PREVALENCE OF *LINGUATULA SERRATA* IN RUMINANTS SLAUGHTERED IN ZARIA, KADUNA AND KANO METROPOLITAN ABATTOIRS, NIGERIA

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DEPARTMENT OF VETERINARY PUBLIC HEALTH AND PREVENTIVE MEDICINE,

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OCTOBER, 2014

DECLARATION

I declare that the work in this thesis titled "**Prevalence of *Linguatula serrata* in Ruminants Slaughtered in Zaria, Kaduna, and Kano Metropolitan Abattoirs, Nigeria**" was performed by me in the Department of Veterinary Public Health and Preventive Medicine, Ahmadu Bello University Zaria, under the Supervision of Dr. J. Kabir and Dr. M. Bello. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this work has been previously presented for another degree or diploma at any institution.

ADAM HASSAN NASSDOURADINE		
Name of Student	Signature	Date

CERTIFICATION

This thesis, titled "**PREVALENCE OF *LINGUATULA SERRATA* IN RUMINANTS SLAUGHTERED IN ZARIA, KADUNA, AND KANO METROPOLITAN ABATTOIRS, NIGERIA**" meets the regulations governing the award of the degree of Master of Science of the Ahmadu Bello University, and has approved for its contribution to knowledge and literary presentation.

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DEDICATION

I dedicate this humble effort, the Fruit of my thoughts and study to my father, Hassan N. (Hassan means Kind) and Affectionate, loving mother, Mariam O. (Mariam means Grace). They always inspired me with kind and graceful ideas of life, their hands always raised in prayers for me and they exhibited a prolonged patience for my studies.

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ABSTRACT

Linguatula serrata is a zoonotic parasite in humans, which causes Linguatulosis. The disease occurs in two forms – visceral and nasopharyngeal. Dog and other carnivorous are the main definitive hosts while most herbivores, including domestic ruminants serve as intermediate hosts for *Linguatula serrata*. The aim of this study is to determine the prevalence of nymphal stages of *Linguatula serrata* in mesenteric lymph nodes of ruminant slaughtered in Zaria, Kaduna and Kano abattoirs. A total of 600 samples were collected, consisting of 100 each of mesenteric lymph nodes of camels, cattle, sheep and goats from Kano, 100 goats from Zaria and 100 goats from Kaduna abattoirs. Eight (1.3%) were found to be infected with *Linguatula serrata* nymphs. The results showed that 3% of camels were infected with *Linguatula serrata* and there was no association between sex (P=0.576), body condition score (P=0.640) and *L. serrata* infection in camels. The infection rate of *Linguatula serrata* nymph in goats in Kano, Kaduna and Zaria were 1%, 2% and 2% respectively, and the overall prevalence in goats being 1.7%, while cattle and sheep were all negative (0%) for *Linguatula serrata* nymph. There was no significant association between age (P=0.197), breed (P=0.513), sex (P=0.180), and body condition score of goats (P=0.797) and *Linguatula serrata* nymphal infection, but there was a significant association between age and *L. serrata* infection in camels (P= 0.030). The higher infection rate of *Linguatula serrata* nymph was found in Zaria and Kaduna than in Kano. The results from this study showed that there was higher rate of *Linguatula serrata* infection in goats and this might be of public health significance.

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CHAPTER ONE

INTRODUCTION

1.1 Background Information

Pentastomiasis is a parasitic zoonosis that is caused by larval stages (nymphs) of pentastome species. They are parasites with the unique phylum which has characteristics of both arthropods and annelids (Muller 2002; Lavrov *et al.*, 2004; Mehlhorn. 2004). It is also called Halzoun syndrome in Middle East and Marrara syndrome in Sudan (Mehlhorn 2004). The species of tongue worms infecting humans are currently classified as *Porocephalida:* they include *Linguatula serrata* and *Armillifer armillatus* (Baird *et al*., 1988).

Linguatulosis (linguatuliasis) is a disease that is caused as a result of body invasion by worm-like parasites of the genus *Linguatula*. Dogs, cats and other wild canines are the main definitive hosts for the parasite while herbivores such as sheep, goats and cattle serve as intermediate hosts. The organism inhabit the upper respiratory tract of terrestrial carnivores and other vertebrates like reptiles and birds (Koehsler, *et al*., 2011). Human infection is often contracted through ingestion of contaminated food and may manifest as nasopharyngeal, visceral, or ocular forms (Lazo.1999; Siavashi.2002). *L. serrata* commonly resides within the nasal passages of canines and felines and occasionally humans. The symptoms in humans are nasopharyngitis, violent coughing, asphyxiation, edematous congestion of gums, tonsils and Eustachian tube, aural pruritus, deafness, frontal headache, sneezing, lacrimation, coryza, yellow nasal discharge, facial edema, vomiting and breathing blockage (Mehlhorn, 2004; John and Petri, 2006).

Humans may serve both as intermediate host with encapsulated larvae in inner organs, and definitive hosts with adult worms in nose (Ma *et al.*, 2002). Human infections can result from

ingesting of raw or undercooked visceral tissues of the intermediate hosts such as sheep, goats, cattle, camel or other herbivores harboring the larval stages of the parasite. The infection can also occur through drinking of water or ingestion of fruits and vegetables contaminated with *Linguatula* eggs (Hami *et al*., 2009).

The parasite is worldwide in distribution but has not been reported in Norway *(*Haugerud., 1986*).* Human infection with *L. serrata* has been reported from different parts of the world including tropical regions of North and South America, Europe, Asia, Africa and Australia (Cheng *et al.*,1986., Tappe, and Buttner 2009). A high frequency of 45% was also reported from a general autopsy study of aborigines in West Malaysia (Prathap *et al.,* 1969).

Pentastomiasis in herbivores is usually asymptomatic but some clinical signs such as diarrhoea, gradual emaciation, anorexia and reluctance to stand has been reported (Ravindran *et al*., 2008; Saiyari *et al*., 1996). In other studies, Marrara syndrome was related to infections of *Fasciola hepatica*, and there was a report of co-infection between *Linguatula serrata* and paratuberculosis, (Drabick 1987 and Mir *et al.,* 2009).

1.2 Statement of Research Problem

Linguatulosis is a disease of veterinary and public health importance in the world including Nigeria. The intermediate hosts are domestic and wild ruminants, which are found mostly in the same environment with the definitive host (dogs). Humans get infected through the consumption of raw or poorly cooked meat.

The pathogen, *L. serrata* is reported to be present in some states of Nigeria in dogs and in ruminants in Sudan (Yagi., *et al*. 1996; Nwosu., *et al*., 2002). Animals from Sudan are moving freely to Chad Republic and Nigeria as initial stock in farms or during E'd festivity every year without any examination or quarantine. Hence, there is a possibility that the disease is present in Nigeria. Dogs are used as pets, hunting animals or in rearing of livestock which bring them in close contact with the owners, sheep, goats and cattle giving room for the complete cycle of the parasite.

The disease is probably misdiagnose in the country since it has symptoms in humans that look like signs of other endemic bacterial and viral conditions that cause sore throat and pharyngitis. There have been reported cases of some Nigerians and Congolese emigrants to Europe and North America that were diagnosed with visceral pentastomiasis and the diagnoses were made after death (Tappe, 2013). This is an indication that, the prevalence in humans is high enough to be noticed in other countries.

1.3 Justification

There is paucity of data on abattoir-based prevalence of *Linguatula serrata* nymph in northern Nigeria despite its presence in dogs within the country (Nwosu *et al*., 2002). In addition, the level of *L. serrata* awareness among abattoir workers and other medical practitioners is low permitting less attention to the disease.

The result obtained from this research will serve as base line information for the disease control and surveillance which may be used for the sensitization of human and animal health workers on the disease and its importance in the area.

In addition, the result of this work will establish the prevalence of *L. serrata*, which will help in development of control strategies for the study area, and will reduce human suffering due to wrong diagnosis and in appropriate treatment.

1.4. Aim and Objectives

1.4.1 Aim

To determine the prevalence of nymphal stages of *L. serrata* in mesenteric lymph nodes of ruminants slaughtered in Zaria, Kaduna, and Kano abattoirs.

1.4.2 Objectives

1. To determine the prevalence of *L. serrata* in ruminants slaughtered in Zaria, Kaduna, and Kano abattoirs.
2. To determine association between age, sex, breed, species, body condition and *L. serrata* infection in ruminants slaughtered in Zaria, Kaduna, and Kano.
3. To determine meat consumption practices that could predispose to *L. serrata* infection.

1.5 Hypotheses

Null hypotheses: Ruminants in Zaria, Kaduna, and Kano do not harbor *L. serrata.*

Null hypotheses: There is no association between age, sex, breed, species, body condition, and *L. serrata* Infection.

CHAPTER TWO

LITERATURE REVIEW

2.1 Biology of *Pentastomids*

The *Pentastomids* are otherwise called "tongue worms" because the adult *Linguatula* worms are tongue-like in shape. Infections with the parasite is referred to as Porocephalosis or Linguatuliasis. Halzoun syndrome is the common name for *L. serrata* infection in the nasopharyngial tract of humans. The disease is also called Marrara syndrome, referring to a popular Sudanese dish consisting of raw liver, lungs, trachea and rumen of goats, sheep, cattle and camel. The animals infected with *Linguatula serrata* may also serve as source of the parasite to humans (Ayinmode., *et al* 2010).

Linguatula serrata is an opportunistic, obligate, endoparasite that infect humans and other omnivores in their immature or mature stages, depending on their diet. It has been found in the eye chambers and livers of humans and mesenteric lymph node of animals where humans or animals have ingested the eggs from the external environment. Carnivores can subsequently feed on infected cadavers or carcasses and the adult parasite develops (Lazo *et al*., 1999).

Linguatula serrata is one of the most commonly studied and understood species of the linguatulids. In fact, *Linguatula serrata* constitutes over 99% of reports from pentastomid infection (Nobel and Nobel., 1982; Lazo *et al*., 1999).

2.2 Morphology of *Pentastomids*

Pentastomids are usually colorless or yellow in colour and vary in size and shape according to their species. The adult parasites are long, flat, or annulated and have four hooks surrounding a central mouth which gives a false picture of five mouths (CDC, 2006).

Most adult linguatulids are elongated, worm-like, cylindrical, and tongue-shaped. Some adult species have body segments ranging between 72–92, while the posterior extremity is often narrow and cylindrical (Sambon, 1922; John and Petri, 2006).

2.2.1 Nymphs

Nymphal stage of the parasite is also parasitic, having C-shaped, hooks and spines. Nymphs are mostly less than 1 cm in diameter, and it can be seeing clearly in chest or abdominal radiographs. (Ma *et al*., 2002; John and Petri, 2006).

