EPIDEMIOLOGICAL STUDY OF TRICHINOSIS

IN KADUNA STATE OF NIGERIA

BY

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DECLARATION

I, Dr. DU-SAI, DAN HIREKAAN MSUGHAONDO hereby declare the originality of this work, carried out by me in the Parasitic Zoonoses laboratory of the Department of Veterinary Public Health and Preventive Medicine, Ahmadu Bello University, Zaria, under the able supervision of Drs. A. O. Aganga (Major), J. U. Umoh and V. C. Ogbogu.

No part of this thesis has previously been submitted elsewhere for a degree or diploma. The work of other investigators is duly acknowledged and referred to.

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CERTIFICATION

This thesis entitled "Epidemiological study of trichinosis in Kaduna State of Nigeria" by DU-SAI, DAN HIREKAAN MSUGHAONDO, meets the regulations governing the award of the degree Master of Science of the Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This piece of work is dedicated to the memory of my dearly beloved late father, CHIEF HIREKAAN SAI, who died on 9th May, 1968. "Daddy may your soul rest in peace". Amen.

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Following the successful completion of a research work, certain people obviously deserve special thanks. I shall therefore use this forum to express my profound gratitude and appreciation to members of my supervisory committee, relations and members of my family, new friends made in the course of this work, and the sponsors of the project.

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ABSTRACT

Tongue and diaphragm samples were collected from a total of 620 pigs slaughtered at different locations in Kaduna State of Nigeria, and 240 randomly trapped brown field rats (Arvicanthus niloticus). between August, 1987 and Nay, 1989. All samples were separately subjected to the artificial enzymatic digestion technique (using 1% acid pepsin). In addition, carcasses were grossly examined for the presence of cystic lesions. Records of striated muscle biopsies done between 1975 and 1987 at Ahmadu Bello University Teaching Hospital (ABUTH) Zaria, were also reviewed for cases of Trichinella spiral is infection.

L- spiral is larvae were recorded in three (0.57.) of the 620 pigs sampled. In all positive cases, larvae were recovered only from the diaphragm and none from the tongue. Less than one larva per gram of musculature was recovered. Gross examination of swine carcasses revealed Cysticercus eellulosae cysts in 13(2.1"/.) of the pigs. Such cysts were distributed in various parts of the body including the tongue (23.17.), thigh muscle (23.17.), masticatory muscle (23.17.), diaphragm (15.47.) and heart (15.47.).a

All the tissues of the brown, field rats examined were negative for T. spiralis l*arvae.* Also records of the human muscle biopsies reviewed did net reveal any case of trichinosis being diagnosed. However, the potential for human infections does exist.

TABLE OF CONTENTS

Declaration i

Certification ii

Dedication iii

Acknowledgement iv

Abstract vi

Table of Contents viii

List of Tables x

List of Plate xi

CHAPTER ONE: INTRODUCTION 1

CHAPTER TWO: REVIEW OF LITERATURE 4

2.1 History 4

2.2 Life Cycle 6

2.3 Trichinosis in Domestic and Wild Animals.. 9

2.3.1 Epidemiology 9

2.3.1.1 Transmission 10

2.3.2 Predilection Sites in Animal Hosts 15

2.3.3 Clinical Manifestations in Animals 16

2.3.4 Diagnosis in Animals 17

2.3.4.1 Parasitological Diagnosis .18

2.3.4.2 Serological Diagnosis 19

2.3.5 Treatment and Control 21

2.4 Trichinosis in Man 23

2.4.1 Epidemiology.. 23

2.4.1.1 Transmission 23

2.4.2 Pathogenesis 25

2.4.3 Clinical Manifestations in Man 26

2.4.4 Diagnosis in Humans 30

2.4.4.1 Immunodiagnosis 31

2.4.4.2 Parasitological Diagnosis..34

2.4.5 Treatments, Prevention and Control 35

2.5 Trichinosis in Africa 37

CHAPTER THREE: MATERIALS AND METHODS 39

3.1 Study Area 39

3.2 Sampling Procedure.. 40

3.2.1 Collection of Samples in Pigs 40

3.2.2 Collection of Samples in Field Rats 41

3.3 Laboratory Procedure. 41

3.3.1 Enzymatic Digestion of Tissues 41

3.4 Review of Human Muscle Biopsy Records 43

CHAPTER FOUR: RESULTS.. ... .44

4.1 Domestic Swine.. 44

4.2 Field Rats.. 44

4.3 Human Muscle Biopsy Records.. .. .45

CHAPTER FIVE: DISCUSSION. 47

5.1 Conclusion and Recommendations... 50

LIST OF REFERENCES 59

LIST OF TABLES

Table		Page
1.	Prevalence of T. spiralis infection in 620 pigs slaughtered in Kaduna State of Nigeria.	52
2.	Location and sex distribution of parasites detacted in slaughtered pigs in Kaduna State, Nigeria	53
3.	Documented biopsy findings in patients at ABUTH, Zaria, between 1975 and 1987 54	
4.	Sex distribution of parasites from biopsy records at ABUTH, Zaria 55	
5.	Distribution of parasites by age groups as revealed by biopsy records at ABUTH, Zaria	56
6.	Geographical distribution of parasites revealed by records of muscle biopsies at ABUTH, Zaria	57

LIST OF PLATE

Plate A: *T. spiralis* muscle larva recovered from pig diaghragm following enzymatic digestion 58

CHAPTER ONE

INTRODUCTION

Trichinosis or trichinellosis, caused by a microscopic nematode Trichinella spiralis (T. spiralis) is one of the most important parasitic infections of the striated muscles of a variety of warm-blooded mammals (both wild and domesticated) including man. It occurs in practically every country of the world (Soulsby, 1968; Gould, 1970).

Consumption of infected pork and pork products constitutes the commonest and most important source of infection to humans. Occasionally man may acquire the parasite through the ingestion of other infected meat, (Forrester et al., 1961; Steele, 1970; Villella, 1970; MMWR, 1986). Both domestic and wild animals acquire the infection through consumption of table scraps, infected rodents or whole carcasses of infected animals (Rothrock, 1965; Hanbury et al., 1986). Available epidemiological and experimental evidence indicate that rodents may be playing an important role in the epidemiology of porcine trichinosis (Murrell et al., 1984; Smith and Kay, 1987).

There is usually no obvious clinical entity associated with natural infection in domestic or wild

animals (Soulsby, 1968). However, human trichinosis may prove fatal as early as the first week post-infection. In most instances, death occurs between the fourth and sixth week post-infection (Gould, 1970).

Considerable epidemiological work has been done on trichinosis in the United States (Zimmermann, 1970a; Leighty, 1974; Pullen et al., 1977), Canada (Smith, 1976; Smith et al., 1976; Smith 1978; Smith, 1987), India (Schad and Chaudhury, 1967), U.S.S.R. (Merkushev, 1970), Germany (Lehmensick, 1970), and The Netherlands (Van Knapen et al., 1980; 1987). In these places, the parasite is detected mostly during meat inspection (Rothrock, 1965; Murrell, 1985). Not much work has been done on trichinosis in Africa as a whole. In Nigeria for instance, the parasite is not routinely checked for during meat inspection, and only one documented report (Akinboade et al., 1984) exists on T. spiralis infection in swine. Because of this paucity of information on trichinosis in Nigeria, this study was undertaken to investigate its epidemiology in Kaduna State of Nigeria.

The specific aims of the present study were:-

i. to determine the prevalence of T. spiralis in domestic pigs and wild edible rodents in Kaduna State of Nigeria, and

ii. to conduct a retrospective study on T. spiralis infections in human beings in Kaduna State.

It is hoped that the findings of this study would bring into focus the magnitude of *T. spiralis* infections in animals and man in Kaduna State of Nigeria so that rigid control measures could be instituted, if need be.

CHAPTER TWO

2.0 REVIEW OF LITERATURE

2.1 HISTORY

The disease trichinosis had been known since the biblical days even before the causative agent, Trichinella spiralis, was recognised. The early Israelites, for instance, were specifically interdicted by the mosaic laws from eating the flesh of swine because disease usually ensued following consumption of infected po**k** and po**k** products. Mohammed, in the seventh century A.D; followed the example of Moses in prohibiting the consumption of pork (Cited in Deadman and Wilson, 1941).

