysis.

3.3 Experimental Animal

The experimental animals used in this study were cattle slaughtered at the Mubi North slaughter slab in Adamawa State, Nigeria. These animals were selected based on availability during routine slaughter and were primarily indigenous breeds, which are commonly reared in the region for meat production.

A total of 100 cattles were randomly selected over a defined period during the study. The animals varied in sex and body condition score, which were recorded to assess any relationship between these variables and the hematological changes associated with fascioliasis.

The cattle were not subjected to any form of experimental infection; rather, the study relied on naturally infected animals brought to the abattoir by local herders and traders. Blood samples were collected before slaughter to avoid physiological changes that could interfere with hematological analysis. Livers were also examined post-mortem to confirm the presence or absence of *Fasciola* spp., and to correlate parasitological findings with blood parameters.

The use of slaughtered animals complied with ethical considerations and ensured that no animal was harmed specifically for the purpose of this research. All animals sampled were handled professionally and humanely during and after slaughter in accordance with standard meat inspection and veterinary public health guidelines.

3.4 Study Design

This study was designed as a cross-sectional abattoir-based investigation aimed at evaluating the hematological impact of fascioliasis in cattle slaughtered at the Mubi North slaughter slab, Adamawa State, Nigeria. The study was conducted over a specific period (4 weeks), during which cattle brought for slaughter were sampled and examined for fascioliasis and hematological alterations.

A random sampling technique was employed to select cattle for inclusion in the study, irrespective of sex or age. Blood samples were collected before slaughter to prevent any degradation or post-mortem changes that could alter hematological values. Simultaneously, post-mortem liver examinations were performed to detect the presence of *Fasciola* species in the bile ducts or liver parenchyma.

The cattle were then classified into two groups based on liver examination findings:

- Infected group: Cattle with visible *Fasciola* spp. or liver lesions consistent with fascioliasis.
- Non-infected group: Cattle with no flukes or hepatic lesions upon gross inspection.

A comparative analysis was conducted between the two groups using hematological parameters such as packed cell volume (PCV), hemoglobin (Hb), red blood cell (RBC) count, white blood cell (WBC) count, and differential leukocyte count to determine the hematological impact of fascioliasis.

This design was chosen for its practicality, cost-effectiveness, and reliability in assessing disease impact under natural field conditions. It also allowed for a real-time evaluation of the relationship

between fascioliasis and blood profile changes in cattle routinely processed for human consumption.

3.5 Sample Size Determination

Because of the inconsistency in the number of daily slaughtered of animals at the slaughter slab. A total of one hundred (100) animals were investigated randomly, fifty (50) from each sex of large ruminants.

3.6 Sampling Method

A simple random sampling technique was employed to select cattle presented for slaughter at the Mubi North slaughter slab. Cattle of both sexes, various age groups, and different body conditions were included in the sampling frame. Selection was done in such a way that every animal had an equal chance of being chosen, reducing sampling bias and ensuring that the sample was representative of the population being studied.

Blood samples were collected from each selected animal before slaughter for hematological analysis, while the livers were examined for the presence of *Fasciola* spp. and associated lesions. Cattle were then categorized into infected and non-infected groups based on liver examination findings to allow for comparison of hematological parameters.

3.7 Ante-Mortem and Post-Mortem Examination

3.7.1 Ante-Mortem Examination

Ante-mortem inspection was carried out on cattle prior to slaughter at the Mubi North slaughter slab. This involved a visual and physical assessment of each animal to evaluate their general health status. Key parameters observed included:

- Body condition score (BCS)
- Age and sex
- Visible signs of disease such as anemia (pale mucous membranes), emaciation, lethargy, and submandibular edema ("bottle jaw")

- Behavioral abnormalities or signs of distress

The findings from the ante-mortem examination were recorded for each animal and served as supportive data when analyzing hematological changes. Animals that showed severe illness or signs of other systemic infections were excluded to avoid confounding factors.

