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Bovine Gastrointestinal Trematodosis In Nigeria: A Review

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Abstract: *In this review, the economic importance of bovine gastrointestinal trematodosis in Nigeria was reviewed, bearing in mind that infections with these parasites affect cattle productivity either directly or indirectly. The epidemiological factors influencing the occurrence of the parasites were reviewed and three species (Dicrocoelium, Fasciola and Paramphistomum) that commonly occur in Nigeria were discussed. The prevalence of infections with these parasites was also reviewed both globally and in Nigeria. Various diagnostic techniques for each of the parasites were discussed as well as control option applicable to the Nigerian situation. Based on existing literatures and data on the epidemiological features of trematode infections in cattle, control and prevention methods are reviewed and modified grazing practices are recommended as this will help reduce host-parasite contact.*

Key words: *Gastrointestinal, Trematodosis, Dicrocoelium, Fasciola, Paramphistomum,Nigeria.*

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I. Introduction

Trematode parasitism is one of the major problems lowering cattle productivity around the world (Vercruysse and Claerebout, 2001). Among the prevailing parasitic diseases in Nigeria, trematodeinfections remain a major problem in cattle and other ruminants. They occur in vast water lodged and marshy grazing fields, a condition known to be ideal for propagation and maintenance ofthe snail intermediate hosts and hence high prevalenceof infection (Solomon and Abebe, 2007).Based on the habitat they usually parasitize, trematodes may also be classified into blood, hepatic, lung and intestinal trematodes. This study focused on the hepatic and intestinal trematodes, comprising mainly Fasciola spp, Dicrocoelium spp and Paramphistomum spp.

Adult flukes lay operculated eggs (they are oviparous), the embryo in the eggs develops into pyriform (pear-shaped), ciliated larva (miracidium). Under the stimulus of light and moisture, the miracidium releases an enzyme which attacks the proteinaceous cement holding the operculum in place. This later springs open and the miracidium emerges within few minutes during hatching then penetrate the soft tissues of the snails, being aided by a cytolytic enzyme. The penetration last for about 30 minutes after which the cilia are lost and miracidia develop into elongated sacs called sporocysts containing germinal cells. The cells develop into rediae which migrate to the hepato-pancreas of the snail. From the germinal cells of the rediae arise the final stages, the cercariae. The cercariae(young flukes with tail) emerge actively from the snail, usually in considerable numbers. Unlike nematodes where one egg develops to an adult, single trematode egg may eventually develop into hundreds of adults due to the phenomenon of paedogenesis (Urquhart et al., 1996). Stimulus for emergence depends on specie but most commonly a change in temperature or light intensity. Infected snails continue to produce cercariae indefinitely, though most infected snails die prematurely due to gross hepato-pancreas destruction (Urquhart et al., 1996).

The cercariae swim for some time and attach themselves to vegetations, shed their tails and encyst. This stage is called metacercariae. The encysted metacercariae have great potential for survival extending to months. Once ingested, the outer cyst wall is removed mechanically during mastication. Rupture of the inner cysts occurs in the intestine leading hatching the metacercariae. The juvenile flukes then penetrate the intestinal mucosa and migrate to the predilection sites where they become adults after several weeks. There in the predilection site, they reproduce and exert effect causing damage and disease in the affected host.

Gastrointestinal rematode infections are a major part of the health problem affecting cattle. Several workers have reported economic losses in cattle production due to these infections in the aspects of reduction in meat quantity and quality, milk production, organ condemnation (liver), loss of draught power, reproductive failure, mortality as well as risk of contracting zoonotic species (Hossain et al., 2011; Odigie and Odigie, 2013). However, their focus was mainly on Fasciola and did not cover other equally important trematode species that

cause substantial economic losses as well. Therefore, this review was done in order to provide relevant information that will help cover gap for intended researchers.