The discovery of the nematode Trichinella spiralis, the causative agent of trichinosis was by James Paget in 1835. This was during an anatomic dissection at St. Bartholomew's hospital in London when the young first-year medical student encountered the cysts in the muscles of an Italian, aged 50 years, who had died of pulmonary tuberculosis. The findings of Paget were then named Trichina spiralis by Richard Owen at a meeting of the London Zoological Society in 1835. The name referred to the fact that the worm was thin as hair and rolled up in appearance (Paget, 1866). Reports indicate that Chazal, who was then the

demonstrator of anatomy in South Carolina medical college, was the first person to have observed the Trichina cysts in the United States in 1841. Bowditch of Boston, in 1842 also encountered the parasitic cysts in a man 36 years of age who had died from a malignant abdominal growth.

Joseph Leidy of Philadelphia first discovered Trichina spiralis in animals in 1846. He found Trichina cysts in the extensor muscles of the thigh of a hog, but it was not until 1866 that he realised that the cysts in the pig were probably of the same worm that caused the disease in human (Gould, 1970). Herbst (1851) carried out an initial experimental infection during which he infected a badger with trichinous dog meat. The infected badger meat was subsequently fed to three young dogs. Upon microscopic examination, he found encysted larvae in the muscles of all the three dogs. Zenker (1860) indicated that human infection could prove fatal within a few weeks. He further suggested that the worm spreads throughout the body of the host through dissemination of larvae, possibly by way of the chyle ducts and the blood stream.

The name Trichina spiralis, proposed by Owen in 1835 was changed to Trichinella spiralis by Railliet in 1896 on the grounds that the name Trichina had already been used for a genus of diptera since 1830. It had also been used by Kirby in 1837 for a genus of beetles

(Cited in Williams, 1901).

2.2 LIFE CYCLE

The adult worms live within the cytoplasm of epithelial cells of the intestine, and as infective larvae in modified muscle cells of a wide range of mammalian hosts (Villella, 1970).

Naturally, the life cycle is initiated when a susceptible host ingests tissues containing viable encysted muscle larvae (Soulsby, 1968; Villella, 1970). Following ingestion, the larvae are liberated within a few hours by the host digestive enzymes and development to the adult stage is rapid, being completed in four days. The specific portion of the intestine where the adult T. spiralis localises is varied depending on the host species. According to Roth (1938), adult T. spiralis localises in the distal portion of the intestine of guinea pig. Gursch (1949) found that in rats, the majority of infecting larvae become localised in the proximal portion of the small intestine, where they penetrate the mu cosal lining. In this species, the larvae are returned to the lumen of the intestine about 22 to 24 hours post-infection. Subsequently, a large proportion of these larvae repenetrate deeply into the mucosa and relatively few of them remain free in the lumen of the intestine. In rabbits, Gardiner (1976) found that the normal environment of adult T. spiralis is in the epithelium at the base of the villi

and in the glandular crypts, where copulation and deposition of new-born larvae both take place. Copulation occurs about 40 hours post-infection (Soulsby, 1968).

The onset of release of larvae occurs between the fifth and seventh day post-infection (Britov, 1962). Larvae are released by the female worm, one at a time, on the average, at the rate of one every half hour. Such larvae are deposited in the epithelial layer of the mucosa in rabbits. From here they migrate into the deeper layers until they reach the lymphatic vessels or venules and are then distributed throughout the host tissues via the circulatory system (Gardiner, 1976). These larvae further develop in the voluntary muscles, especially the diaphragm, tongue, larynx, eyes, masticatory and intercostal muscles. The larvae may also be carried to the liver, kidneys and pancreas although they die off rapidly at these sites (Soulsby, 1968).

Experimental evidence has shown that the routes of migration of the larvae from the intestines to the skeletal muscles may differ depending on the host. In rats, most of the larvae migrate to the skeletal muscles through the connective tissue (Berntzen, 1965). Berntzen based his assumption by finding numerous larvae in the mesentery and in the fluid of the abdominal and thoracic cavities.

1934; Villella, 1970). The time during which calcification begins is, however, dependent on the species of the host. In the rat, calcification was reported as early as 60 days post-infection. In mice, calcification began after 24 months and was completed after 29 months (Hemmert and Buggue, 1934). Although calcified cyst wall sets up a thick barrier between the larvae and the environment, such larvae still remain viable within the cyst for many years.

2.3 TRICHINOSIS IN DOMESTIC AND WILD ANIMALS

2.3.1. EPIDEMIOLOGY

Two cycles of the parasite T. spiralis are known to exist: the urban and sylvatic cycles. T.spiralis spiralis strain is responsible for the urban cycle while T. spiralis nativa is responsible for the sylvatic cycle. The domestic swine and wild rodents are said to maintain the urban cycle (Smith, 1985). Sylvatic trichinosis, on the other hand, is mostly maintained in the arctic mammals such as the polar bear and whales in temperate regions (Cameron, 1962). T.spiralis nativa strain responsible for sylvatic trichinosis is known to have a low infectivity for the domestic swine and wild rodents (Britov, 1974; Smith, 1985). The specific role of wild rodents in the transmission of sylvatic trichinosis had been a subject of debate (Nelson et al., 1961;Schad et al.,1987), although available epidemiological and experimental evidence indicate that rodents may be

Only a few in samples of blood taken from the heart and pulmonary vessels, and from blood collected by complete exsanguination of the experimental animals. Larvae reach the muscle tissue at approximately eight days post-infection. In the muscle, the larvae penetrate the sarcolemma and enter the muscle cells where they grow rapidly. Within 30-35 days post-infection the larvae begin to coil inside a cyst which arises from the tissue histiocytes (Soulsby, 1968). The cyst is formed when the first stage larvae penetrate a striated muscle cell of the host. The invaded cell undergoes re-organisation such that the myofilaments disappear. The cell forms a new type of cell which is considered to function as the nurse cell. The nurse cell becomes surrounded by layers of collagen to form a capsule or cyst which eventually gets completely formed after three months (Hertwig and Graham, 1895). It is at this stage of development that the larvae which developed in the muscle cells of the host become potentially infective to another host that might ingest the parasitised muscle initiating the life cycle over again (Villella, 1970).

Once capsule formation is complete, death of the larvae becomes less likely. Although the affected muscle fibres degenerate and the cyst usually begins to calcify after about six to nine months, the larvae in them may live for several years (Hemmert and Buggue,

playing an important role in the transmission of porcine trichinosis (Murrell et al., 1984; Hanbury et al., 1986; Smith and Kay, 1987).

2.3.1.1 TRANSMISSION

Several modes of transmission of T. spiralis have been examined. Among those were ingestion of infected flesh, prenatal infection, colostral infection, ingestion of infective larvae in transport hosts and faecal transmission (Husar, 1979).

The domestic pig acquires infection through the consumption of table scraps (garbage feeding), infected rodents, or flesh of dead whole carcasses of swine (Rothrock, 1965; Hanbury et al., 1986). The consumption of infected swine carcasses appears to be of particular significance in the perpetuation of the disease through several swine generations in a feedlot. This is because such feedlots usually contain swine of various ages and weight classes, and at any one time, is never free of swine. Tail chewing in live animals has been suggested as a possible mode of transmission especially when pigs are maintained together in a feedlot (Zimmermann et al., 1962; Smith, 1975a). In this respect, the potential of other domestic pets such as dogs being involved in the transmission cycle cannot be dismissed (Hanbury et al., 1986).

Rabbits and horses which are only partially

herbivorous readily become infected following ingestion of decomposed meat containing viable T. spiralis cysts (Keller and Lawo, 1949 ; Van Knapen et al., 1987). The finding that larvae in decomposed meat maintained at 18-25^{o}C remained viable for 259 days is good supportive evidence that scavengers as well as predators could readily become infected following ingestion of trichinous meat (Gaugusch, 1950). Generally the opportunities for marine animals such as whales, seals and fish to become infected with T. spiralis are limited by their range, diet and dilution factor of the sea (Smith, 1976). Experimental evidence tend to show that fish are completely resistant to trichinosis (Steele, 1970).