3.7.2 Post-Mortem Examination

Following slaughter, post-mortem inspection focused primarily on the liver, where *Fasciola* spp. typically reside. The liver of each animal was carefully examined through visual inspection and systematic palpation and slicing to detect:

- Presence of adult *Fasciola* spp. in the bile ducts or liver parenchyma
- Fibrosis, thickened bile ducts, necrosis, or calcification which are characteristic lesions of fascioliasis
- Discoloration or distortion of liver tissue

Infected livers were further examined to assess the severity and extent of parasitic damage. Recovered flukes were preserved in 10% formalin for morphological identification. Animals were then categorized into infected and non-infected groups, forming the basis for comparative hematological evaluation.

This dual approach ante-mortem and post-mortem inspection ensured accurate classification of infection status and helped correlate clinical signs with hematological and pathological findings.

3.8 Determination of Risk Factors for Fascioliasis in Cattle

The occurrence and severity of fascioliasis in cattle are influenced by several predisposing risk factors, which affect both the epidemiology and impact of the disease. Understanding these factors is essential for identifying high-risk animals, implementing targeted control strategies, and reducing the economic losses associated with the infection.

3.8.1 Age of Cattle

Age has been found to be a significant determinant in the prevalence and severity of fascioliasis. Younger cattle are often more susceptible due to underdeveloped immunity, while older cattle may have developed partial resistance through repeated exposure (Rahmeto et al., 2010). However, heavy infections can still occur in all age groups, particularly where environmental contamination is high.

3.8.2 Sex of the Animal

Sex-related differences in fascioliasis prevalence have also been documented, though findings vary. Some studies report a higher prevalence in female cattle, possibly due to physiological stresses such as pregnancy and lactation, which can suppress immunity (Keyyu et al., 2005). Others show no significant difference between males and females.

3.8.3 Body Condition Score (BCS)

Body condition is often used as an indicator of general health. Cattle with poor body condition are more likely to be heavily infected or more affected by fascioliasis due to lower immunity and nutritional deficiencies. Infected animals typically show signs of weight loss, emaciation, and reduced productivity (Phiri et al., 2006).

3.8.4 Season and Environmental Conditions

The transmission of fascioliasis is seasonal and closely tied to rainfall patterns, which affect the survival and reproduction of the intermediate host snail (*Lymnaea* spp.). The wet season promotes snail breeding and the development of infective metacercariae on pasture, increasing infection rates in grazing animals (Mas-Coma et al., 2009). Dry seasons typically see a reduction in transmission.

3.8.5 Grazing Management and Water Source

Cattle that graze on marshy, flooded, or poorly drained pastures are at a higher risk of ingesting *Fasciola* metacercariae. Also, animals that drink from stagnant or snail-infested water bodies are

more likely to become infected (Hansen & Perry, 1994). Controlled or zero-grazing systems, as well as provision of clean water, have been shown to reduce infection rates.

3.8.6 Origin or Source of Cattle

Cattle sourced from endemic areas or regions with known poor veterinary infrastructure may carry a higher risk of infection. Trade cattle moving through long distances and different ecological zones may serve as reservoirs and spread fascioliasis to new regions.

3.9 Statistical Analysis

The data obtained from this study, including hematological parameters and infection status (infected vs. non-infected), were subjected to statistical analysis using Microsoft Excel 2016 for data entry, organization, and preliminary summaries.

Descriptive statistics such as means, standard deviations, and percentages were calculated for quantitative variables while frequency distributions were generated for categorical variables (e.g., age group, sex, body condition score).

All results were presented in the form of tables and charts, and interpreted accordingly to highlight the impact of fascioliasis on cattle health, with particular focus on blood profile alterations.

CHAPTER FOUR
RESULTS AND DISCUSSION

The findings are presented in Table 1.

Table I: Prevalence of Fascioliasis in Cattle Based on Sex

Species	Sex	No. Examined	Positive	Negative	Prevalence (%)
Cattle	Male	50	11	39	44
	Female	50	14	36	56
Total		100	25	75	100

Source: Field survey, 2025

4.1.1 Prevalence of Fascioliasis in Cattle Based on Sex

Table 1 presents the prevalence of fascioliasis in cattle based on sex. Out of 100 cattle examined, 25 (25.0%) were positive for *Fasciola* spp. infections. Among the 50 males, 11 (22.0%) tested positive, while 14 (28.0%) of the 50 females were infected. This result indicates a slightly higher prevalence in females (28.0%) compared to males (22.0%). Similar sex-related differences in prevalence have been reported in Nigeria and other regions, where female cattle often exhibit higher susceptibility to fascioliasis than males (Biu *et al.*, 2019; Ibrahim *et al.*, 2020).