Economic importance of gastrointestinal trematodes

Infections due to gastrointestinal trematodes are of great veterinary importance in cattle, accounting for considerable economic losses. The losses encountered are seen in the areas of mortality, morbidity, organ condemnation and also decreased meat quantity and quality, milk production, production efficiency and loss of draught power (Malone et al., 1998; Chaudhri, 2000; Bianchin et al., 2007; Javed, 2008; Addis et al., 2014). The economic impact of these trematodes in cattle is enormous. Great losses are evident especially where farmers have little or no knowledge on the disease (Ozung et al.,2011). Losses are more common during the rainy season when more cattle are exposed to the flukes.

Significant economic losses to global agriculture have been estimated to be more than $3.2 billion annually due to infection with trematodes (Olsen et al., 2015). In Europe, Ayaz et al., (2014) reported an incidence of infections up to 77%. Losses due to these parasites in the UK and Ireland alone are greater than £70.67 million a year (Bekele et al., 2010) and a Swiss study by Morgan et al., (2013) reported £37.2 million loss in cattle due to subclinical infection.

In Africa, gastrointestinal trematodosis is considered as one of the most important helminth infection in cattle with reported prevalence of 30-90% (Nwosu and Srivastava, 1993; Bunza et al., 2008; Ayalew et al., 2016). Losses due to this infection have been reported by Kithuka et al., (2002) who reported up to $0.26 million annual loss due in cattle slaughtered in Kenya, Abebe et al., (2010) also reported the loss of $8,312 annually in Ethiopia and about $45,271.07 was lost in South Africa between 2010 and 2012 (Ishmael et al., 2017).

Nigerian livestock industry contributes about 5% of the gross domestic product (GDP), and is about a quarter of total agricultural output (BBI, 2004). Losses in the livestock industry due to infection by these parasites consequently affect the overall economy of the country negatively. In Maiduguri Borno State for example, Biu et al., (2006) reported the loss of $1,415.85 due to the infections among cattle over a 6-year period. Similarly, Uduak (2014) reported the loss of $1,683.09 in cattle as a result of similar infections in Port Harcourt. If reports from the 36 States and the FCT were available, the enormity of the situation will be clearer.

II. Epidemiology

Epidemiology of dicrocoeliosis

The parasite dicrocoelium has a worldwide distribution and this may be due to several factors supporting the distribution and survivability of the parasite. These include environmental factors, intermediate host and definitive host factors. Various species of the parasite have been reported in areas where they are endemic. Dicrocoelium dendriticum was reported by Rudolphi (1819) as the specie with widest distribution commonly found Europe, Asia and also North America. Looss (1907) was among the earliest to have reported the endemicity of D. hospes in Western Central and East Africa. D. chinensis was also reported by Tang et al., (1983) to be distributed in China, Japan and East Siberia. Dispersal and contamination of pastures by eggs of dicrocoelium can be by domestic and wild ruminants and also by hares and rabbits (Boray, 1985). The eggs passed through faeces are highly resistant to temperature variations and can persist on pasture for up to 20 months (Urquhart et al., 1996). This may serve as reservoir for infection. Though the eggs can persist for long time in the environment, favourable condition of temperature and moisture supports the hatchability of the egg.

Dicrocoelium have wide host-range involving several mollusk species (Manga-Gonzalez et al., 2001). The role played by molluses in epidemiology of dicrocoeliosis is very important as D. hospes egg hatching and miracidium liberating only occurs in the intestine of the molluscs intermediate hosts. Moreover, the parasites multiply enormously by asexual reproduction inside the mollusk (Urquhart et al., 1996). Therefore, this increases the likelihood of parasite transmission. The mollusk intermediate hosts are then of paramount importance as both the ingestion of D. hospes eggs and survivability of the parasite within depends solely on the mollusk activity. Manga-Gonzalez et al., (2001) reported that development of larval stages in the 1st intermediate host can be influenced by specie, age, nutritional state of molluscs, infective dose, ambient temperature and relative humidity.