Prenatal infection with T. spiralis appears to be rare, but it has been produced experimentally following heavy infections in guinea pigs, rabbits and rats (Augustine, 1934; Roth, 1936; Chroust and Jerabek, 1968; Soulsby, 1968; Gould, 1970). Similar experiments conducted on pregnant pigs, cats, dogs mice and ferrets failed to produce the infection in offsprings (Hartmannova and Chroust, 1968). It is possible that prenatal infection may be a species-specific form of transmission. It is also possible that even within the same species, prenatal infection may only occur at specific stages of development of the embryo. This is because mothers infected at different times will produce migrating larvae at different time intervals.

It is definitely uncertain as at now, if prenatal infection occurs in all animals (Husar, 1979). Although experimental evidence point to the fact that prenatal infection may be occurring in some animals, its universality is open to doubt.

The ingestion of viable T. spiralis larvae in milk is considered another possible mode of transmission. Denham (1966) reported that mice acquired infection after suckling mothers that had migrating T. spiralis larvae. Although several other litters were employed in the study, only the offspring that suckled during the time of larval migration became infected.

The ingestion of viable T. spiralis cysts in transport hosts has been reported as a possible mode of transmitting trichinosis. This is supported by evidence that various species of insects can serve as short term transport hosts for T. spiralis. Merkushev (1955) exposed necrophagous beetles to feed on the carcass of a T. spiralis infected mouse. The adult beetles did not ingest the trichina cysts, but the larval beetles did consume the trichina cysts. Once ingested, the viable cysts remained infective for up to five days. Kullman et al. (1975) also fed trichinous meat to 51 different species of beetles. On subsequent examination, he recovered larvae in the alimentary tract of only one family of beetles, Caribidae. Negrobov (1960) found that the beetles Geotrupes

stercorous, G. vernalis and Scriba vernalis could all harbour T. spiralis in their intestines. Similar experiments conducted in blowflies also indicated that various larvae remained infective for up to eight days.

Under experimental conditions, marine crustaceans may also serve as transport hosts for T. spiralis. Britov (1962) fed meat containing T. spiralis to crustaceans and 12 hours later, he exposed dogs and cats to feed on the crustaceans. Larvae were recovered from the dogs and cats 17 days post-infection. Cray fish and various species of fish appeared to be resistant to infection with T. spiralis. In frogs, incomplete development of larvae was experimentally induced during which the larvae remained non-encysted in the striated muscles (Gaugusch, 1950).

Reports indicate that birds can serve as both transport and definitive hosts for T. spiralis. Schmidt (1950) found encysted larvae in the faeces of many carrion-eating birds like eagles (Haliaeetus spp.) and crows (Corvus brachyrhynchus). Experimental studies by Merkushev (1960) indicated that carnivorous birds are capable of passing out excysted larvae which had not moulted. Such larvae remained infective to mice for over 15 days within moist faeces. Birds with less pronounced carnivorous habits on the other hand, produced moulted larvae which developed sexually within the intestine of the birds. Consequently, when the

intestines of birds containing infective larvae were fed to pigs, dogs and cats, muscle larvae were recovered from these host (Matoff, 1961).

The ingestion of T. spiralis in faeces as a mode of transmission has been investigated by several workers (Spindler, 1953; Zimmermann et al.,1959,1962; Schnurrenberger et. al., 1964)

Spindler (1953) fed meat containing 300 trichina cysts to mice and 1,500 trichina cysts to rats. During the first 24 hours post-infection. 4.9% and 1.8% of the inoculate was recovered in the form of cysts and larvae from mice and rats respectively. Four weeks later, the same number of cysts were fed to the same animals and they passed 10.3% and 16.9% of the inoculate for mice and rats respectively. Only few cysts or larvae were passed out after 24 hours post-infection. Reports by Zimmermann et al. (1959; 1962) indicate that the domestic pig readily acquired infection with T. spiralis when fed moist faeces from infected rats. T. spiralis cysts or larvae are said to retain viability better in moist faeces than in dry faeces.

Hill (1968) postulated that faecal transmission could occur by ingestion of four different forms of the parasite:-

a. coiled infective larvae as derived from muscle tissue, either free or encysted.
b. uncoiled intestinal larvae after moulting.
c. adult females or
d. ovoviviparously produced embryos.

Zimmermann et al. (1959) enumerated a number of factors capable of influencing faecal transmission of T. spiralis as: (i) time interval between infection and passage of faeces to donor, (ii) immunity of the donor and (iii) the total number of trichinae ingested by the donor.

2.3.2 PREDILECTION SITES IN ANIMAL HOSTS

The new-born larvae of T. spiralis produced by adult worms at the base of epithelial cells of the host intestines produce the most important pathological lesions. Studies on the distribution of T. spiralis larvae have been carried out by several workers (Matoff et al., 1960; Matoff, 1961; Olsen et al., 1964; Van Knapen et al., 1987). These studies indicate that skeletal muscles are generally the predominant predilection sites of T. spiralis larvae. Hill (1956) reported recovering an adult gravid female worm from the urinary bladder of a young boar. In 1957, Hill also reported that he observed unencysted larvae in other body organs, and pointed out the importance of thoroughly cooking all pork products. Variations in the host could, however, lead to varied predilection sites in the skeletal muscles. In many animal species, the diaphragm and the massector muscles are the most heavily infected (Weatherly, 1983). Experimental infections in pigs indicate the tongue to have the

highest muscle larvae densities (Olsen et al., 1964; Kotula et al., 1984). Similar studies in ponies and adult horses indicate the massester musculature, tongue and diaphragm as favourite predilection site (Smith and Snowdon, 1987; Van Knapen et al., 1987).

2.3.3. CLINICAL MANIFESTATIONS IN ANIMALS

The exact number of larvae required to establish a clinical infection in animals is unknown. Reports, however, estimated that two to three larvae are required to establish an infection in guinea pigs, three larvae in rats and 40-50 larvae in the domestic pig (Doerr and Menzi, 1933; Schmidt, 1958). Although there is no obvious clinical entity associated with natural trichinosis in animals (Soulsby, 1968), experimental infections in pigs are accompanied by a number of clinical signs. Leuckart (1860) observed loss of appetite in a pig on the second day post-infection. Thereafter its head and tail drooped and the animals gnashed its teeth, drew its belly in, and apparently was seized with abdominal pain. The symptoms became progressively more severe, and after three weeks, the hind legs appeared to be completely paralysed, incontinence of urine and faeces occurred, and the voice became hoarse and weak. Rupprecht (1865) noted that adult pigs were quite tolerant to *T. spiralis* infection, and that only after severe infections did they manifest signs of the disease.

Young pigs were, however, said to be unable to tolerate a heavy worm burden.

Severe trichinous infections in pigs will invariably lead to death usually after about a month, although death has been observed as early as four days post-infection (Hemmert and Buggue, 1934). During light infections in rats, adult worms could be recovered from the intestines for only 14-16 days post-infection (McCoy, 1931, 1932). Massive infections could, however, kill rats within two weeks, usually during the intestinal phase. The death of white rats within 48 and 72 hours post-infection was attributed by Thornbury (1897) to a profound systemic toxaemia. A high dose (about 230 larvae/kg body weight) in experimental infection with viable T. spiralis larvae in horses produced no clinical signs during the infection period. There was no temperature rise in the first four weeks after oral infection (Van Knapen et al., 1987).

2.3.4 DIAGNOSIS IN ANIMALS

Diagnostic problems of this disease includes the fact that the demonstration of adult forms of Trichinella in stool is difficult and impractical.

Demonstration of larvae forms in blood is usually inefficient and time consuming (Kagan and Norman,

1970). In the domestic swine, diagnostic tests are generally required to identify contaminated meat during mass screening to detect chronic infections including animals with a low parasite burden (Ortega-Pierres et al., 1987). The two main methods of diagnosis are by serology and parasite isolation.