Females of *Linguatula serrata* are reported to be much bigger than males, with an average length of up to 80-130 mm and anterior and posterior widths of 8-10 mm and 2 mm respectively. Males are 18-20 mm long; 3-4 mm wide anteriorly, and 0.5 mm posteriorly. The parasite has a simple digestive, nervous systems and primordial genital organs. Eggs are 90 by 70 microns. Color is yellowish and nymphal forms have a single row of minute spines (Sambon, 1922).

L. serrata is the only human pentastome that has prominent spines attached to the parasite's cuticle. The spines measure from 32 mm in the anterior part of the nymph to 16 mm in the posterior parts. They are separated by a mean distance of 11μm, and are placed on each body segment in a row (Lazo *et al.,* 1999).

2.3 Reproduction

Although sexually dimorphic, larger females attempt to find similarly sized males to mate. *Linguatula serrata* females mate once over the course of their lifetime, but due to huge spermathecal storage and oocytes continuously being ejected from the ovary, females can lay thousands or millions of eggs per year (Riley, 1983).

2.4 Life Cycle of *Linguatula serrata*

Linguatulida are obligate parasites having two hosts namely intermediate and definitive host. Development of larva occurs in an intermediate host such as fish, ruminant, rodents and man, while the adults are found in the definitive host which include carnivorous, reptiles, birds and mammals (Hami, *et al*., 2009). Female worms produce several million eggs with the size of 70 - 90 µm, which contain fully grown larvae and are discharged with nasopharyngeal secretion of the definitive hosts into water or on vegetable (Riley, 1983; Haugerud, 1989). Intermediate hosts then ingest the eggs as feed or water contaminant and they hatch in the intestine to release the larvae, which then burrow through the intestine wall and lodge themselves in liver, lungs and mesenteric lymph nodes (Tajik *et al*., 2006). The larvae mature to a pupa-like stage within the viscera, next-developmental-stage nymphs are coiled in a flat, (infective larva) stage in which hooks, annular rings, and spines develop (Tappe and Buttner 2009). The matured nymph migrates to the pleural cavity and other visceral organs like liver and mesenteric lymph nodes and encapsulate until when eaten by definitive host (Drabick, 1987). Once the intermediate host had eaten by a natural definitive host, the larvae migrate to the nasal cavities and mature to adults. The adults ingest food in the final host's respiratory tract using hooks to attach; they feed on blood, lymph and mucus from epithelial cells before they are eject from the definitive host (Drabick, 1987).

L. serrata larvae have been reported to survive for up to two years encysted before they calcify and die in the intermediate host, but the longevity of the adult is not well established (Drabick, 1987; Hami *et al*., 2009). Humans may serve both as intermediate host with encapsulated larvae in inner organs, and definitive hosts with adult worms in nose (Ma, 2002).

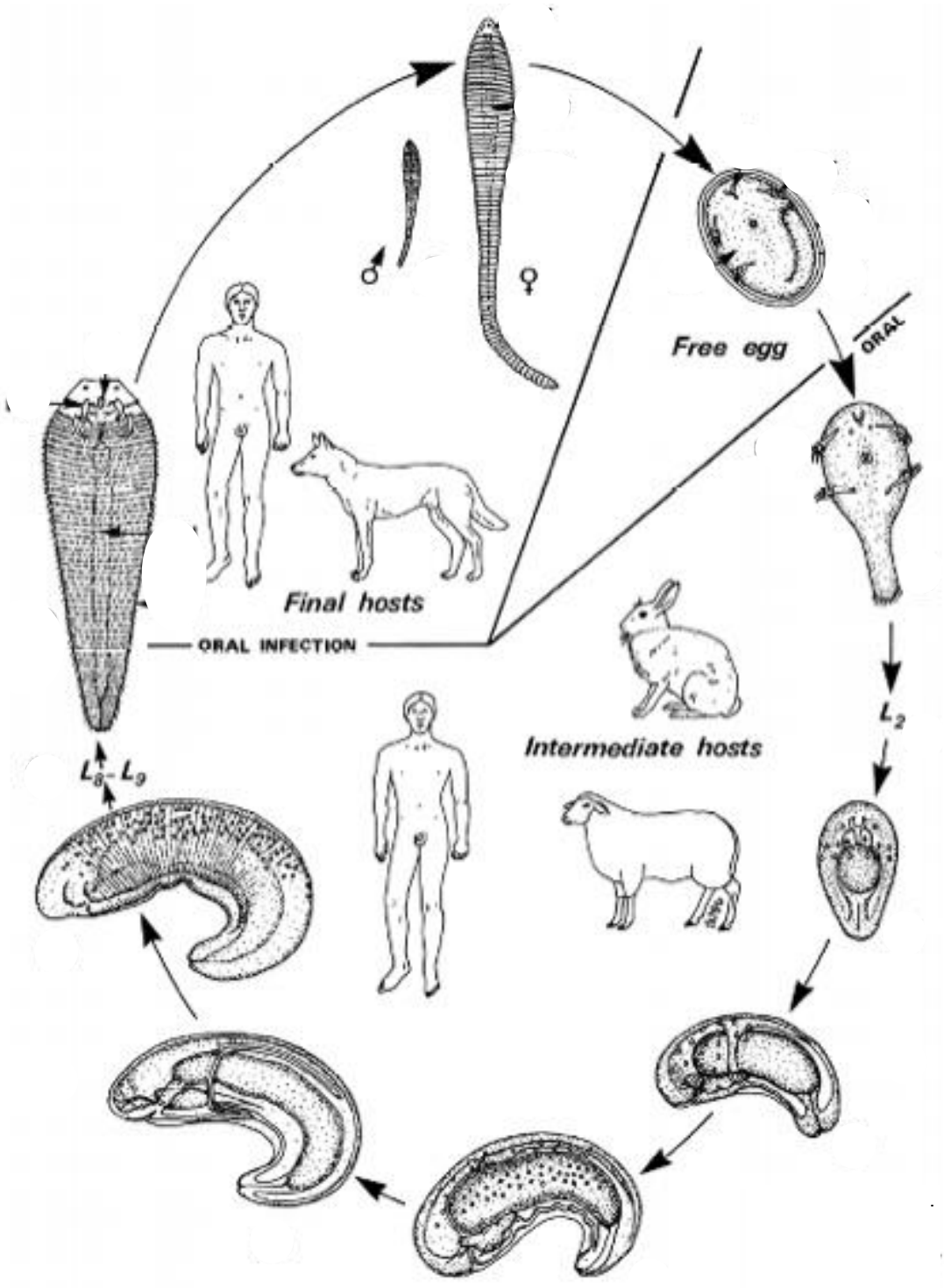

Figure 2.1 Life Cycle of *L. serrata* and definitive hosts by H. Melhorn (2004)

2.5 Incubation Period:

The larval stage development depends on many host factors and also varies across species but it takes several hours for ingested *Pentastomid* eggs to hatch and become primary larvae. In case of Halzoun syndrome, the third-stage larvae migrate almost immediately to the nasopharyngial tract and begin to cause symptoms within a few hours while some may encysted for weeks or months (Hopps *et al*., 1971).

2.6 History of *Linguatula serrata*

Linguatula serrata has been identified and classified long time ago. Froelich made the first classification of the genus *Linguatula* in 1789 and Hayck classified *Linguatula*, a separate order for Tongue-worms, in 1881 (Sambon, 1922). Numerous *Linguatula*-related classifications occurred between 1789 and the early 1900s by other scientist. The complexity of the parasite created problems in taxonomy of the *Pentastomids.* Therefore, in 1819, the Linguatula and several other similar genera were grouped together under the name *Pentastomum*. Van Beneden complicated the situation in 1848 by placing it under genus *Arthropoda*, and Leuckart in 1860 under the class *Arachnida*.

A human infection in Cairo was the first reported case of the disease by Pruner in 1847. Early in its history, Pentastomiasis received much attention from prominent pathologists, but subsequently its study became more sporadic. Leuckart in the 1860's, Sambon in the 1920's, and Fain in the 1960's contributed greatly to our knowledge of Pentastomiasis. Several monographic articles have been written about Pentastomiasis since then, but it still remains a rather obscure condition.

Chabert, a Veterinary Surgeon in 1787 who found *L. serrata* in the nasal cavities of several dogs and horses during his practice, was the first to describe Pentastomiasis as an animal disease (Stanford, 2001).

Linguatulosis in humans has been reported from Africa, Southeast Asia, America and the Middle East (Gardiner *et al*., 1984; Barid *et al*., 1988; El-Hassan *et al*., 1991; Yagi *et al*., 1996; Lazo *et al*., 1999; Acha and Szyfres, 2003). Several reports have documented nasopharyngeal linguatulosis in Iran following consumption of liver kebab (barbecue) (Hodjati and Naghili, 1987; Fata *et al*., 1994; Sadjjadi *et al*., 1998).

2.7 Epidemiology

Pentastomiasis is widespread in distribution, with most human cases occurring in Asia and Africa, Western Hemisphere, and *L. serrata* is usually the infecting species, although rare imported *Armillifer armillatus* infections have been reported in Nigeria (Guardia *et al.,* 1991; Dakubo *et al.,* 2006). Autopsies performed in Nigeria revealed that *Armillifer* was found in 33% of patients who died of malignancies (Smith *et al*., 1975).

In Southern part of Nigeria the disease is also diagnosed in humans through X ray and has been established by detection of calcified, C-shaped, encysted larvae in radiologic films of the abdomen (Dakubo *et al*.,2006; Du *et al.*, 2007). In Malaysia, larval pentastomes were found to be positive in over 45% of a series of consecutive autopsies (Prathap, 1969).

A study in the Democratic Republic of Congo (DRC) found an autopsy prevalence of 23% (Mouchet, 1914). Seroepidemiologic surveys have so far yielded prevalence lower than those

derived from autopsy, however, advances in the serologic detection of pentastomiasis may provide more accurate data (Jones *et al.,* 1991).

2.8 Risk Factors

Close contact to dogs and their secretions predispose to infection with *L. serrata*, and people associated with snakes either by way of consumption snake meat, snake farming, as zoo workers, as veterinarians, keeping snake as pets, and owners of several species of pythons, vipers, cobras, and rattlesnakes may be exposed to ova of *L. serrata, Armillifer, and Porocephalus*. In Nigeria, risk factors such as eating undercooked or poorly roasted meat or visceral, poor hygiene and vegetation contamination of herbs with dog faeces may also pose danger to humans. Consumption of dog meat and offal as delicacies by some tribes in Nigeria may also be a predisposing factor to this zoonosis (Tappe and Buttner, 2009).