Schuster (1993) reported on measuring the infection rate for D. dendriticum in the snail Helicella obvia in Germany for four grazing seasons. He observed fluctuation in the population structure of the snail with small snails predominating from April to June medium sized snails from July to September and largest snails in the spring of the following year. He further asserted that young snails were less involved in the epidemiology than medium-shell diameter snails and largest snails were more susceptible to Dicrocoelium. This may be due to active metabolism and good nutritional condition for developing sporocyts in the largest snails (Alunda and Rojo-Vazquez, 1983). Conversely, decrease infection with Dicrocoelium may occur after high infection rate in the largest snails. This could be as a result of death of the heavily infected snails in which sporocyts cause

disruption of hepatopancrease (Urquhart et la., 1996), then impairment of reproductive activity and shortening of life expectancy (Schuster, 1992). Maturation of sporocyts follows the snails' life cycle thus becoming active more often in spring (Otranto and Travarsa, 2002).

Ants serves as the second intermediate host and their relevance in the epidemiology of dicrocoeliosis is mainly due to their abundance, wide distribution and alteration to their behavior caused by the parasite in their brain which facilitate their ingestion by definitive hosts as they settle on tip of grasses. Manga-Gonzalez et al., (2001) report about 21 ant species from the genus formica have been described as receptive to this parasite in different countries. The number and size of metacercariae is directly related to the ant specie and sex (Schuster, 1991). Variations in the number of Dicrocoeliummetacercaria exist among different ant species and even among the same species. This variability could be due to season, as it appears higher in summer (Parachivescu et al., 1976), difference in affinity for slime-balls by the ant species (Loos-Frank., 1978). Plant topping by ants is caused by encystment of the metacercariae matures in the stomach of the ant. Tetany like behavior by infected ants occurs due to decrease in high intensity and temperature which alter the ants behavior and favour ingestion of the parasite by definitive host (Urquhart et al., 1996).

The main definitive hosts of Dicrocoelium parasite are herbivores. However, infection have been reported in rodents and primates and even humans (Schuster, 1993). Susceptibility to infection among various animal species differs Jithendran and Bhat, (1996) reported that sheep are more susceptible to dicrocoeliosis than goat. Animal age and relative susceptibility to the parasite have not been fully elucidated. Manga-Gonzalez et al., (1991) reported higher mean parasitic burden in lambs than in adults while a contrast result was report by Ducommun and Pfister (1991).

Stressinducing factors such as animal transportation and confinement enhance Dicrocoelium egg production probably and inducing immune depression in animals (Sotiraki et al., 1999). Gender is considered as an important epidemiological factor. Susceptibility to infection by the parasite varied greatly among males and females (Phiri et al., 2005). Investigation on the effect of sex on infection with D. hospes by Asanji and Williuams (1984) who reported that female had more infection than males. The higher rate in females may be because dairy heifers and cows grazed for several seasons, acquiring infections while steers and Oxen spend considerable period of their life in fattening units (Ducommun and Pfister, 1991). Seasonality of infection is favoured by movement of animals from low land to mountain pastures where they become infected by ants and then bring back the infection to low land during winter.

Human infection could be related to consumption of fresh vegetables where infected ants attached or particular Asian food habits involving the consumption of ants (Azizova et al., 1988). Gastrointestinal symptoms due to dicrocoeliosis were reported in a patient in Germany by Rack et al., (2004). Also, Karadag et al., (2005) reported a case of biliary obstruction by D. dendriticumin a 65yrs old patient.

Epidemiology of fasciolosis

Fasciolosis is caused by Fasciola hepatica which commonly predominate in Europe and South America and Fasciola gigantica which predominates in the tropics of Africa and Asia (Boray, 1985). There is an overlap in their distribution in the central Asia and East African regions, where hybrid forms of the parasites have been isolated (Mascoma, 2005). The occurrence of the disease is fundamentally linked to the mollusc of the genus Lymnea spp which acts as the intermediate host shading the infective stage called metacercaria (Mascoma, 2005). There are three main factors influencing the production of large number of metacercaria necessary for breakout of fasciolosis, these include temperature, moisture and availability of suitable snail habitats.