2.3.4.1 PARASITOLOGICAL DIAGNOSIS

The direct parasitological demonstration of encysted T. spiralis larvae in striated muscle tissue of the host animal serves as the most important and significant means of diagnosis for trichinosis in animals. This could be achieved through the use of trichinoscopes or artificial enzymatic digestion technique (Leighty, 1974; Pullen et al., 1977; Smith et al., 1988). The trichinoscope is a simple instrument which consists of a compressorium to press the muscle tissue projecting the image onto a screen (Soulsby, 1968). The method is, however, slow, expensive, lacks adequate sensitivity, and hence in low degree infections, it could miss a percentage of infected animals (Leighty, 1974; Soulsby, 1975).

Compared to trichinoscopy, the artificial enzymatic digestion technique is more sensitive and specific. The muscle tissue is first homogenised after which it is then digested with an acid-pepsin mixture for several hours, and the resulting sediment examined

microscopically for T. spiralis larvae. The major limitations of the enzymatic digestion is that it is laborious, time consuming and cannot identify tissues containing dead or infective larvae that have not yet encysted. The possible level of this larval digestion has been indicated in a study by Zimmermann (1977) where 6.2 dead trichinae per gram of muscle were recovered from a frozen bear diaphragm sample but as high as 172 trichinae per gram were evident on trichinoscopic examination. Gross examination of carcasses at meat inspection could also be considered as a means of diagnosis to a lesser extent. The limitation here is that of differentiation from other parasitic cysts such as Cysticercus cellulosae infection (Soulsby, 1975).

2.3.4.2 SEROLOGICAL DIAGNOSIS

There is persistence of Trichinella antibodies in the host following infection. Previously infected animals could, therefore, appear serologically positive for trichinosis but parasitologically negative and thus harmless to the consumer (Smith and Snowdon, 1987; Smith et al., 1988). Various serological tests have been studied especially in swine, and though they will adequately detect experimental infections, their level of usefulness is low in natural infections (Soulsby, 1968). The major problems associated with such diagnostic tests include lack of ability to detect low

level natural infections, the cost and ease of integrating them into the routine slaughterhouse procedure (Leighty, 1974; Soulsby, 1975). The recently developed tests like radioactive antigen microprecipitin (RAMP) test (Williams et al., 1971), immunofluorescence test (IFT) (Van Knapen et al., 1980), and the enzyme-linked immunosorbent assay (ELISA) test (Ljunstrom et al., 1974; Ruitenberg and Van Knapen, 1977; Smith, 1987) have proved to be highly sensitive and specific (Smith et al., 1988). The RAMP test uses ^{131} Iodine labelled antigen and is capable of detecting skin sensitising antibodies in vitro. Antibodies detected by this test show similar thermolability and mercaptoethanol sensitivity as immunoglobin E type antibodies, and also are inhibited by absorption with antigamma E serum (Soulsby, 1975). Although the test is not appropriate for field use, it could be used to advantage with purified antigen preparations.

The ELISA method has been shown to be very sensitive, being able to detect a level of infection as low as 0.1 larvae per gram of muscle (Van Knapen et al., 1980; 1981). In its present form, the ELISA cannot be recommended as an effective procedure to certify or ensure the safety of meat from infection with trichinosis (Smith, 1987; Smith and Snowdon, 1987), except in epidemiological studies of trichinosis

within herds or defined focus of infection, where one is interested in detecting all infected animals regardless of the degree of infection (Ruitenberg and Van Knapen, 1977; Smith, 1987; Van Knapen et al., 1987)

2.3.5 TREATMENT AND CONTROL

Thiabendazole (R) has been shown to be effective against both the adult intestinal stage and the larval muscle stage. Methyridine (R) has also been shown to be effective against the muscle stage of the infection in experimental animals (Soulsby, 1968).

Although the prevalence of trichinosis in most countries is reported to be low, it is high enough to constitute both a public health concern and a significant economic burden. An effective control program of trichinosis should be based on a solid understanding of the epidemiology of T. spiralis. This would, in effect, allow focusing of efforts on those sources that are of actual significance in a particular location rather than attempting to control every conceivable transmission route.

The control strategies should therefore be designed to include all measures aimed at preventing its spread among swine which is the main source of human infections (Steel, 1970). Such control strategy will depend largely upon preventing the ingestion of viable cysts in infected flesh. This in effect will

require the identification of the sources of such infected meat (Murrell, 1983). The feeding of raw garbage was, and may still be, an important source of infection to swine. A strong enforcement of garbage cooking before feeding to swine is therefore suggested (Murrell, 1985; Hanbury et al., 1986) as in Germany (Gould, 1970).

Another important source of infection to swine is the ingestion of infected farm rats (Murrell et al., 1984), and infected wild animal carcasses. Rodents should, therefore, be eliminated from hog farms. The practice of feeding wild animal carcasses or meat scraps to pigs should be discouraged.

There is good evidence that antigen from the stichosome of the larval stage of T. spiralis is capable of inducing protective immunity in swine, though the degree of resistance is said to be incomplete (Murrell et al., 1984). Rats and pigs were shown to have complete protection against infection when vaccinated with doses of T. spiralis nativa larvae (Smith, 1987). It is therefore possible for producers in a region where persistent infections (endemic areas) cannot be prevented, through normal control on waste feeding and rodent populations, to vaccinate all pigs raised, either soon after farrowing or upon arrival at the farm if purchased as feeders (Murrell, 1985).

2.4 TRICHINOSIS IN MAN

2.4.1 EPIDEMIOLOGY

Trichinosis is a parasitic disease which affects man and many other mammals with a world-wide distribution. The domestic pig serves as the intermediate host in human infections. Despite major advances in the control of the disease through the application of public health measures, isolated outbreaks from all over the world are still being reported (MMWR, 1986; Ortega-Pierres et al., 1987). Although the indiscriminate consumption of infected port and pork products constitutes the commonest and most important source of infection to man, occasionally human infections could be acquired through the consumption of bear meat, other wild animal meat and even horsemeat containing viable trichinae cyst (Steele, 1970; Villella, 1970; Bellani et al., 1978; Van Knapen, 1988).

2.4.1.1 TRANSMISSION

The largest outbreaks of human trichinosis are traditionally among those ethnic groups with preference for raw or partially cooked pork (Schantz, 1983). Extensive surveys of trichinosis in human cadavers conducted in the United States revealed a higher infection rate in persons of Italian and Germany ancestry than in persons of Jewish ancestry (Wright et

al., 1943, 1944; Zimmermann et al., 1968, 1973). This was attributed to the fact that Italians and Germans have a fondness for raw pork and pork products. The Jews on the other hand have a general abstinence from pork.

The ingestion of infected bear meat in the arctic is increasingly becoming important as a source of infection for humans (Cameron, 1970; Smith, 1978). Schultz and Juranek (1974) noted that with the decline in swine trichinosis, infected bear meat is gaining increased significance as a direct source of human infection. He attributed the over 7.8% of all clinical cases in the last few years in the United States to the ingestion of infected bear meat. In the U.S.S.R. most human cases are now traceable to the consumption of infected wild animal meat (Bessonov, 1980). Similarly in Alaska, all the human cases of trichinosis have stemmed from consumption of bear or walrus meat containing viable T. spiralis cysts (Schantz, 1983). The wild pig (Potamochoerus porcus) was incriminated as being the source of infection to humans in East Africa South of the Sahara, where the parasite had never been demonstrated in the domestic pig (Hammond, 1955; Forrester et al., 1961; Nelson et al., 1961).

Outbreaks of human trichinosis in Italy and France in 1975 and 1976 respectively were all traced to the consumption of infected horsemeat (Bellani et al.,

1978). Another outbreak of human trichinosis occurred in France in 1985 and was also associated with the consumption of infected horsemeat (MMWR, 1986; Van Knapen, 1988). Reports indicate that although horses are herbivorous, they do not have an aversion to eating raw meat of rodents or other animals, and hence under certain circumstances the occasional horse may enter the Trichinella life cycle and be a potential source of infection for humans (Bellani et al., 1978; Van Knapen et al., 1987; Van Knapen, 1988).