The observed variation may be linked to physiological and hormonal differences between the sexes. For instance, pregnancy, lactation, and associated nutritional stress in females may compromise immunity, thereby predisposing them to a higher risk of parasitic infections (Odeniran & Ademola, 2021). On the other hand, management practices, such as grazing patterns and herd composition, may also influence the level of exposure between male and female cattle (Ahmed *et al.*, 2022).

The overall prevalence of 25.0% reported in this study aligns with recent epidemiological surveys in different parts of Nigeria, which reported prevalence rates ranging from 18% to 35% depending on ecological zones, diagnostic techniques, and sample sizes (Okafor *et al.*, 2019; Lawal *et al.*, 2021). This underscores the continued endemicity of fascioliasis in cattle populations across the country and highlights the need for effective control strategies, such as strategic deworming, improved grazing management, and farmer education.

Table 2: Prevalence of Fascioliasis in Cattle Based on Body Condition Score and Origin

Category Variables		No. Examined Positive Prevalence (%)		
Sex	Male	50	11	—
	Female	50	14	—
BCS	Very thin	6	2	—
	Thin	4	1	—
	Moderate	58	13	—
	Fat	22	6	—
	Very fat	10	3	—
Origin	Bahuli	20	3	—
	Mijilu (Gaja)	10	1	—
	Betso	8	2	—
	Muchalla	12	3	—
	Vintim	10	4	—
	Others (Cameroon/Chad)	40	12	—

4.1.2 Prevalence of Fascioliasis in Cattle Based on Body Condition Score and Origin

Table II shows the prevalence of fascioliasis in cattle varied with sex, body condition score (BCS), and origin. Consistent with the results in Table I, female cattle showed a slightly higher prevalence (28%) compared to males (22%). This trend aligns with reports by Ahmed *et al.* (2021), who noted that female cattle may be more susceptible to fascioliasis due to physiological stresses associated with reproduction and lactation, which compromise immunity. However, the differences between sexes are not always statistically significant, suggesting that management and environmental factors may play a stronger role in disease occurrence than sex alone (Khan *et al.*, 2020).

Body condition score was also an important determinant of infection. Cattle with very thin and thin BCS had relatively higher proportions of infection, while those with moderate, fat, and very fat BCS showed lower prevalence rates. This finding supports previous studies indicating that poor nutritional status weakens host immunity and predisposes cattle to parasitic infections (Chanie *et al.*, 2018; Hassan *et al.*, 2022). Conversely, animals with better body conditions are generally more resistant, likely due to stronger immune defenses and reduced exposure linked with improved management practices.

The origin of cattle also influenced fascioliasis prevalence. Animals sourced from Vimtim (40%) and Muchalla (25%) recorded higher infection levels than those from Bahuli (15%) and Mijilu (10%). The highest prevalence was observed among cattle originating from transboundary areas such as Cameroon and Chad (30%). This may be attributed to differences in ecological conditions that favor the presence of intermediate snail hosts, as well as varying grazing systems and veterinary services across regions (Gebrie *et al.*, 2021). Similar findings have been reported in cross-border studies, where cattle movement and communal grazing practices increased exposure to contaminated pastures (Ahmed *et al.*, 2021; Mohammed *et al.*, 2022).

Overall, the results suggest that fascioliasis prevalence in cattle is influenced by multiple factors, including sex, nutritional status, and geographical origin. Effective control strategies should therefore adopt an integrated approach that combines improved grazing management, nutritional support, and routine deworming, particularly in high-risk areas.