2.9 Pentastomiasis in Nigeria

In the mid-western part of the Country *Armillifer armillatus* has been reported (Azinge *et al*., 1978). In 2002, Nwosu *et al.,* carried out a ten-year (1990-1999) retrospective study on prevalence of *Linguatula serrata* among dogs, around the Mambilla Plateau, North-eastern Nigeria, and reported a prevalence rate of 71.9%. These authors also reported a prevalence of 29.4% in a prospective study on 218 dogs. In the same state in Jalingo a prevalence of 37.45% was recorded by Oseni *et al*., 2014. *Armillifer* species has been reported in a 57-year-old female Nigerian farmer - a habitual snake eater - presented with clinical and radiological features of *Armillifer* infestation with hepatic encephalopathy (Ademola *et al*, 2011).

In most cases, the parasites were detected at surgery or at autopsy, mainly in the liver, lungs, and lymph nodes not under diagnostic condition. This may be due to absence of specific clinical symptoms in parasitized dogs (Tappe and Buttner, 2009).

2.10 Predilection Site for the Parasite

Pentastomid nymphs may be found throughout the peritoneal cavity, from which motile living parasites can be extracted during surgery or autopsy. Most parasites are located in the sub peritoneal tissue around the liver, mesentery, spleen, and in the intestinal wall (Reeder *et al*., 2000). Infections of the liver parenchyma (Gast-Galvis, 1960 and Arroyo *et al*., 1986 and Baird *et al*., 1988, and Ma *et al*., 2002.and Machado *et al*., 2006) and abdominal lymph nodes are also frequently noted. Less often, parasites are found in the parenchyma of the lungs and on the pleural surface. (Pampiglione *et al*., 2001; Tappe *et al*., 2006). Rarely, involvement of the heart, eye and other organs have been described (Lazo *et al*., 1999; Ma *et al*., 2002).

2.11 Clinical Features and Pathogenesis

Human infections can result from ingestion of raw or undercooked visceral tissues of the intermediate hosts such as sheep, goats, cattle, camels or other herbivores harboring the larval stages of the parasite. The infection can also occur through drinking of water or ingestion of fruits and vegetables contaminated with *Linguatula* eggs (Wayne and Ronald, 2011).

The halzoun and marrara syndromes are characterized by discomfort in the nasopharyngeal and throat, accompanied by paroxysmal coughing, sneezing, and sometimes dysphagia and vomiting (Khalil *et al*.,1965). These syndromes result when third-stage larvae ingested in raw flesh of an intermediate host migrate from the upper gastrointestinal tract to the throat and nasopharyngeal.

Halzoun and Marrara are most common in the Middle East and the Sudan. Hypersensitivity reactions may lead to dyspnea or even fatal asphyxia. Rarely, infective larvae in the nasopharyngeal develop into adults.

Humans are usually highly tolerant of infection by pentastomes. Some authorities attribute this tolerance to the immune modulatory effect of the frontal gland secretions that coat the larvae's cuticle and facilitate evasion of the host immune response (Jones *et al*., 1991). The initial phase of pentastomiasis in all intermediate hosts is probably the penetration of the gut wall by first-stage larvae, after embryonated eggs have been ingested in contaminated meat, water, or vegetation (Wayne and Ronald, 2011). In the abdomen, first-stage larvae molt twice and develop into infective third-stage larvae. Most, but not all, third-stage larvae encyst and lodge in various sites, showing a predilection for the mesentery and peritoneum, and on or within parenchymatous abdominal organs. First-stage larvae that enter the lymphatic or blood system in the gut wall frequently invade the lungs and occasionally the brain, but may appear in virtually any site. Even when infection involves numerous third-stage larvae, pentastomiasis is usually asymptomatic. However, as the developing larvae gradually enlarge, they may exert pressure on surrounding structures, causing complications such as biliary obstruction, dysphagia and dyspnea (Wayne and Ronald, 2011). In the eye, pentastomes may cause multiple lesions, including iritis, subluxation of the lens, secondary glaucoma, conjunctivitis, and invasion of lacrimal caruncles (Lazar, and Traub 1967; Polderman and Manschot, 1979; Lang *et al*., 1987). Other conditions attributed to pentastomes, including pneumonitis, collapsed lung, peritonitis, nephritis, meningitis, and pericarditis, in most cases only a tenuous causal relationship has been established (Tiendrebeogo, *et al*., 1982; Drabick, 1987; and Yapo *et al.*, 2003). Intestinal obstruction and

hepatoma-like syndrome may be caused by pentastomiasis as well (Fisch *et al*., 1985; Machado *et al*., 2006).

2.12 Transmission

2.12.1 Visceral linguatuliasis

Man acquires the visceral form by ingesting vegetables or water contaminated with parasite eggs shed with the faecal matter, saliva or nasal discharge of dogs or other definitive hosts (Yilmaz *et al*., 2011). When the infection occurs from the ingestion of eggs, the larvae become encapsulated in various organs, where they can survive up to two years. When the larvae die, they are absorbed or the cyst can calcify. The larvae are located as mainly in the liver and, to a lesser extent, in the mesentery and intestinal wall (Baird *et al*., 1988). Ocular linguatuliasis is extremely rare with fewer than ten cases having been described from the southern US, Portugal, Israel, Ecuador and Austria (Lang *et al.*, 1987; Lazo *et al* 1999; Koehsler *et al*., 2011; Pal *et al.*,2011).

2.12.2 Nasopharyngeal linguatuliasis

The nasopharyngeal form, also known as "Halzoun" (named for the traditional Middle Eastern dish made by raw mutton or beef) or "Marrara" syndrome (named for the traditional dish consisting of raw sheep or goat liver common in the Sudan), often occurs after consumption of raw or undercooked viscera (liver, lung and lymph nodes) of goats, cattle, or other infected domestic herbivores. (El-Hassan *et al.*, 1991; Yagi *et al*., 1996; Acha and Szyfres., 2003). In these cases, the larvae emerge from their cysts in the stomach and migrate up the esophagus to the nasopharynx, where they anchor to the mucosal epithelium with prominent hooks (Baird *et al*., 1988).

2.13 Symptoms

Most cases of linguatuliasis are asymptomatic and many go undetected. Symptoms depend on the organ system involved and result from the death of nymphs or their migration. If only a few parasites are present, *L. serrata* may mimic hepatic or pulmonary malignancy clinically and on radiological assessments (Tappe and Buttner, 2009).

2.13.1 Visceral linguatualiasis

Although most human infections are, asymptomatic patients may develop abdominal pain, chronic cough or night sweats. Encysted nymphs do not produce clinical symptoms and the infection is always discovered during surgery, radiological examination or autopsy.

2.13.2 Nasopharyngeal linguatualiasis

Symptoms appear a few minutes after the infective food is consumed (Acha and Szyfres., 2003). Incubation period varies depending on where the nymphs are released from their cysts. The most common symptoms are throat irritation and pain. Sometimes there is congestion and intense edema of the area. Lacrimation and nasal discharge are common. At times, there is also dyspnea, dysphagia, vomiting, headaches, photophobia and exophthalmia. The course of the disease is rapid and benign. About half of patients recover in less than one day; in others, the illness may last one to two weeks.

Symptoms depend on the organ system involved and result from the death of the nymphs or their migration. If only a few parasites are present, *L. serrata* may mimic hepatic or pulmonary malignancy clinically and on radiological assessments. Patients may develop abdominal pain, chronic cough, or night sweats (Pampiglione, *et al.,* 2001; Machado *et al.,* 2006; and Tappe *et al.,* 2006). In heavy infections with *Armillifer* spp., death may occur due to secondary

septicemia, pneumonia, or severe enterocolitis (Ma *et al.*, 2002; Yapo *et al.*, 2003). However, most human infections are asymptomatic, and the disease may be an incidental finding during routine medical consultation or at autopsy.

The symptoms usually subside within 7-10 days, but sometimes complications can occur damage to facial nerves or perforation of the eustacean tube have sometimes been observed. Halzoun syndrome is also related to infections of *Fasciola hepatica*, liver flukes. (Drabick, 1987). The larvae, in almost every case ever reported, do not mature, their human hosts elminating them within three weeks. However, in two reported cases, adult *Linguatula* developed within humans' nasopharyngial tracts, causing nosebleeds and pressure within the nose (Hopps 1971). Infections of other areas, like the eyes, by third stage larvae, has also been observed

In most cases infected dogs and cats show no clinical signs. However, massive infections can cause rhinitis (inflammation of the nose) and nasopharingitis with chronic sneezing and/or coughing, purulent nasal discharge, nose bleeding (epistaxis), and so on.

In livestock**,** most infections with nymphs are benign and remain asymptomatic. In case of infrequent massive infections, clinical signs may develop depending on the affected organs (Junquera, 2013).

2.14 Pentastomosis and Cancer

The living nymph provokes little inflammation, whereas the death of the parasite leads to a prominent host response (Baird and Carey, 1997). Most findings of visceral linguatuliasis are made at autopsy. In (1921) Galii-Valerio reported a human case of fibrosarcoma of the nasal cavities invaded by an adult of *Linguatula serrata.* Tobie *et al.,* (1957) reported a tongue worm

(Linguatula serrata) infestation in a patient with acute leukemia. They have observed a bronchial carcinoma in a Komodo *varanus* which was infected with *Sambonia lohrmanni.* This cancer had apparently originated from a villous papilloma of the bronchial mucosa (Fain, 1974). Several young larvae of this pentastomid were found inside the intestinal villi. Other larvae or nymphs were embedded in the tracheal mucosa, this host was also infected by the adult form of the same pentastomid (Fain, 1960). These observations are however not sufficient to prove the carcinogenetic action of larval pentastomids. In addition, high frequency of the primitive cancer of the liver in Africans, could be in relation with the great prevalence of the nymphal pentastomosis of the human liver in Central Africa (Meyers *et al*. 1976). It should be necessary to select for that purpose animals that are especially susceptible to this kind of cancer (Fain, 1974). In addition, many researchers speculate that pentastomes provoke malignancies (Smith, *et al*., 1975).

2.15 Diagnosis

Diagnosis should be made etiopathologically, subetiologically or presumptively on the basis of whether entire nymphs, cuticle-associated structures, or pearly lesions (linguatula nodules) with structure appearance are found (Tappe, 2006). The parasitic lesions may be confused with malignancies, leading to a delay in correct diagnosis.

Linguatula serrata can be detected on pulmonal or abdominal radiographs, showing a horseshoe or C-shape (Reeder *at el*., 2000). Hematology of total blood picture also may reveal a mild eosinophilia. An ELISA based on the 48 kDa frontal gland metalloproteinase of pentastomes may increase the efficacy of serologic testing (Jones and Riley., 1991). Recently, PCR has been used for diagnosis in veterinary infections (Brookins *et al*., 2009; Tappe *et al*., 2011).