The ingestion of viable T. spiralis larvae in colostrum is of less significance as a mode of transmission of trichinosis in humans. However, Salzer (1916) recovered T. spiralis larvae in milk of a patient suffering from trichinosis who was nursing her young at the time. It is therefore possible that such an offspring could acquire infection through ingestion of viable T. spiralis larvae in milk.

2.4.2 PATHOGENESIS

Following infection, T. spiralis induces pronounced tissue inflammation. Three phases of pathogenicity have been described in the course of the disease (Gould, 1970). The first phase is caused by the adult parasite in the intestine producing some degree of irritation and marked enteritis in heavy infections. This may be accompanied with diarrhoea,

nausea, vomiting and abdominal pains. In some cases, weakness, muscular twitching and pain, as well as oedema of the face and eyelids may occur (Forrester et al., 1961).

The second phase of illness begins nine to ten days post-infection when the larvae are entering the musculature, and this is accompanied by severe muscular pains, eosinophilia, difficulty in breathing, chewing and swallowing as well as inflammation of the face and eyelids. The third phase begins at about six weeks post-infection, during the encystment stage. During this phase, painful swellings of the legs, arms, abdomen and face may appear. There may also be pneumonia, anaemia and intermittent fever (Forrester et al., 1961; Soulsby, 1968; Husar, 1977).

2.4.3 CLINICAL MANIFESTATIONS IN MAN

The exact number of larvae required to establish a clinical infection in man is not known. Reports indicate that about 50-75 viable *T. spiralis* larvae are required to establish infection in man following ingestion (Piekarski, 1954; Zimmermann, 1970b). In this respect, infected carcasses containing less than one viable trichinae per gram of musculature are generally not considered capable of causing clinical trichinosis in man (Smith, 1985).

Severe cases may terminate fatally as early as the first week post-infection. However, most deaths occur

between the fourth and sixth week post-infection (Gould, 1970). In majority of cases, the range of the incubation period is five to fifteen days, with an average of ten days. Occasionally, the symptoms of infection may appear as early as a few hours following ingestion of infected material, or as long as 43 days thereafter. Varied clinical entities are associated with the disease and this is said to be related to the widespread distribution of the parasite in the body. The severity of clinical symptoms manifested in the host depends on several factors which includes: the infective dose, degree of immunity of the host as a result of previous infections, age of the patient involved, organs affected and to a lesser extent, individual susceptibility and length of incubation period (Gould, 1970). These factors not withstanding, the majority of trichinous infections in man as revealed by autopsy studies, are subclinical.

Children are apparently more resistant to trichinosis than adults (Gould, 1970), and the severity of such infections depend upon the number of viable T. spiralis larvae ingested. Several authors have attributed the relative mildness of trichinosis in children to different factors. Virchow (1864) attributed this to the short length of their intestinal tract. Wolff (1864) ascribed it to the relative small amounts of meat eaten, and possibly to less favourable

conditions of the intestinal tracts of children for the development of trichinae. Mosler (1865) and Lesshafft (1885) were of the opinion that the frequent intestinal evacuations result in less thorough digestion of meat to release viable T. spiralis larvae. Kratz (1866) attributed relative resistance in children to the greater activity of the intestinal tract, presumably effecting the more rapid expulsion of intestinal trichinae, while Cohnheim (1866) to more frequent intestinal evacuations as well as greater capacity for regeneration of damaged tissues. Flury (1913) ascribed it to ..re the more active metabolism of growing children, which can more easily assimilate or breakdown the injurious products of trichinosis. In rare instances, however, trichinosis may be rapidly fatal to a child (Buis, 1935; Sobel, 1936).

The intestinal phase which is the initial stage of the disease sets in during the first week after ingestion of infected meat, and it has a sudden onset characterised by a certain degree of irritation and marked enteritis. In mild infections, clinical manifestations of this phase may be entirely absent or may pass unnoticed (Gould, 1970). Other observable symptoms include malaise, anorexia, nausea, vomiting, abdominal fullness or bloating, abdominal aches, mild fever, diarrhoea or constipation, excessive thirst in diarrheaic patients, frontal headache, dizziness, weakness and exhaustion. Infrequently, this phase may

be the only phase of the disease attended by symptoms.

The muscular phase is caused by migrating new-born larvae, and begins as early as seven days post-infection. Symptoms may persist up to five weeks or longer depending on the severity of the disease. Such associated clinical symptoms are caused by invasion of the skeletal muscles by larvae, and by inflammation of the muscles owing to presence of larvae within the fibres. Characteristic findings include oedema of the face and dependent parts of the body, intense pain of the affected muscles, persistent fever, weakness, dyspnea, anorexia, trismus, prostration and general loss of condition (Forrester et al., 1961). Eosinophilia and leukocytosis have been reported as an important clinico-pathological finding (Soulsby, 1968). Most human deaths from trichinosis occur during this phase, between the fourth and sixth week post-infection.

The convalescence phase begins after the sixth week post infection and is usually among patients with infections of moderate severity, and this is followed by complete recovery. Symptoms may, however, persist for three to four months in some cases, and occasionally an individual may sustain some permanent residual symptoms or disabling complications (Gould, 1970).

2.4.4 DIAGNOSIS IN HUMANS

Trichinosis is often difficult to diagnose clinically because atypical cases are the rule rather than the exception (Dunham, 1938). Most commonly, Trichinella infections are subclinical and with transient clinical symptoms lasting a few days to a week, and are rarely recognised in sporadic cases.

The diagnosis of trichinosis in human is tentatively made on the basis of clinical symptoms of persistent fever, muscular pains, oedema of the eyelids and face particularly when trichinosis is known to be endemic in the area. A case history of having consumed raw or only partially cooked pork or wild animal meat, parasitological demonstration of T. spiralis larvae in meat portion, coupled with the demonstration of circulating eosinophilia in the more active stages of the disease is good supportive evidence for a diagnosis of trichinosis in humans (Soulsby, 1968). The major limitation of this diagnostic approach is the diversity of the clinical symptoms of the disease among different patients (Forrester et at., 1961), and this is responsible for the initial false clinical diagnosis (Kratz, 1865). Also the identity of the infection may not be evident at its onset particularly in isolated cases. The disease is more likely to be suspected if two or more persons in a household or a number of persons in the same community are affected.

2.4.4.1 IMMUNODIAGNOSIS

Immunodiagnostic techniques used generally in helminth infections rely on the detection of antibody either by serological tests or by skin tests. Such techniques however, give no indication as to the severity of the infection or, whether the infection is still active (Soulsby, 1975). Unless there is a recognised outbreak of trichinosis where the clinical signs are displayed or expected, a provisional diagnosis is frequently made on the results of serological procedures. In symptomatic cases of trichinosis, whatever serological test is used, a good correlation exists between the incidence of positive reactions and the incidence of clinical disease. In asymptomatic cases on the other hand, especially when immunological tests are used in surveys, considerable difficulty can by expected in assessing the results, this being especially so for skin tests (Soulsby, 1975).

Immunological techniques like the intradermal reaction, and several serological tests including complement fixation (CF) test (Strobel, 1911); precipitin test (Bachman, 1928): flocculation tests (Suessenguth and Kline, 1944); and fluorescent antibody (FA) test (Sadun et al., 1962), are widely used as aids in the diagnosis of human trichinosis.

The intradermal test has been used extensively for the diagnosis of individual cases of trichinosis and also for the large-scale diagnosis of asymptomatic infections (Soulsby, 1975). Both adult and larvae could be used for the test. Because positive reaction may be evident as late as 20 years post infection, it is extremely difficult to correlate positive results with the presence of infection when used for survey purposes. Cross reactions are also said to occur with other helminth infections such as in ascariasis (Soulsby, 1975).