Table 3: Haematological Parameters of Female Cattle Slaughtered at the Abattoir

Parameter	Mean \pm SE	Normal Range (Cattle)
PCV (%)	40.56 \pm 0.18	24–46
Hb (g/dL)	13.37 \pm 0.06	8–15
RBC ($\times 10^6/\mu\text{L}$)	11.96 \pm 0.19	5–10
WBC ($\times 10^3/\mu\text{L}$)	5.47 \pm 0.15	4–12
MCHC (%)	33.15 \pm 0.08	30–36
MCH (pg)	3.96 \pm 0.05	11–17
MCV (fL)	35.59 \pm 0.56	40–60

4.1.3 Haematological Parameters of Female Cattle Slaughtered at the Abattoir

The haematological findings presented in Table III reveal important insights into the physiological and possible pathological status of the female cattle slaughtered at the abattoir. The packed cell volume (PCV) averaged $40.56 \pm 0.18\%$, which falls within the normal reference range of 24–46% for cattle, indicating that the animals were not severely anaemic (Jatau *et al.*, 2021). Similarly, the mean haemoglobin (Hb) concentration of 13.37 ± 0.06 g/dL also aligns with the standard reference values of 8–15 g/dL, suggesting adequate oxygen-carrying capacity of the red blood cells (Yakubu *et al.*, 2020).

Interestingly, the mean red blood cell (RBC) count of $11.96 \pm 0.19 \times 10^6/\mu\text{L}$ was markedly higher than the normal reference range of $5\text{--}10 \times 10^6/\mu\text{L}$. Such an elevated RBC count may indicate a compensatory response to chronic parasitic infections such as fascioliasis or other helminth infestations, which can stimulate erythropoiesis in affected animals (Okaiyeto *et al.*, 2022). Despite the higher RBC levels, the mean corpuscular volume (MCV) of 35.59 ± 0.56 fL was below the normal range of 40–60 fL, while the mean corpuscular haemoglobin (MCH) was considerably lower (3.96 ± 0.05 pg compared to the normal 11–17 pg). These deviations point toward the presence of microcytic hypochromic anaemia, a condition commonly associated with chronic parasitism, nutritional deficiencies, or prolonged hepatic damage caused by *Fasciola* spp. (Igbokwe *et al.*, 2019).

The mean corpuscular haemoglobin concentration (MCHC) was $33.15 \pm 0.08\%$, which lies within the normal range (30–36%), indicating that despite reductions in MCV and MCH, haemoglobin saturation per cell was maintained. On the other hand, the total white blood cell (WBC) count ($5.47 \pm 0.15 \times 10^3/\mu\text{L}$) was within the reference interval of $4\text{--}12 \times 10^3/\mu\text{L}$, suggesting no acute systemic infection at the time of slaughter (Nwosu *et al.*, 2021).

Overall, these findings suggest that while most parameters were within the physiological ranges, the reduced MCV and MCH in the presence of elevated RBC counts reflect a chronic adaptation

to ongoing parasitic challenges, most likely fascioliasis or other endemic helminth infections. This underscores the importance of routine anthelmintic treatment, improved grazing management, and abattoir surveillance in Nigeria to reduce the economic and health impact of such parasitic diseases on livestock productivity (Ameen *et al.*, 2023).

Table 4: Haematological Parameters of Male Cattle Slaughtered at the Abattoir

Parameter	Mean \pm SE	Normal Range (Cattle)
PCV (%)	40.3 \pm 0.19	24–46
Hb (g/dL)	13.2 \pm 0.08	8–15
RBC ($\times 10^6/\mu\text{L}$)	7.64 \pm 0.19	5–10
WBC ($\times 10^3/\mu\text{L}$)	8.49 \pm 0.24	4–12
MCHC (%)	2.7 \pm 0.13	30–36
MCH (pg)	4.10 \pm 0.03	11–17
MCV (fL)	54.0 \pm 1.13	40–60

4.1.4 Haematological Parameters of Male Cattle Slaughtered at the Abattoir

The haematological profile of male cattle presented in Table IV shows that most parameters fall within the reported normal physiological ranges for cattle. The mean packed cell volume (PCV) of $40.3 \pm 0.19\%$ lies comfortably within the reference interval (24–46%), indicating that the animals were not generally anaemic. Similarly, hemoglobin concentration (Hb) was 13.2 ± 0.08 g/dL, which is consistent with the established range of 8–15 g/dL, further supporting adequate oxygen-carrying capacity of the blood. The red blood cell (RBC) count ($7.64 \pm 0.19 \times 10^6/\mu\text{L}$) also fell within the normal range ($5\text{--}10 \times 10^6/\mu\text{L}$), suggesting stable erythropoietic activity in the examined cattle.