Histopathological diagnosis remains the gold standard for visceral pentastomiasis. The visceral form caused by nymphs is rarely diagnosed in living persons or domestic animals, except during surgery, radiological examination (X-rays detect cysts or granulomas), or autopsy (Lazo *et al.,*1999). Specific diagnosis can be made by identification of the nymph in a biopsy specimen.

Diagnosis in dogs and cats is based on the respiratory signs and can be confirmed through detection of eggs in the nasal discharge or in the feces. However, egg shedding is intermittent, which can lead to false negatives. Adult worms can be directly visualized in the nasopharynx through rhinoscopy or rhinotomy. (Junquera, 2013).

2.16 Treatment

Pentastomiasis in humans does not require drug treatment. However, patients who become symptomatic, such as those with halzoun or marrara, may require surgical removal of free or encysted parasites in the eye, throat, or nasal passages (Wayne and Ronald, 2011). Supportive treatment with drugs such as antihistamines may be required in case of hypersensitivity reactions brought on by the syndromes.

Exploratory laparotomy may be carried out for patients with acute abdominal symptoms or those with radiologic evidence of pentastomiasis. Infected mammals, snakes, and captive monitor lizards have been successfully treated with ivermectin, sometimes combined with corticosteroids to reduce inflammation and surgery to remove dead pentastomes (Haugerud *et al.*, 1993; Flach *et al*., 2000). There are no reports of humans being treated with ivermectin, but the drug's efficacy in humans should be investigated. Diethylcarbamizine has been suggested as a treatment for

linguatuliasis, but its usefulness has not been established. In general, pentastome infections in humans can be prevented by adequate sanitary precautions and good eating habit.

Once diagnosis is established, no treatment is necessary for the parasites will degenerate after some time, and no effective anti-parasitic therapy exists. Only in symptomatic infections with numerous parasites may a surgical approach have to be considered (Tappe and Buttner, 2009).

2.17 Prevention

Larval infection through the ingestion of the eggs can be prevented by guarding against drinking water used by canine and other wild carnivores or raw food contamination with depositions of the raw viscera of goats, sheep or other herbivores (Acha and Szyfres, 2003).

Public health education on the route of the disease transmission to those at higher risk like dog handlers and snake owners. There is need to establish endemic foci of the disease and it's prevalence for policy making and stake holders sanitization (Baird *et al*.,1988; Tappe and Buttner, 2009).

There is need for improved meat inspection in *Linguatula serrata* in endemic regions to prevent human infection.

2.18 Control of *Linguatula serrata* Infections

The best control measure of *Linguatula serrata* consists in keeping dogs and cats away from raw offal of cattle, sheep, and other livestock, and preventing them to scavenge on potentially contaminated food such as abattoir scraps as well as preventing dogs from patronizing livestock grazing areas and watering points to diminish vegetation and water contamination.

To prevent human infection in endemic regions, the basic hygienic measures have to be followed which include; frequent hand washing with soap, eating only cooked or well washed food, never eating uncooked innards or vegetable, avoiding also close contact with pets and quickly removing their droppings. Improved sanitation and Public health education concerning the disease danger and preventive measure is also important.

In Heavily infected dogs or cats, surgical removal is often the only alternative. There are virtually no veterinary medicines approved for the control of *Linguatula serrata* in dogs, cats or livestock. There are a few reports showing that injectable ivermectin was effective against a related species, *Linguatula arctica* in reindeer (Junquera, 2013).

There are so far no true vaccines against *Linguatula serrata*. Biological control of *Linguatula serrata* (i.e. using its natural enemies) is so far not feasible (Junquera, 2013).

2.19 Economic Importance for Humans

Many human infections occur in underdeveloped areas of the world like the Middle East, India, Africa, and Southeast Asia, where eating raw glands of cattle, sheep, and other herbivorous mammals is a part of a normal diet. Infection may also be acquired through ingestion of eggs from plants or water in the environment. Infestations of the worm are frequent in humans, and deaths have even been reported due to blocked nasal passages. Because humans are often the accidental intermediate or final host of *L. serrata*, the pentastomid is of medical and economic importance. (Behrmann, 2012) Those who can afford medical help can direct their treatment

either towards eliminating the nymphs in their system or relieving the symptoms of infestation through nasal sprays or antihistamines. (Tavassoli *et al*., 2007).

Linguatula serrata frequently infects domesticated animals used for agriculture, stray animals, and animals used for different purposes. Infection in liver, mesenteric lymph nodes, and other glands may cause weakening and death of the animals, thus weakening the agricultural economy (Behrmann, 2012).

2.20 Cases Reported

2.20.1 Iran.

This specimen was isolated from a 10-year-old boy resident in Shahriar County in Tehran Province, with presentation of a discomfort and prickling sensation in the throat, sneezing, coughing and nasal discharges following the consumption of hamburger in the last day and undercooked sheep liver (Anaraki *et al.*, 2008).

2.20.2 Turkey.

A patient, who was 26 years old, lived in the Erciş town of the Van region, East Turkey. She was admitted to the Infectious Diseases Service of Erciş Government Hospital with complaints of coughing out a worm about 4 cm long from oral cavity. Besides coughing, a burning sensation in the nasopharyngeal mucous membranes, sore throat, and loss of voice, vomiting and fatigue were among the patient's complaints, and she reported that the complaints began three days earlier (Yılmaz *et al*., 2011).

2.20.3 Germany

A recent infection with *L. serrata* in a patient who had pulmonary symptoms and in whom malignancy was suspected. The patient was a 39-year-old man of Russian origin who had been lived in Germany for some years. He was admitted to the hospital with weight loss, night sweats,

chest pain, and coughing. He had been a smoker for 20 years, and his past medical history included pneumonia and sinusitis (Tappe *et al*., 2006).

2.20.4 China

A 53-year-old male native of Shanghai died of heart failure because of cardiovascular syphilis. During the postmortem examination many protruding `pearls' (< 1 cm in diameter) were found incidentally over the serosal surface of the small intestine and the capsules of liver and spleen with extensive adhesions to the diaphragm. Histological examination revealed neither the embedded pentastomid nymph nor pathognomonic hallmarks of pentastomiasis or any of the pathological signs of tuberculous infection. However, in the protruding `pearls', characteristic concentric targetoid calci® cations were found, each in a core of caseation with hyalinized capsule (Ma *et al*., 2002).

2.20.5 Middle East

Nymphs of *Linguatula serrata* have been removed from the naso-pharynx of patients suffering from halzoun or marara syndrome (Schacher *et al.*, 1969).

2.20.6 North America

Nymphs have been found in the anterior chamber of the eye of a man on two occasions in North America.So far, the halzoun syndrome had been attributed to the presence in the naso-pharynx of flukes *(Fasciola hepatica)* or leeches. (Hunter and Higgins, 1960; Rendtorff *et al.*, 1962)

2.21 Disease Contracted

The highest prevalence of visceral pentastomiasis due to *L. serrata* has been reported from the Middle East (Khalil, 1972), where high infection rates of dogs, the final host for *Linguatula*, have been noted. In Central and South America, sporadic cases have also been described (Arroyo *et al.*, 1986; Machado *et al.*, 2006). The disease is rare in Europe, the United States, and China,

where only a few cases have been reported (Tappe and Buttner, 2009). Infections with *Armillifer* spp. are most prevalent in West Africa, Central Africa and Malaysia (Prathap *et al.*, 1969), where snakes, the final hosts of these parasites, are locally prepared for food. Autopsies performed in med-western part of Nigeria revealed that *Armillifer* was found in 33% of patients who died of malignancies (Smith *et al*., 1975, and Dakubo *et al*., 2006). A high frequency of 45% was also reported from a general autopsy study of aborigines in West Malaysia (Prathap *et al.*, 1969). In Europe and North America the disease is rarely diagnosed, but it may be observed in immigrants from endemic areas and long-term travelers. The disease prevalence of 71% was reported from dogs at Mambilla Plateau state but data on human prevalence around the areas is limited.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Area of Study:

3.1.1 Kano

Kano State is the densely populated State in Nigeria with an estimated population of 9,383,682 people according to 2006 census (KSG, 2013). It has 44 Local Government Areas, 12 of which are within the metropolitan. The State is located on latitude 11° 30 North and longitude 8° 30 East in north-western Nigeria, with an area of 42,592,8km^2 (KSG, 2013). The metropolitan abattoir where the study took place has an average slaughter figure of about 70–100 camels, 450–500 cattle, 700 sheep and goats (Sanusi, 2012).

3.1.2 Kaduna

Kaduna State is located in north-west zone of Nigeria. It lies between latitude 09° 02 N 11° 23 N and longitude 06° 15 E and 08° 60 E. The State has an area of about 46,053 km² with a human population of 6.066.562 (2006 census), and 23 Local Government Areas (LGAs). Zaria, one of the major towns in the State, has a population of 408,198 according to 2006 census (KDSG, 2008). There are two distinct seasons in Kaduna State, namely wet and dry seasons, the wet season spans the period between April/ May and September/ October with a total annual rainfall varying between 1,000mm and 1,500mm. While the dry season spans the period between October /November and March/ April (Mamman *et al*., 2000).

Agriculture is the main stay of the economy of Kaduna State with about 80% of the people actively engaging in farming. Animals reared including cattle, sheep, goats, and pigs (Mamman

et al., 2000). Samples for this study were obtained from Zango abattoir in Sabon-gari Local Government Area and Kawo abattoir in Igabi LGA (Fig 3.1).