The complement fixation test has served for many years as a major serodiagnostic test for trichinosis probably because of its high sensitivity and complete independence on the availability of known and defined antigen and antibodies (Herbert,. 1974; Soulsby, 1975). Once an antigen-antibody reaction occurs, complement which has been added to the mixture becomes fixed to the complexes formed. In this way, it is possible to discover whether a serum sample contains antibody specific for a known antigen merely by observing whether complement disappears when the serum is mixed with it. Although the CFT is still employed as a routine test in some laboratories, it has to a great extent, been replaced by other, more simple, and equally efficient techniques (Soulsby, 1975).

The ring precipitin test has also been used extensively in the diagnosis of trichinosis. A modification of the technique relies upon the use of living T. spiralis larvae. Larval worms are incubated in the serum under examination. If antibody is present after a number of hours, precipitates develop at the natural orifices of the larvae (Southan et al., 1949). Although the test is easy to perform, it lacks adequate sensitivity and may show false reaction following the use of certain chemotherapeutic agents in some neoplastic diseases (Southam et al., 1949).

The flocculation test, a modification of the kline technique for the diagnosis of syphilis, is one of the serological tests of choice for the diagnosis of trichinosis in man. Several other particles have been assessed as antigen carriers, but the bentonite particles were found to be of most use (Bozicevich, et al., 1951). The test is highly sensitive, easy to run, simple and capable of detecting antibodies during the acute phase of the disease since it will detect both IgG and IgM classes of antibodies (Kagan et al., 1968).

The fluorescent antibody test utilises washed muscle larvae of T. spiralis, fixed in 10% formaldehyde in saline containing 0.5% bovine serum albumin (Sadun et al., 1962). Test sera are reacted with the larvae and following adequate washing, any adsorbed globulin

is detected by a fluorescein conjugated anti-species globulin serum. A modification has been the substitution of the anti-species serum by a fluorescein conjugated anti-guinea pig complement serum (Crandall et al., 1966). The test is highly sensitive and specific, but the fact that it can only be performed in laboratories with the necessary equipment and trained personnel is major limitation of its applicability.

2.4.4.2 PARASITOLOGICAL DIAGNOSIS

The direct parasitological examination of skeletal muscle tissues removed for biopsy or at autopsy, provides a reliable information for a confirmatory diagnosis of trichinosis (Kagan and Norman, 1970). Such skeletal muscle sample could be examined histologically, by use of trichinoscopes or the artificial enzymatic digestion technique, as described for animals. The presence of freshly encysted larvae in muscle tissue removed for biopsy is positive indication of infection (Ortega-Pierres, 1987). Unfortunately, however, biopsy often fails to detect larvae in early and light infections. In rare instances, the diagnosis of clinical trichinosis could be confirmed by the demonstration of T. spiralis larvae in blood beginning on the fifth day post-infection, or the demonstration of adult intestinal trichinae in faeces (Kagan and Norman, 1970).

2.4.5 TREATMENT, PREVENTION AND CONTROL

Thiabendazole(R) has been recommended as an effective drug of choice against both the adult and larval stages of *T. spiralis* in humans (Soulsby, 1968).

Considering that indiscriminate consumption of infected pork and pork products constitutes the commonest and most important source of infection to humans, strategies for control of human trichinosis must therefore be designed to:- (i) reveal the presence of trichinae in swine carcasses and (ii) render all infected pork and pork products safe for human and animal consumption (Steele, 1970; Villella, 1970). But because human infections are occasionally acquired through the consumption of infected bear meat and other wild animal meat, such control strategies could be extended to cover wild animal carcasses (Murrell, 1985). The prevention of *Trichinella* infections in humans by adequate meat control has been important since meat inspection was introduced (Van Knapen and Ruitenberg, 1984).

Practical meat inspection procedures applying the use of trichinoscopes; the digestion technique; and serology to a lesser extent, have assumed a major role in reducing the risk of infection to consumers (Murrell, 1985, Novo Food Diagnostic, 1987; Smith, 1987). This approach involves two principal patterns:-

a. education of the general public to recognise the hazard posed by the consumption of infected raw meat and the need to cook all meats, particularly pork, adequately to destroy the organism;

b. control of manufactured pork products that may be eaten without adequate cooking and may have the appearance of being ready to eat, or may, because of their nature, be undercooked in the home or restaurant, are given special attention.

The use of low temperature refrigeration to destroy all viable trichinae at a critical temperature of $-30^{o}C$ in appreciably short period of time prior to cooking is an effective means of preventing human infections (Smith, 1975b; Murrell, 1985). Augustine (1933) showed that trichinous muscle of guinea pig could be rendered safe either by rapidly lowering its temperature to $-18^{o}C$ and holding it at that temperature for at least 24 hours. Most deep-freeze cabinets used in the home today have temperature varying between $-15^{o}C$ and $-17.5^{o}C$, and thus sufficiently low temperatures are available to effectively kill trichinae. The widespread use of home freezers will therefore give consumers added protection against the ingestion of infected meat (Gould, 1945). Curing of pork meat for

40 days followed by smoking for another 10 days will also effectively kill encysted trichina larvae (Zimmermann, 1970a).

Public education of swine producers, consumers, wild game hunters, and trappers of rats on modes of transmission of T. spiralis, and the possible dangers associated with the consumption of raw or partially cooked pork or game meat is also an important control measure. Such educational effort could be extended to custom butchers so as to enlighten them on the possible danger in mixing wild animal meat with pork and of the need for safe and proper disposal of carcass remains (Murrell, 1983).

2.5 TRICHINOSIS IN AFRICA

Trichinosis is relatively unknown in African when compared to the Western and Eastern worlds. The first documented report on the disease in humans was in East Africa (Forrester et al., 1961; Nelson et al., 1961), where the parasite had never been demonstrated in the domestic pig. The source of infection to humans was traced to the consumption of infected wild pig (Potamochorus porcus). Studies by Gretillat and Vassilades (1968) indicate that generally the West African strain of T. spiralis has a low infectivity for laboratory animals, wild rats and the domestic pig. In

Nigeria, a prevalence rate of 5% was recorded in scavenger pigs slaughtered at Ibadan, Oyo State (Akinboade et al., 1984). As at the time of writing, no documented report on human trichinosis was available in Nigeria.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY AREA

This study covered the area within the present Kaduna State (North-Central), Nigeria. For the purpose of this work, the whole state was divided into three zones to facilitate sample collection. These were the Northern zone comprising Basawa army barracks and the Nigerian Army depot, both in Zaria; the central zone comprising Kaduna metropolis; and the southern zone comprising Kafanchan and Zonkwa towns. The pig industry in Kaduna State is maintained predominantly by private enterprise. Although the majority of the pigs are owned and reared by small-scale farmers, a few commercial farms do exist around Kaduna metropolis. Such commercial farms are stocked with imported exotic breeds of swine from different parts of the world.

Over half of the populace resident in Kaduna State are non-muslims, and to them port consumption is not considered a taboo. Eating of roasted pork meat is, however, not a common practice in this part of the country. The usual practice is to purchase the pork meat from the open market, subject it to thorough cooking at home for family consumption. It is not common to find either roasted or cooked pork meat being

served at public restaurants here.

The work commenced with an informal meeting with the butchers in each zone to solicit for their co-operation, and to obtain information on the sources of the animals slaughtered. The pigs were said to be purchased locally from small backyard pig rearers, who in most instances practised the semi-intensive type of management. No routine meat inspection procedure was practised in any of the slaughterslabs sampled.

Letters were also sent to the medical directors and their chief medical record officers of selected medical centres in each zone, to seek for permission to review their medical records for diagnosed cases of Trichinella spiralis infections, for the period 1975 to 1987 inclusive. This was followed by visits to the medical record officers of the various hospitals previously contacted within the study area.

3.2 SAMPLING PROCEDURE

3.2.1 COLLECTION OF SAMPLES IN PIGS

A total of 620 slaughtered pigs were sampled at various slaughterslabs in Zaria (Northern zone), Kaduna (central zone), and Kafanchan and Zonkwa (southern zone) between August, 1987 and May, 1989. For each slaughtered animal, approximately, 200 gram sample each of the tongue and diaphragm were collected in sterile airtight polythene bags, identified according to sex,

date of slaughter and location. Gross pathological findings in the form of cysts were also looked for on the carcass and offals, and recorded accordingly, following eviscertation. Where cysts were evident, such portions were also collected for laboratory identification. Collected samples were transported in coldbox packed with ice to the Parastitic Zoonoses laboratory in Zaria within three days of collection for processing.