The white blood cell (WBC) count ($8.49 \pm 0.24 \times 10^3/\mu\text{L}$) was within the expected physiological limit of $4\text{--}12 \times 10^3/\mu\text{L}$, reflecting no evidence of systemic leukocytosis or leukopenia, which could have otherwise indicated infection or immunosuppression. However, the mean corpuscular hemoglobin concentration (MCHC) and mean corpuscular hemoglobin (MCH) values were markedly lower than the standard reference ranges ($2.7 \pm 0.13\%$ compared to 30–36%, and 4.10 ± 0.03 pg compared to 11–17 pg, respectively). These values suggest possible hypochromic erythrocytes, which could be associated with subclinical nutritional deficiencies, parasitism, or methodological variations in laboratory determination.

The mean corpuscular volume (MCV) was 54.0 ± 1.13 fL, lying within the reference range of 40–60 fL, indicating normocytic erythrocytes. Taken together, the values suggest that, while general haematological indices were within normal limits, deviations observed in MCH and MCHC may require further investigation to rule out iron deficiency anemia or chronic parasitic infestations such as fascioliasis, which is known to cause alterations in blood parameters (Akinrinmade & Akinrinde, 2020; Elghazali *et al.*, 2022).

Overall, the results indicate that the male cattle examined were largely within normal haematological limits, but the abnormal MCH and MCHC values highlight the importance of regular blood profiling to detect early deviations that may not be clinically obvious.

Table 5: Differential Leukocyte Count of Female Cattle Slaughtered at the Abattoir

Leukocyte Type	Mean \pm SE	Normal Range (%)
Neutrophils	26.1 \pm 0.55	15–45
Eosinophils	1.16 \pm 0.16	0–7
Monocytes	1.58 \pm 0.19	0–5
Basophils	0.82 \pm 0.15	0–2
Lymphocytes	70.3 \pm 0.64	45–75

4.1.5 Differential Leukocyte Count of Female Cattle Slaughtered at the Abattoir

The findings from the present study on the differential leukocyte count of female cattle slaughtered at the abattoir revealed mean values for neutrophils ($26.1 \pm 0.55\%$), eosinophils ($1.16 \pm 0.16\%$), monocytes ($1.58 \pm 0.19\%$), basophils ($0.82 \pm 0.15\%$), and lymphocytes ($70.3 \pm 0.64\%$). These values were compared with established reference ranges for cattle, which are 15–45% for neutrophils, 0–7% for eosinophils, 0–5% for monocytes, 0–2% for basophils, and 45–75% for lymphocytes (Radostits *et al.*, 2007; Jones & Allison, 2022). The leukocyte values observed in this study largely fall within the normal physiological ranges, indicating that the cattle were in a relatively healthy hematological state at the time of slaughter.

The neutrophil count was within the expected range, suggesting that the animals did not experience acute bacterial infections or systemic inflammation, as such conditions typically elevate neutrophil levels (Rosenberger, 2021). Similarly, eosinophil counts were normal, which may imply an absence of parasitic infestation or allergic reactions, since elevations in eosinophils are generally linked with such conditions (Tóthová *et al.*, 2019). The monocyte and basophil levels were also within the normal ranges, indicating stable immune surveillance and the absence of chronic inflammatory responses.

Interestingly, the lymphocyte percentage ($70.3 \pm 0.64\%$) was close to the upper limit of the normal range. This lymphocytic predominance is a common finding in healthy cattle, as lymphocytes are the major leukocyte population in ruminants (Kehrli & Harp, 2020). Such findings may also reflect adaptive immune readiness in response to environmental and management conditions at the abattoir. Overall, the results of this study emphasize that the differential leukocyte count can serve as a reliable indicator of the immune and health status of cattle prior to slaughter. These findings are consistent with recent studies reporting similar hematological values in cattle populations under comparable management systems (Adili *et al.*, 2020; Tóthová *et al.*, 2019).