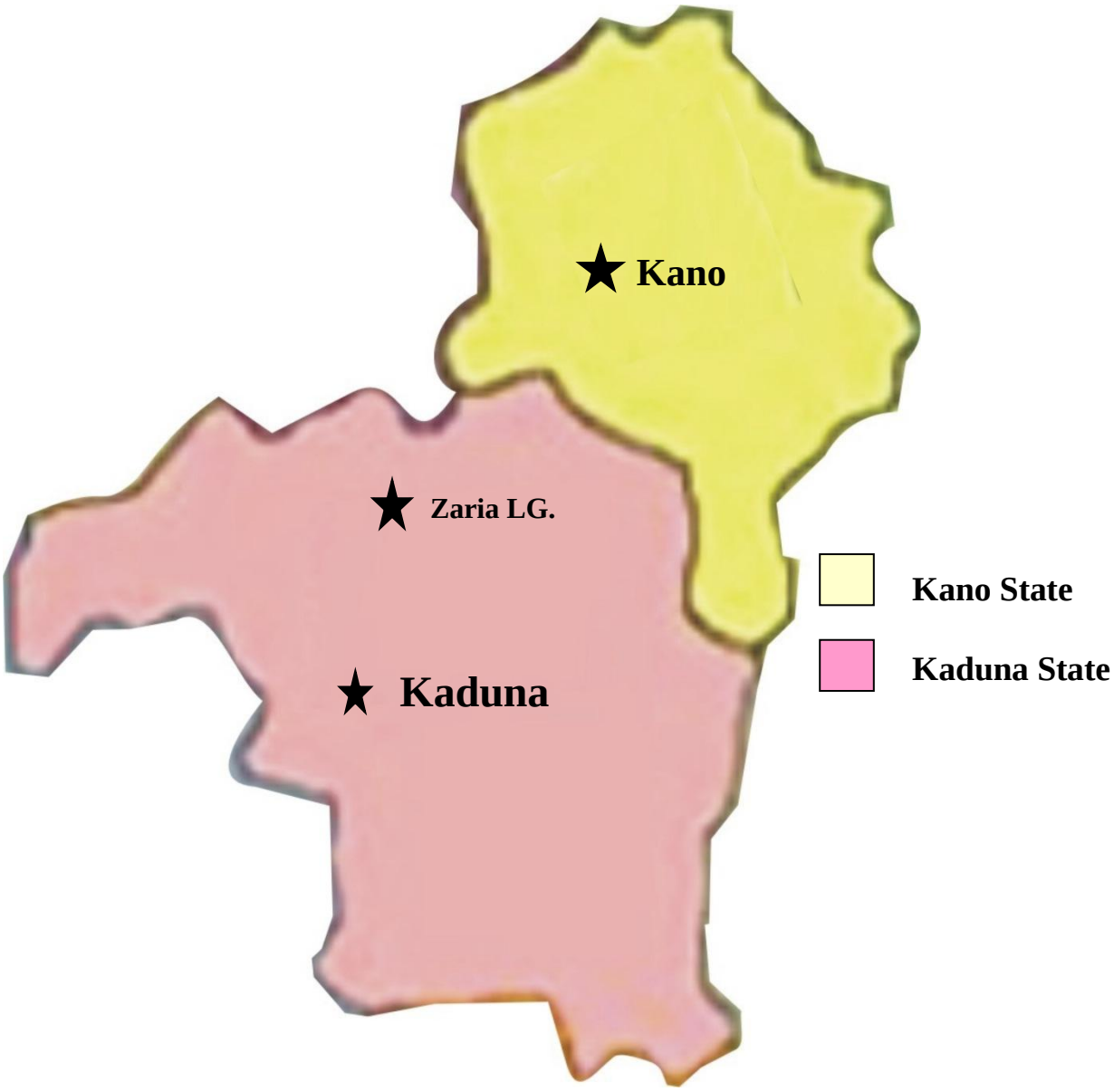

Fig 3.1 Map of Kaduna and Kano States showing study areas.

Source: Modified from www.mappery.com

3.2 Study Design

This is a cross-sectional study in which animals slaughtered in Kano, Kaduna, and Zaria abattoirs were selected for the presence of *L. serrata* nymph. The largest abattoirs were identified, and selected as sampling units in each town.

Four species of livestock commonly slaughtered, namely: cattle, sheep, goats and camels were studied. Only animals meant for slaughter and available in the abattoir were sampled.

3.3 Sample Size Determination

Sample size was determined by using the formula of Thrusfield (1997) at 95% confidence level.

$n = z^2pq/d^2$

Where;

n = sample size

n = appropriate value for the standard normal deviate set at 95% confidence interval (1.96)

q = complementary probability (1-p)

p = prevalence

d = desired absolute precision 0.05

A pilot study was conducted on four species of food animals meant for slaughter namely: cattle, sheep, goat and camel from which 100 samples were under taken. The prevalence of 1% was recorded and used in the sample size calculation. A total of 600 animals were proportionately sampled based on availability and the prevalence in the pilot study.

3.4 Sample Collection Procedure

Mesenteric lymph nodes were sampled from the carcasses of cattle, sheep, goats and camel conveniently based on availability and willingness of the owner to either sell or donate. Mesenteric lymph nodes are located around the small intestine embedded in the connective tissues and fat surrounding the intestine. Blunt dissection method was used in removing the lymph nodes intact without breaking the nodes or the intestine. At the time of slaughter species, breed, sex, and body condition score of each animals were determined. The body condition score was determined using the method of Morrical and Hettel 1986. The lymph nodes collected were placed on ice in coleman boxes and transported to parasitic zoonoses laboratory, Ahmadu Bello University. Zaria.

Aging of the animal was done through examination of cornual ring markers in cattle and dentition in sheep, goats and camels as described by Philips (1977).

Species of animals (Sheep, Goats, Cattle, and Camel) were determined using visual identification.

Meat consumption practices that predispose to *L. serrata* infection was determined through administration of structured pretested questionnaire to meat consumers at the abattoirs, within and surrounding meat marketing premises.

3.6 Sample Processing

The digestion solution was prepared as described by Muller (2002). Briefly, 5g of pepsin enzyme was added to 25 ml of 1.0M hydrochloric acid. The resulting solution was topped up with water to a total volume of one litter. Approximately one hundred gram of minced tissues was

submerged in the solution and incubated at 37 °C for 24 hours, after which the solution containing the digested tissues was poured into a Petri dish and viewed using stereomicroscope. Positive samples were determined by the presence of the nymphs of *L. serrata*. Confirmation of the worms nymph was by the features of the nymphs such as tongue shape, transverse striation and spines (Tappe and Buttner, 2009). All these features were achieved by examining the parasite under x40 magnification of a microscope.

3.8 Data Analysis

Statistical Package for Social Sciences (SPSS version 17.0) was used to analyze the data obtained and results were presented in form of Tables and charts. Chi-square tests, Odds ratio and 95% confidence interval was used to show the association between variables (Age of animals, sex, Breeds, species, Body condition and presence of *L serrata*). P value < 0.05 was considered significant, for these analyses.

CHAPTER FOUR

RESULTS

4.1 Prevalence of *Linguatula serrata* in Different Variables

4.1.1 *Linguatula serrata* in ruminants slaughtered in Zaria, Kaduna and Kano

Of the 600 animals examined, 300 were goats, 100 sheep, 100 cattle, and 100 camels. The overall prevalence of *Linguatula serrata* in the animals studied was 1.3% (8/600). The larval and the nymphal stages of the parasite was recovered from mesenteric lymph nodes of 5 (1.6%) goats and 3 (3%) camels. The larval was a C-shaped (Plate I), and the nymphal stage of the parasites were tongue-shaped, flatted, transversely striated with spines (Plate II).



Plate I: Larval stage of the *Linguatula serrata* recovered from the Mesenteric Lymph Nodes of camel (Light microscope x40 magnification using digital camera) at this stage it showed C-shape and no striation rings no spines.

4.1.2 Prevalence of *Linguatula serrata* based on the abattoirs location

Out of the 400 animals tested in four different species in Kano, only 4 were positive, giving prevalence of (1%) of *Linguatula serrata*. In Kaduna abattoir out of 100 goats sampled, 2 (2%) were positive. In Zaria abattoir 100 goats were studied out of 2 (2%) were positive. Thus, the prevalence of infection with *Linguatula serrata* in the three abattoirs was 1.3 (8/600). (Table 4.1)

4.1.3 Prevalence of *Linguatula serrata* in sex of goats and camels slaughtered at abattoirs

Based on the sex of goats, the infection was higher in the females, 3 (2.2%) than in the males 2 (1.2%). The prevalence in male camels was 3.6%, and only one in female with a prevalence of 2.2%. In general, 3 camels were positive out of 100 camels examined. There was no significant difference ($p > 0.05$), in the prevalent rates in both sexes, (Table 4.2).

4.1.4 Prevalence of *Linguatula serrata* based on goats breed

Of the 147 Sokoto Red goats sampled, 4 were positive (2.7%) ; while only 1 of the 123 Kano Brown goats (0.8%) were positive .None of the 30 West African Dwarf goats were positive for infections (0%) with *Linguatula serrata*. There was no significant association between the breed (P=0.513) and infection with *Linguatula serrata* (Table 4.3).

Table 4.1: Prevalence of *Linguatula serrata* based on the abattoir location

Location	No examined	No Positive	Percentage (%)	Variance	P-value
Kaduna	100	2	2.0	0.019798	0.81751
Kano	400	4	1.0	0.01	
Zaria	100	2	2.0	0.019798	
Total	600	8	1.3	-	