3.2.2 COLLECTION OF SAMPLES IN FIELD RATS

A total of 240 brown field rats (Arvicanthus niloticus) were trapped around Zaria. All rats were identified on the basis of sex, date trapped and location, and transported live in metal cages to the laboratory. They were fed on sugar cane and raw carrots until they were finally sacrificed and eviscerated. The entire tongue and diaphragm were then removed, and weighed. Following evisceration, the carcass was grossly examined for the presence of cystic lesions.

3.3 LABORATORY PROCEDURE

3.3.1 ENZYMATIC DIGESTION OF TISSUES

In both pigs and rats, the diaphragmatic pillars were trimmed off adipose tissue and fascia to facilitate artificial enzymatic digestion and

subsequent microscopic examination as described by Martin et al. (1968). The digestion medium used contained one gram of powdered pepsin dissolved in 0.5 millilitre of 1M hydrochloric acid and 100 millilitre of water. For each animal species, the diaphragm and the tongue were separately trimmed to approximately five gram portions, minced with scissors and placed in flasks containing the digestion fluid which had been previously pre-warmed to 40°C. In rats where the diaphragm was less than five gram weight, the whole tissue was digested. The flasks were labeiled, covered with cotton plugs and placed in an incubator maintained at 37°C for 12 hours. The flasks were subsequently subjected to constant agitation at regular intervals until digestion was completed. Thereafter, 10% buffered formalin was added to the content of the flasks in order to preserve any larvae present. The content of each flask was then emptied into two 50 millilitre centrifuge tubes and centrifuged at 1,500 r.p.m. for 10 minutes. The supernatant was aspirated and discarded leaving just about one millilitre of fluid which was pipetted and placed on a clean glass slide for microscopic examination for larvae using the x10 magnification. Where larvae were evident, a higher magnification was also employed for more details and identification.

3.4 REVIEW OF HUMAN MUSCLE BIOPSY RECORDS

During visits to Chief Medical Record Officers of the selected hospitals within the study area, it was discovered that apart from Ahmadu Bello University Teaching Hospital (ABUTH), Zaria, none of the hospitals in the various zones had facilities for processing muscle biopsies, and therefore all muscle biopsies obtained at other hospitals within the study area were consequently referred to the Pathology Department of ABUTH, Zaria for processing. Request to review the bench record books of the Pathology Department for cases of *T. spiralis* recovered in muscle biopsies from human patients for the period 1975 to 1987 was granted. Necessary information as regards the nature of sample collected, sex and age of the patient, location and the disease condition diagnosed were all extracted from the bench record books for analysis. Only cases within the present Kaduna State were included in the study. A total of 53,912 bench records, out of which 890 were muscle biopsies, were reviewed within the study period.

CHAPTER FOUR

4.0 RESULTS

4.1 DOMESTIC SWINE

Trichinella spiralis larvae were recovered only in three (0.5%) of the 620 pigs examined. In all positive cases, larvae were recovered only from the diaphragm and none from the tongue (Table 1). Less than one larva per gram of muscle tissue was found in the positive cases. Two of the positive cases were recorded in female pigs (Table 2). Gross examination of the carcasses revealed cystic conditions in 13(2.1%) of the pigs. The cysts were identified as those of Cysticercus cellulosae. The cysts were distributed in various parts of the body including the tongue 3/13 (23.1%), thigh muscle 3/13 (23.1%), masticatory muscle 3/13 (23.1%) diaphragm 2/13 (15.4%) and heart 2/13 (15.4%).

4.2 FIELD RATS

All the tissues of the brown field rats examined were negative for T. spiralis larvae. Gross examination following evisceration revealed no parasitic cysts.

4.3 HUMAN MUSCLE BIOPSY RECORDS

Of the 890 muscle-tissue biopsy records reviewed, no Trichinella spiralis infection was documented. However, 130 (14.6%) of the 890 different muscle biopsies reported examined between 1975 and 1987 inclusive, were positive for other parasites. Of these parasites, 13.3% (118/130) were encountered in intestinal muscle biopsies, 0.3% (3/130) in gluteal muscles, 0.2% (2/130) in the tongue and 0.8% (7/130) in unspecified skeletal muscle (Table 3). No parasite was evident in the diaphragm, check muscle, thigh and mandibular muscles. Schistosoma ova and Schistosoma granulomas were the predominant parasitological findings, and they constituted 90% of all parasites detected (Table 4). Other parasites detected in muscle biopsies reported examined within the study period included Entamaeba histolytica (3.1%), Onchocerca vulvulus (2.3%), unidentified parasitic cysts (2.3%), Dracunculus medinensis (0.8%), Toxoplasma gondii (0.8%) and Trichuris spp. (0.8%). Generally, higher infection rates were observed in males (77.7%) than in females (22.3%), except for dracunculiasis and Trichuris infection where the only cases were in females. Equal infection rates of amoebiasis were seen in both males and females (Table 4). The young adult (21-30 year) age group had the highest infection rate (32.3%). This was closely

followed by the 11-20 year age group (29.2%), and the 31-40 year age group (15.4%). The only case of dracunculiasis was encountered in the advanced age group (above 61 years) (Table 5).

Over 70% of cases with amoebiasis were from Kaduna metropolis while for schistosomiasis, higher infection rates were from Zaria (50.4%) and Kaduna (40.2%) (Table 6).

CHAPTER FIVE

5.0 DISCUSSION

The prevalence rate of trichinosis recorded in pigs surveyed in this study may appear low, but is of considerable public health significance. In Nigeria where there is gross inadequacy of meat inspection, the consumer is exposed to the risk of infection. Although the degree of infection is low (less than one larva per gram of muscle tissue), human infections could readily occur if up to 70 viable cysts are consumed in infected meat, without adequate heat treatment. All the three positive cases were recorded at the Kaduna slaughterslab. It is likely that the three pigs came from the same source, which could be one of the few commercial farms stocked with exotic breeds. The negative result on demonstration of T. spiralis larvae in the field rats tally with the negative finding in pigs surveyed around Zaria, because both the domestic pig and the wild rat maintain the urban cycle of T. spiralis infection. The non-recovery of T. spiralis larvae from human biopsies as indicated by records on human muscle biopsies is most unexpected. Despite the low recovery rate in domestic swine here, there is no doubt that the potential for human infections exists. The problems of routine diagnosis of T. spiralis

infections in humans coupled with the general poor reporting system on food borne disease outbreaks might contribute to this unexpected finding.

In a survey like this, the accuracy of the results might be affected by the methods of diagnosis. Several diagnostic methods are available for the detection of T. spiralis larvae in infected tissues. These have their relative advantages and limitations (Leighty, 1974). The sensitivity of the digestion technique used in this study is quite good, although it cannot detect tissues containing infective larvae that have not yet encysted. However, interest here was establishing that T. spiralis infections exists regardless of the degree.

Although the prevalence rate found in this study is low when compared to a similar study in Oyo State (South-West), Nigeria, where 5% of scavenger pigs were found to be infected (Akinboade et al., 1984). It is, however, comparable with the low rates in many other countries (Steele and Schultz, 1978). Most importantly, the results of this survey work has clearly provided evidence of T. spiralis infection of pigs in Kaduna State (North-Central), Nigeria. The majority of pigs slaughtered here were raised under the semi-intensive management system, where they were allowed to scavenge and wander extensively, sharing common feeding grounds with wild animals such as rodents, several of which had been incriminated in

other parts of the world (Gretillat and Vassilades, 1968; Gould, 1970; Smith and Kay, 1987) as reservoirs of T. spiralis infections.

The demonstration of Cysticercus cellulosae, a developmental stage of Taenia solium, causing human taeniasis is a significant finding. These two muscle tissue parasites of pigs are zoonotic, causing profound illness in humans following ingestion. Both parasites could be effectively destroyed by adequate refrigeration or heat treatment of all port meat before consumption.