Table 6: Differential Leukocyte Count of Male Cattle Slaughtered at the Abattoir

Leukocyte Type	Mean \pm SE	Normal Range (%)
Neutrophils	30.3 \pm 0.59	15–45
Eosinophils	0.36 \pm 0.09	0–7
Monocytes	0.76 \pm 0.12	0–5
Basophils	0.64 \pm 0.10	0–2
Lymphocytes	68.0 \pm 0.66	45–75

4.1.6 Differential Leukocyte Count of Male Cattle Slaughtered at the Abattoir

The differential leukocyte count of male cattle slaughtered at the abattoir (Table VI) revealed that neutrophils had a mean value of $30.3 \pm 0.59\%$, which falls within the reported normal physiological range of 15–45%. This indicates a stable innate immune response among the animals examined. Neutrophils are the first line of defense against bacterial infections, and their percentage often increases during acute inflammation or stress (Abebe *et al.*, 2023). The recorded values suggest that the cattle were in generally good health at the time of slaughter, with no evidence of acute bacterial challenge.

The eosinophil count was $0.36 \pm 0.09\%$, which is markedly low but still within the expected normal range of 0–7%. Low eosinophil levels are often associated with the absence of parasitic infestations or allergic reactions, conditions that typically elevate eosinophil counts (Akinyemi *et al.*, 2022). This finding suggests that the male cattle were not significantly burdened with parasitic infections, an important consideration in livestock health and productivity.

Monocytes were recorded at $0.76 \pm 0.12\%$, also within the normal reference range (0–5%). Monocytes play a key role in chronic infections and tissue repair, and values within this range indicate a healthy balance of immune surveillance without significant chronic inflammatory stimulation (Okeke *et al.*, 2021). Similarly, basophil levels were $0.64 \pm 0.10\%$, which fall within the physiological range of 0–2%. Basophils are typically the least numerous leukocyte type, and their presence within this range suggests the absence of hypersensitivity reactions (Ibrahim *et al.*, 2022).

Lymphocytes constituted the majority of the leukocytes with a mean value of $68.0 \pm 0.66\%$, also within the normal range of 45–75%. The dominance of lymphocytes is consistent with findings in cattle, where lymphocytes typically outnumber other leukocyte types due to their essential role in adaptive immunity (Choudhary *et al.*, 2023). The balance between neutrophils and

lymphocytes observed in this study indicates a stable immune status, further suggesting that the male cattle were free from significant pathological stressors.

Overall, the leukocyte distribution observed in male cattle at the abattoir suggests that the animals were in good physiological health. The predominance of lymphocytes, coupled with normal neutrophil levels, highlights a balanced immune profile consistent with healthy bovine populations (Tesfaye *et al.*, 2024). These findings contribute to understanding baseline hematological values for cattle in the region, which are essential for disease monitoring and effective veterinary management.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study concludes that fascioliasis remains a significant parasitic disease of cattle in Mubi, with a prevalence rate of 25%. The higher infection rate in female cattle, along with the observed hematological abnormalities, underscores the negative impact of the parasite on animal health, productivity, and by extension, the economic well-being of farmers and butchers. The disease contributes to losses through reduced meat and milk yield, lowered reproductive efficiency, and the condemnation of infected livers at slaughterhouses.

From a broader perspective, fascioliasis represents both a veterinary and public health concern. Considering its zoonotic potential, continuous surveillance and effective control measures are essential. Without intervention, the persistence of the parasite in the cattle population could exacerbate food insecurity and economic hardship for livestock-dependent households.

5.2 Recommendations

Based on the findings of this study, the following recommendations are made:

- i. Farmers should adopt regular and strategic deworming programs using effective anthelmintics to minimize parasite burden.
- ii. Cattle should be restricted from grazing in snail-infested wetlands and irrigation fields where the intermediate host of *Fasciola* thrives. Rotational grazing practices should be encouraged.
- iii. Government agencies and veterinary services should implement environmental snail control programs, particularly in high-risk grazing areas.
- iv. Regular blood tests should be encouraged to identify infected animals early and prevent severe clinical complications.

- v. Extension workers should intensify awareness campaigns on fascioliasis transmission, risk factors, and preventive measures to improve community participation in control programs.
- vi. Policymakers should integrate fascioliasis surveillance into national livestock health programs, with adequate funding to support research, veterinary services, and abattoir inspection systems.

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