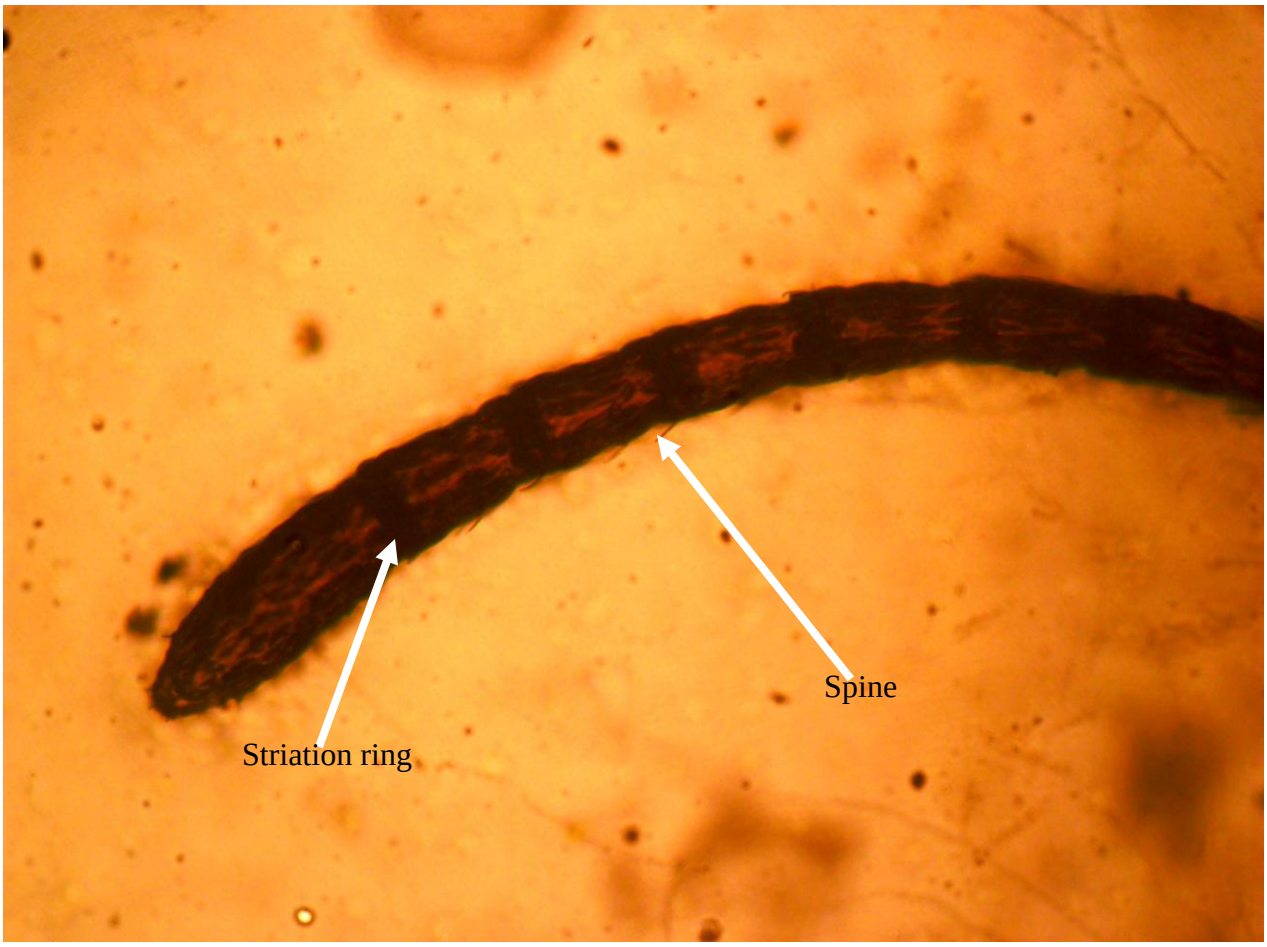

Plate II: Nymphal stage of the *Linguatula serrata* recovered from the Mesenteric Lymph Nodes of goat (Light microscope x40 magnification using digital camera) arrows showing the striation rings and spines.

Table 4.2: Prevalence of *Linguatula serrata* in different sexes of goats and camels slaughtered at abattoirs

Sex	Goats			Camels		
	No Examined	No Positive (%)	**0R (95%CI)**	No Examined	No Positive (%)	**OR (95% CI)**
Male	164	2(1.2%)	0.55 (0.09-3.32)	55	2(3.6)	1.66 (0.15-18.93)
Female[(ref)]	136	3(2.2%)	1	45	1(2.2)	1
Total	300	5(1.6 %)		100	3(3.0)	

*ref; Reference category

Fishers Exact Test: P = 0.180 P = 0.576

Table 4.3: Prevalence of *Linguatula serrata* based on goats breed

Breed	No examined	No infected	Percentage
Dwarf	30	0	0.0%
Kano brown	123	1	0.8%
Sokoto red	147	4	2.7%
Total	300	5	1.6%

Fishers Exact Test: P = 0.513

4.1.5 Prevalence of *Linguatula serrata* across age groups of goats and camels

The prevalence of *Linguatula serrata* across age groups of animals is shown in Table 4.4. Out of the 300 goats examined, 26 were under 1 year of age and *Linguatula serrata* was not recovered from any member of this age group, while 2 (2.1%) out of the 169 goats, aged 1- 2 years had the parasite. Similarly, 3 (2.9%) of the 104, 3 – 4 years old goats were positive for *Linguatula serrata.* Only one goat was found to be more than four years of age and was negative for the parasite.

Out of 100 camels examined, 12 (12%) were under the age group of 1-2 years and none was found habouring the parasite, 1 (1.5%) member of the age group 3-4 years was positive for *Linguatula serrata* nymph while 2 (9.5%) of camel in the more than 4 years group were positive for the nymphal stage of the parasite. There was a statistically significant difference between age group of camels and infection with *Linguatula serrata* ($p = 0.03$).

4.1.6 Prevalence of *Linguatula serrata* in relation to body condition score of the animals

When the occurrence of the parasite was recorded based on body condition score, 43 goats with poor body condition score had a prevalence of 2.3%. While the 209 goats with medium body condition score had a prevalence of 1.9%. Goats with good body condition score were 48, the parasite was not recovered from any of the goats in this category. The 27 of camels with poor body condition score had a prevalence of 3.7%, while the 41 camels with medium body condition score had a prevalence of 4.9%. All the camels with good body condition score were negative. There was no significant association ($P=0.640$) between infection with *Linguatula serrata* and body condition score of the animals sampled (Tale 4.5).

Table 4.4: Prevalence of *Linguatula serrata* across age groups of goats and camels

Age (years)	**Goats**		**Camels**	
	No Examined	No Positive (%)	No Examined	No Positive (%)
< 1	26	0 (0.0%)	0	0 (0.0%)
1 – 2	169	2 (1.2%)	12	0 (0.0%)
3 – 4	104	3 (2.9%)	67	1(1.5%)
> 4	1	0 (0.0%)	21	2 (9.5%)
Total	300	5 (1.6 %)	100	3 (3.0)

Fishers Exact Test: P = 0.197 P = 0.030

Table 4.5: Prevalence of *Linguatula serrata* in relation to body condition score of goats and camels

***B.C.S/Species**	Goats		Camels	
	No Examined	No Positive (%)	No Examined	No Positive (%)
Poor	43	1 (2.3%)	27	1 (3.7%)
Medium	209	4 (1.9%)	41	2(4.9)
Good	48	0 (0.0%)	32	0 (0.0%)
Total	300	5 (1.6 %)	100	3 (3.0)

*B.C.S: Body Condition Score: Poor = 2, Medium = 3, Good = 4

Fishers Exact Test : P = 0.797 P = 0.640

4.2 Result of Questionnaire Summary

4.2.1 Demographic features of the respondents.

One hundred and fifty structured questionnaires were administered to the meat consumers at Kano, Kaduna, and Zaria abattoirs. Up to 78.0% (117/150) of the respondents were males while 22.0% (33/150) were females. Thirty one (20.7%) of the respondents were in the <18 age category, 68.7% (103/150) between 18-60, and 10.6% (16/150) > 60 years of age. Among these 150 respondents, 14% (21/150), 31.3% (47/150), 27.3% (41/150) and 27.3% (41/150) had either tertiary, secondary, primary, or other forms of education respectively. Based on their occupation, 13.4% (20/150) were civil servants, 8.7% (13/150) were farmers, 20% (30/150) were business men, 31.2% (47/150) were butchers, 26.6 (40/150) were others (Table 4.6).

4.2.2 Preferred meat for consumption of the questionnaire respondents

Majority of the respondents preferred beef (38%) followed by goat meat (32.1%), mutton (20.6%), camel meat (9.3%), and snake meat (0%), (Fig 4.1). As regards the preferred part of the animal for consumption, liver was most preferred (47%), followed by meat (29%), kidney (17%), fat (5%), lung (2%), and lymph nodes (0.0%), (Fig 4.2). Also, majority of the respondents (47%) did not know about any meat-borne disease. Only 16% knew about tuberculosis, while 10%, 7%, 5%, 4%, 3%, 3%, 2%, and 2% knew about taeniasis, fasciolosis, salmonellosis, F.M.D, *E.coli*, C.B.P.P, Brucellosis, and Anthrax respectively (Appendix IV).

Table 4.6: Demographic Characteristics of Respondents

Variables		Number	Percentage (%)
Gender	Male	117	78.0
	Female	33	22.0
Age (years)	<18	31	20.7
	18-60	103	68.7
	>60	16	10.6
Level of education	Tertiary	21	14.0
	Secondary	47	31.3
	Primary	41	27.3
	Others	41	27.3
Occupation	Civil servant	20	13.4
	Farmer	13	8.7
	Business	30	20.0
	*Butcher	47	31.2
	Others	40	26.6