The role of rats in the transmission of T. spiralis to swine had long been debated. Evidenced have accumulated on the role of rats in the transmission of trichinosis to swine (Schad et al., 1987; Smith and Kay, 1987). Since all the rodent sampled in this study were negative, it seems likely that Arvicanthus niloticus does not play any role as of now in the transmission of trichinosis to swine in this area.

Whether these observations are consistent with a more widespread national pattern requires additional observations from different areas. However, since the domestic swine is the primary source of human infections, there is no doubt that the potential for human infections clearly exists. Therefore, not

finding T. spiralis larvae in human muscle biopsies at ABUTH, Zaria provides a somewhat deceptive perspective of the problem. This may be attributed to different factors. The current view among medical practitioners and health workers is that T. spiralis is relatively not in existence in Nigeria and thus unimportant. Therefore, trichinosis might not have been suspected and the larvae specifically looked for. Also infective T. spiralis larvae are relatively heat-labile, their thermal death point being about 55°C (Steele, 1970). This is considerably lower than the temperature in which meats are traditionally cooked in this part of the world. Because of this, many human infections might have been caused by doses of larvae too low to cause significant illness. It is generally believed that about 70 live larvae must be ingested to cause clinical illness in man (Zimmermann, 1970C). Since routine autopsies are not normally done, it remains to be seen whether non-clinical infections may be occurring.

5.1 CONCLUSION AND RECOMMENDATIONS

In Nigeria today, it is increasingly becoming more difficult to depend on beef and beef products as the sole source of animal protein. There is, therefore, an increase in the consumption of pork and pork containing products, some of which are imported.

Because of the inadequacy of our meat inspection facilities, a good number of the population are exposed to the risk of meat-borne infections. Although trichinosis may not seem to be a problem in this part of the world now, it might be of significant public health problem in the future as current routine meat inspection procedures are inadequate to detect infected meat.

Based on the findings of this survey work, the following recommendations are suggested:-

i. Further survey work on T. spiralis infections be conducted in other states of the federation, particularly in those states where massive consumption of pork meat is practised, to reveal the true prevalence of the disease in Nigeria.

ii. Meat inspection regulation to be enforced to detect the parasite in all infected animals at at slaughter so that human infections could be prevented.

iii. Efforts be made to develop and adapt a serological technique for the ante-mortem testings in swine herds.

Table 1: Prevalence of T. spiralis infection in 620 pigs slaughtered in Kaduna State of Nigeria

	No. Examined		No. Positive (%)	
Location	Tongue	Diaphragm	Tongue	Diaphragm
Kaduna	395	395	0(0)	3(0.75)
Kafanchan	90	90	0(0)	0(0)
Zaria	65	65	0(0)	0(0)
Zonkwa	70	70	0(0)	0(0)
Total	620	620	0(0)	3(0.5)

Table 2: Location and sex distribution of parasites detected in slaughtered pigs in Kaduna State

Location of Parasite	T. spiralis M	T. spiralis F	C. cellulosae M	C. cellulosae F	Total Positives
Diaphragm	1	2	2	-	5
Heart	-	-	1	1	2
Masticatory muscle	-	-	1	2	3
Thigh muscle	-	-	3	2	3
Tongue	-	-	1	2	3
Total	1	2	8	5	16

Table 3: Documented biopsy findings in patients at ABUTH, Zaria between 1975 and 1987

Site of biopsy	Amoebic trophozoites	Dracunculus medinensis	Onchocerca volvulus	Schistosoma ova	Toxoplasma trophozoites	Trichuris spp.	Unidentified parasitic cysts	Non-parasitic findings	Total (% Positive)
Intestinal biopsy	4	-	-	113	-	1	-	606	724(13.30)
Gluteus	-	1	-	2	-	-	-	4	7(0.30)
Tongue	-	-	1	-	-	-	1	24	26(0.20)
Diaphragm	-	-	-	-	-	-	-	2	2(0.00)
Cheeck muscle	-	-	-	-	-	-	-	10	10(0.00)
Thigh muscle	-	-	-	-	-	-	-	16	16(0.00)
Mandibulus muscle	-	-	-	-	-	-	-	7	7(0.00)
Undefined skeletal muscle	-	-	2	2	1	-	2	91	98(0.80)
Total	4	1	3	117	1	1	3	760	890(14.6)

Table 4: Sex distribution of parasites from biopsy records at ABUTH, Zaria

Parasite	Sex M	F	Total (%)
Amoebic trophozoites	2	2	4(3.1)
Dracunculus medinensis	0	1	1(0.8)
Onchocerca volvulus	2	1	3(2.3)
Schistosoma ova	95	22	117(90.0)
Toxoplasma trophozites	1	0	1(0.8)
Trichuris spp.	0	1	1(0.8)
Unidentified parasitic cyst	1	2	3(2.3)
Total	101(77.7)	29(22.3)	130(100)

Table 5: Distribution of parasites by age group as revealed by biopsy records at ABUTH, Zaria

Age group in years	Amoebic trophozoites	Dracunculus medinensis	Onchocerca volvulus	Schistosoma ova	Toxoplasma trophozoites	Trichuris spp.	Unidentified parasitic cysts	Total (%)
1-10	-	-	1	11	1	-	-	13(10)
11-20	1	-	1	35	-	1	-	38(29.2)
21-30	3	-	-	38	-	-	1	42(32.3)
31-40	-	-	-	20	-	-	-	20(15.4)
41-50	-	-	1	7	-	-	2	10(7.7)
51-60	-	-	-	5	-	-	-	5(3.9)
61 and above	-	1	-	1	-	-	-	2(1.5)
Total								130(100)

Table 6: Geographical distribution of parasites revealed by records of muscles biopsies at ABUTH, Zaria

Locality	Amoebic Trophozoites	Dracunculus medinensis	Onchocerca volvulus	Schistosoma ova	Toxoplasma trophozoites	Trichuris spp.	Unidentified parasitic cysts	Total (%)
Kaduna	3	-	1	47	-	-	-	52(40)
Kafanchan	-	-	-	7	-	-	-	7(5.4)
Zaria	-	1	2	59	1	1	2	66(50.8)
Zonkwa	1	-	-	4	-	-	-	5(3.8)
Total	4	1	3	117	1	1	3	130(100)

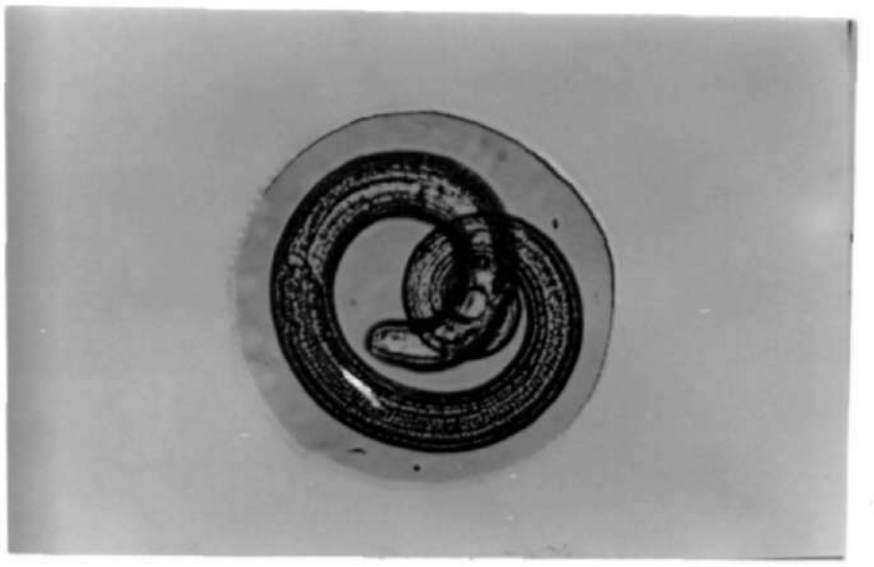


Plate A: T. spiralis larva recovered from pig diaphragm following enzymatic digestion.

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