* Including meat sellers

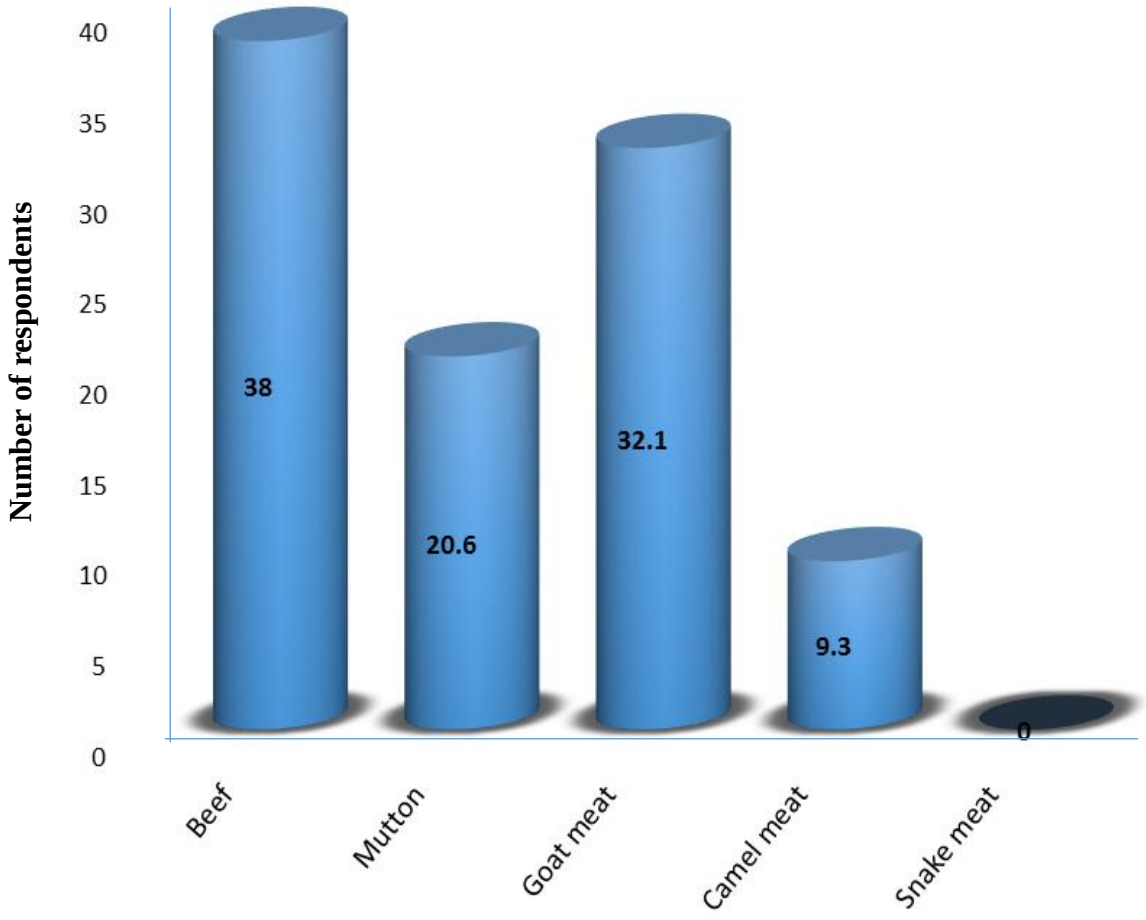

Fig: 4.1 Preferred animal meat for consumption by the questionnaire respondents

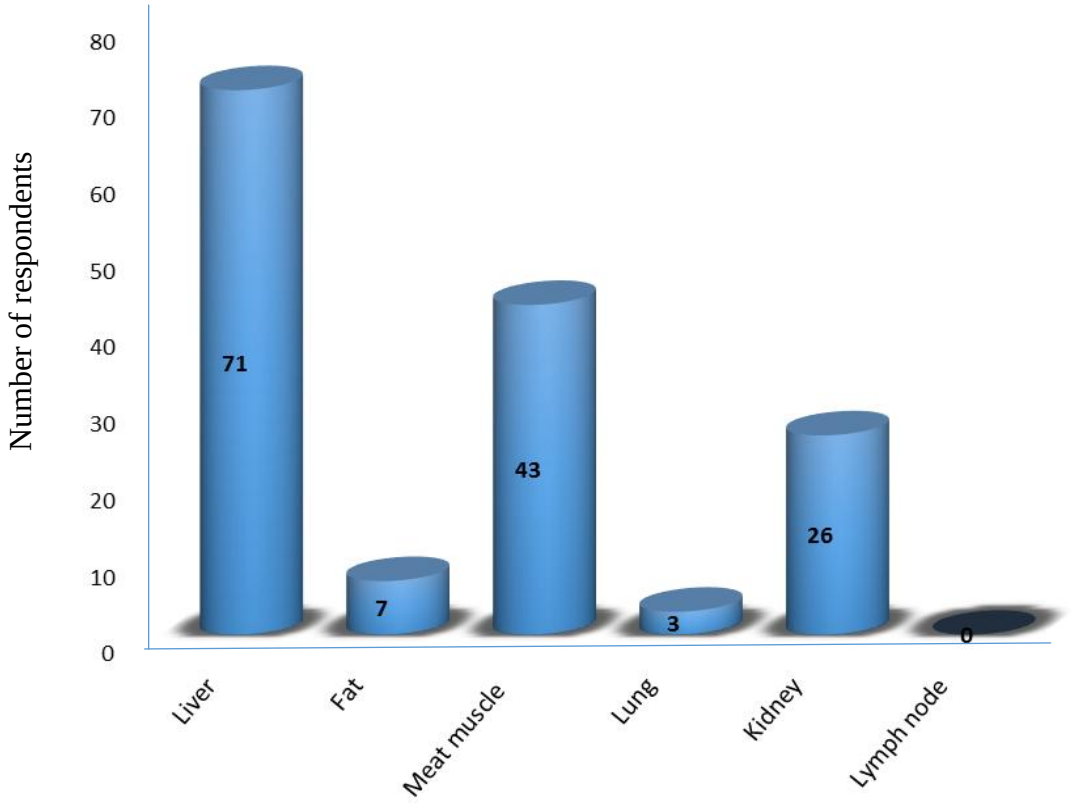

Fig 4.2: Meat preference of the questionnaire respondents

4.2.3 Respondent's response to questions on risk factors associated with *Linguatula serrata* infection.

Meat preparation: 84.7% of the participants preferred well-cooked meat, while 12.6%, 2.7% and 0.0% preferred partially cooked, under-cooked, and raw meat respectively. Consumption of raw meat by respondents was evaluated further. Majority (67.3%) reported never eating raw meat, 22.7% rarely ate, 4.6% ate while 5.6% ate frequently.

Consumption of lymph nodes: Majority did not eat at all (60.8%), some (22%) ate occasionally, few (121%) rarely ate. Most of the meat consumers preferred to buy their meat from abattoir (56%), with some 32.7% preferring market and very few (11.3%) bought from other places available.

Consumption of snake meat: 74% of the respondents had never tasted snake meat, (13.4%) had rarely, and (8%) had occasionally and (4.6%) reported frequently ate snake meat (Table 4.7).

4.2.4 Level of awareness on meat-borne diseases in the abattoirs

Level of awareness on risk of eating raw meat was high with majority (69.3%) being aware, and (30.7%) not aware about any risk associated with for eating raw meat. Awareness to risk of eating under-cooked meat was also evaluated and majority of the respondents (63.3%) were found to be aware about the risk, 14.7% were not aware and 22.0% were not sure whether there was any risk.

Table 4.7 Occurrence of practices among respondents reported in literature to be associated with *Linguatula serrata* infection.

Factors		Number	Percentage (%)
Meat preparation	Well cooked	127	84.7
	Partially	19	12.6
	Undercooked	4	2.7
	Raw	0	0.0
Consumption of raw meat	Frequently	8	5.4
	Occasionally	7	4.6
	Rarely	34	22.7
	Never	101	67.3
Consumption of lymph nodes	Frequently	7	4.6
	Occasionally	33	22.0
	Rarely	19	12.6
	Never	91	60.8
Preferred meat out let	Abattoir	84	56.0
	Market	49	32.7
	Other places	17	11.3
Consumption of snake meat	Frequently	7	4.6
	Occasionally	12	8.0
	Rarely	20	13.4
	Never	111	74.0

Table 4.8 Level of awareness on meat borne diseases in the abattoirs

Factors	Respondents	Number	Percentage (%)
Awareness to risk of eating raw meat	Yes	104	69.3
	No	46	30.7
Awareness to risk of eating under cooked meat	Yes	95	63.3
	No	22	14.7
	Not sure	33	22.0

CHAPTER FIVE

5.0 Discussion

There are very limited studies on the occurrence of *L. serrata* in Nigeria. Two recent studies established the endemic state of the parasite in different parts of Nigeria (Nwosu *et al.*,2002; Oseni *et al*., 2014). This study may be the first to determine the prevalence of *L. serrata* infective nymphal stage in food animals mesenteric lymph nodes in Nigeria. A prevalence of 3%, and 1.7% were established for camels and goats respectively with an overall prevalence of 1.3% in food animals (camel, cattle, goats, and sheep). The finding is in support of preponderance of the parasite in food animals reported earlier by Saeid *et al* (2010) who reported 37% prevalence in goats, Wahba *et al*. (1997) in Egypt who reported 4.90% prevalence of *Linguatula serrata* in camel and Oryan *et al.,* (1993) reported prevalence of 7.50% in Iran. This study recorded lower prevalence, which may be due to the period of study since most farmers feed their animals with dry forage, hence reducing the risk of infection.

Linguatula serrata was not detected in cattle and sheep across both sexes, which may be due to its lower prevalence in those species compared to goats and camel. Hami *et al* (2009) reported a prevalence of 0.25% in cattle out of 400 samples, compared to this study. Sherkov and Rabie (1976), reported 11% prevalence in sheep compared to prevalence of 50.7% in goats by Rezal (2011). Goats has higher prevalence likely because of their feeding habit. But the higher prevalence seen in camel in this study may have a relation with their origin from northern-Africa such as Sudan where the parasite is endemic with a prevalence of 20% (Yagi *et al.,* 1996).

The prevalence of *Linguatula serrata* nymph in mesenteric lymph node is higher in Zaria and Kaduna abattoirs compared to Kano abattoir. Dog population is higher in Kaduna state than in Kano state as observed during the studies, and dogs are known to disseminate the parasite eggs on vegetation and water, which is the source of infection to the ruminants. This work it may be the first finding in both states as there is no other available literature on the subject in the two states.

Majority of goats slaughtered were found to be around age 1-2 years, the old (> 4 years) and the young (<1 year) were found to be negative. The number of old goats slaughtered were very few (only one) that is difficult to make conclusive statement. The young ones (n= 26) were negative because of their type of feeding, and less contact with the definitive host. Furthermore, nymphs develop at about 5-6 months (Shakerian *et al*., 2008) which minimise their chances of detection the parasite. A similar finding was reported by Rezael *et al* (2011). Goats belonging to age group 3-4 years had higher prevalence of the parasite 2.9% (n= 104) compare to those in age group 1-2 years with prevalence of 1.2%. This is likely due to long time they spend, since the parasite is picke from environment and the nymphal stage remains in mesenteric lymph node. Probably the older the animal, the more parasite it accumulate. Camels in <1, and 1-2 years group of age samples were negative, while that in the age group 3-4 years had a prevalence was 1.5%, while the highest prevalence of 9.5% was seen in camels >4 years. This is similar to the report of Farid *et al* (2012). There was an association between age groups of camel and *Linguatula serrata* infection.

Linguatula serrata was not detected in Camels and goats with good body condition score, this may indicate that good management minimises the chance of infection with the parasite since

animals that are well managed tend to have good body condition. Also, abundance of pasture may reduce consumption of contaminated pasture. The prevalence was higher in poor and medium body conditioned animals likely, because they scavenged for food in the dirty and heavily contaminated places, which exposed them to the infection.

Prevalence was higher in male camels compared to the females likely because majority of the traded camels to Nigeria are males and is higher in female goats compared to the male probably because most female goats slaughtered are nannies (aged). The finding is in agreement with Saeid *et al* (2010) in which they reported that sex is not important in *Linguatula serrata* infection since animals of same age group did not show differences across sex.

Majority of the respondents (78%) were males. This is attributable to the fact that males are the majority at abattoir and meat shops where most of the questionnaires were administered. Out of 150 respondents (68.7%) were between the age of 18- 60 this maybe because this age range contains the active members of the population. This is in agreement with Olaore (2014) who observed that majority of the active population falls within the age group of 18-60.

Majority of the respondents preferred beef probably because the questionnaire was administered in large towns where meat quantity is important and where cattle are the most slaughtered animals. Sanusi (2012) reported that in Kano abattoir large number of cattle are slaughtered compared to any other species of animals. Snake meat is not popular among the participants probably because of the geographical location, since most of the snakes found in Savanah region of the country are small in size unlike those found in forest zones. In addition culture of the northerners does not encourage eating snakes.

None of the respondents indicated preference for consumption of lymph nodes (0.0%). This may be attributed to the level of public health awareness of the respondents that lymph node is a source of diseases like tuberculosis, since the questionnaires were administered in major towns. Majority indicated interest on eating liver than other parts of the animal, which may also be associated with medical advocacy that liver is good for the body compared to other parts of the animal.

Majority of the respondents (47%) did not know about meat-borne diseases. This may be due to low level of veterinary public health education in the country. In addition, none of the respondents mentioned linguatulosis a meat-borne disease, which is possibly due to low level of the awareness since the disease known as neglected tropical zoonoses. The preference for well-cooked meat by the majority (84.7%) of the participants are not far away from cultural eating habit of Africans. However, the fact that 15.3% of the population preferred partially or undercooked meat indicates a potential risks of having linguatulosis among the people since the disease is transmitted through consumption of poorly cooked infected meat (Hami *et al*., 2009).

At least 10% of the people are eating raw meat. Hence, there is a probability of them being infected with *Linguatula serrata* larva since the larva is found in carcasses and visceral organs of the ruminants. In addition, (26.6%) of respondents admitted that they eat lymph nodes, and mesenteric nymph node is the major predilection site for *Linguatula serrata* larva (Saeid 2010).

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study estimated *L. serrata* prevalence in food animals. It also established a low level of public awareness to the parasite and practices that may predispose to human infection. The study recorded an overall 1.3% prevalence in food animals, of which cattle and sheep were negative while camel and goats had 3% and 1.7% prevalence respectively. Across location (abattoir) *L. serrata* prevalence was established as 2%, 1%, and 2% prevalence in Kaduna, Kano and Zaria abattoirs respectively. There was no statistically significant association ($P>0.05$) between sex and the presence of the parasite across the species.

There was high risk of infection with *L. serrata* due to low level of awareness about the disease (linguatulosis), and the practice of consumption of raw meat and lymph node.

6.2 Recommendation

1- There is need to establish *L. serrata* prevalence across all the states of Nigeria.
2- Medical personal need to include linguatulosis in their differential diagnostic list when dealing with respiratory (nasopharyngeal), and visceral diseases.
3- The study to be extended for long periods to avoid season effects and the true prevalence of the parasite.
4- Dogs must not be fed with raw visceral of goats, sheep, or other ruminants.
5- There is need for public awareness on the mode of transmission of *Linguatula serrata*.

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Appendices

Appendix I



Marrara dish, from where Marrara syndrome gets the name.

Source: www.sudaneseonline.com

Appendix II

Determination of Body Condition

Prior to sample collection, body condition was scored from 1 (very poor) to 5 (very good) based on the method of Morrical and Hettel (1986) in which body condition has classified as:

Condition 1: appearance angular and narrow, backbone raised and sharp, hollow behind ribs, tail feels bony, neck bones prominent

Condition score 2: backbone raised but smooth, ribs are easily felt and tailbone easily detectable, thin neck.

Condition score 3: backbone slightly raised, ribs smooth can just be felt, and tail bones barely detectable.

Condition score 4: appearance well rounded, backbone can just be felt, ribs are covered, tail firm and rounded.

Condition score 5: appearance very well rounded, backbone barely detectable ribs cannot be felt, tail fat and broad.

Appendix III

Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria.

Research questionnaire on: meat consumption practices that predispose to *Linguatula serrata* infestation. This information you are providing will be treated as confidential and used only for academic activity. Please kindly provide the information to the best of your knowledge.

DEMOGRAPHIC DATA:

1- Date: ……

2- Gender: male ( ) female ( )

3- Age less than 20 ( ) 20 – 59 ( ) 60 and above ( )

4- Level of education

a) Tertiary ( )

b) Secondary school ( )

c) Primary School ( )

d) Others ( )

5- Occupation

a) Civil servant ( )

b) Farmer ( )

c) Business ( )

d) Butcher ( )

d) Others ……..

6- Which animal do you prefer to consume?

Cattle ( ) Sheep ( ) Goat ( ) Camel ( )

7- Which part of the animal do you like more?

Lymph nodes ( ) Liver ( ) lung ( ) Kidney ( ) Meat ( ) Fat ( ) Others ( )

8- How do you cook/prepare your meat?

Well cooked ( ) Partially cooked ( ) Undercooked ( ) Raw meat ( )

9- Do you consume raw meat?

Frequently ( ) Occasionally ( ) Rarely ( ) Never ( )

10- Do you consume lymph nodes?

Frequently ( ) Occasionally ( ) Rarely ( ) Never ( )

11- From where do you buy your meat?

Abattoir ( ) Market ( ) Other places (specify)……

12- Do you eat snake meat ?

Frequently ( ) Occasionally ( ) Rarely ( ) Never ( )

13- Do you know that one can get infected with disease through consumption of raw meat?

a) Yes ( ) b) No ( ) c) Don't know ( )

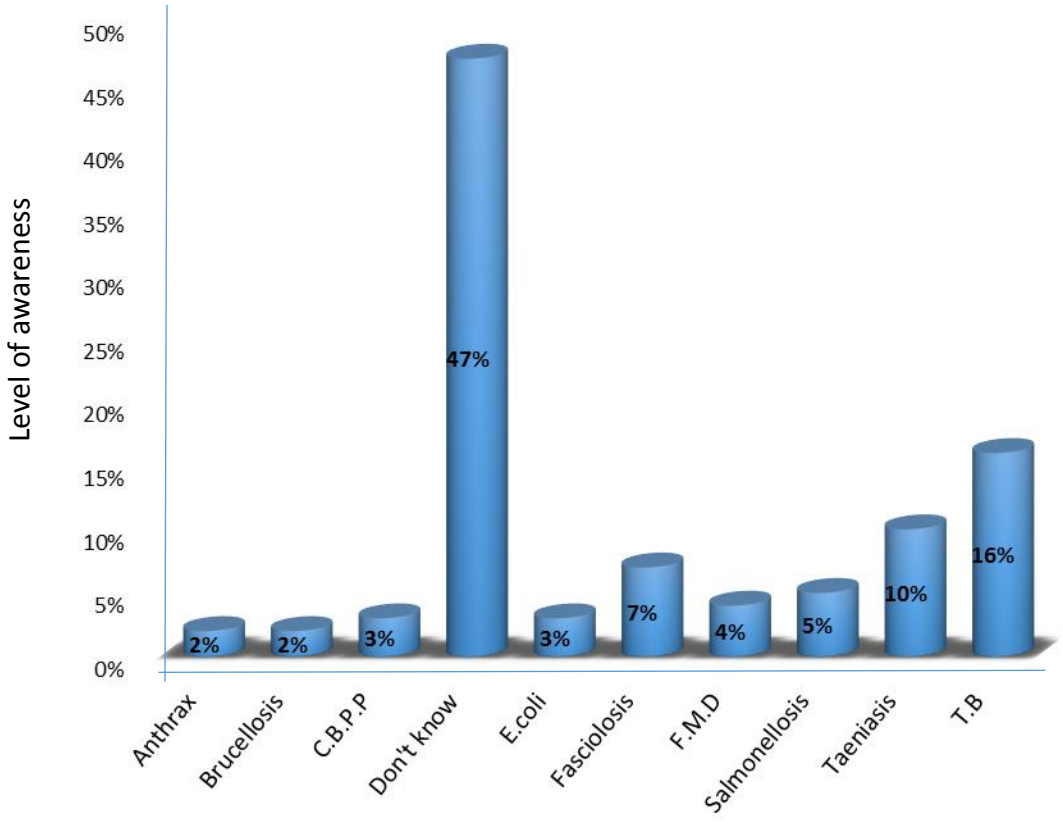
14- Do you know that undercooked meat can cause diseases?

Yes ( ) No ( ) Not sure ( )

15- What are the common meat-borne diseases do you know?

1-…… 2-……..3- …….4…….

Appendix IV



Common meat-borne diseases mentioned by the questionnaire respondents

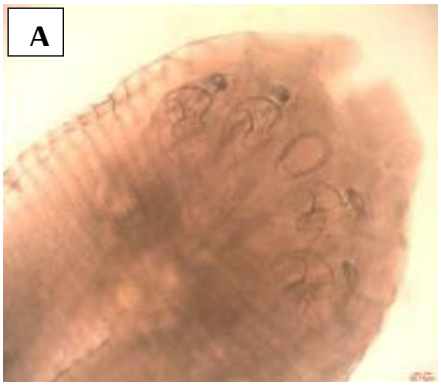
Appendix V

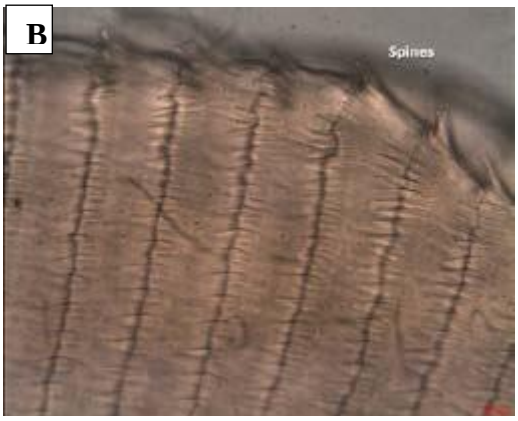


Youssefi, *et al.,2011* Iran



(Smith 2009)





(Farid Rezaei *el al.*,2012)

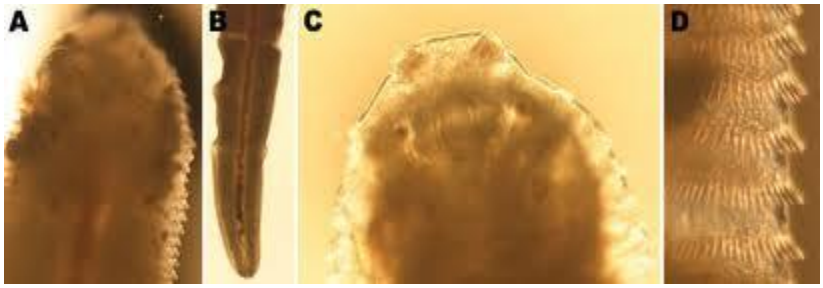


İlimili ilim *et al,*. (2010)



http://www.atl.nu/lantbruk/tungmask-hittad-i-nos

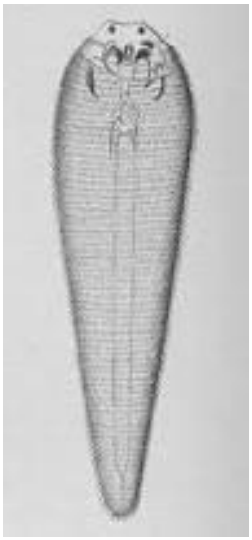
CDC Emerging Infectious Disease Journal (2011)



Khalil (1972)







Cheng, T.C. **(1986)**





www.bariparasitology.uniba.it/Gallery1.html www.vetinst.no/Nyheter/Hundeimport-utgjoer-helsefare