Temperature plays a vital role in the development of fasciola egg. Temperature of about 9.5^0c favours the development of F. hepatica and higher temperature limit above 30^0c inhibit the development (Rowcliffe and Ollerenshaw, 1960). The variation in the rate of development of the eggs with temperature may be influenced by topography. Dinmik and Dinmik (1962) reported on longer development time of F. gigantic egg in the Kenyan high lands due to temperature variation between 10^0c and 22^0c. Kendall (1965) also reported that a minimum temperature 10^0c is needed for the development of Lymnea truncatula and maximum growth occurs at 18-27^0c. At 15^0c, F. hepatica cercaria will complete development in the snail in 80 days, decreasing to less than 20days at 30^0c (Gettinby and Byrom, 1991). There is no development below 10^0c and above 20^oc mortality of the cercaria increases, one infected the snail appears to remain infected for life (Urquhart et al., 1996). Temperature limits of 12-14^0c is suitable for survival of metacercariae but this is reduced in hot condition. Boray and Enigk (1964) reported that metacercaria can remain viable only 3days at 20^0c whereas at 10^0c they can survive longer period of 107days. For prolonged survival, the relative humidity needs to be above 70%. Metacercariae can survive on moist hay for 8 months but few days on silage.

Increased water in the environmental favour both the intermediate host and intermediate stages. Flukes eggs will not develop in fecal mass, moisture is necessary to break up the mass and even the presence of soil may reduce the rate of development of the egg. (Rowcliffe and Ollerenshaw, 1960). Eggs in moist feaces can survive up to 10 weeks, but if the fecal material dries out rapid mortality of the eggs may occur (Ollerenshaw,

1966). Free swimming cercariae released from the snails encyts on vegetation surface by secreting a encyst wall and losing their tail. The longevity of metacercariae depends on moisture and temperature in the environments. Environmental colonization by the snail intermediate host is greatly influenced by moisture when water dried up snail like Lymnea truncatula undergo aestivation during which the transmission of the parasite is suspended (Malone and Craig, 1990). In some areas like Australia and Spain, the prevalence of fasciolosis is high due to increase moisture Uriarte et al., (1985). The total fluke counts and fecal egg counts are highest at the beginning of the wet season in West Africa (Schillhorn Van veen, 1980) and this coincides with the time when snail populations are rising. Large numbers of infected snails are present at the end of the wet season and beginning of the dry season and this support ruminant hosts infection. Chaudhri et al., (1993) gave a similar report on the developmental cycle of snails and infection in cattle and buffalo in India which is related to the rainy season.
The snail intermediate host Lymnea natalensis was reported by Ndifon and Ukoli (1989) to be widely spreaded throughout Africa and also distributed in Nigeria usually confined to permanent water bodies. The snail is commonly found in areas with rainfall over 1000mm (Schilhorn Van Veen, 1980) and tolerates relative high temperatures (Njoku-Tony, 2011) consistent with tropical climates. Andrews (1999) reported that temperature between 10-25^{0}c, low elevation areas, presence of flooded and wetlands areas, irrigated rice cultivations and extensive livestock breeding are factors that contribute to the maintenance of the mollusc and spread of fasciolosis. These are important factors for the development of large number of metacercariea which would increase the infection rates (Taylor et al., 2007). In Uganda, Howell et al., (2005) reported on the abundance of L. natalensis at lower altitudes below 1800m while Galba truncatula (intermediate host of F. hepatica) was only found on high altitudes above 3000m. Thepresence of the two snail intermediate hosts indicates the possibility of finding the two fasciola parasites in Uganda.

In Nigeria, Schilhorn Van Veen (1980) reported that developing Lymnea snails are washed away in torrential streams after heavy rain and this may be important in the spread of fasciolosis. He also reported that abundance of snails at the beginning of dry season with peak in the middle of dry season and decreased towards the end of the dry season when ponds and streams dry up. This was supported by Ndifon and Ukoli (1989) who reported that dry season conditions favour snails and this was said to be due to low turbidity reduced currents and substantial growths of algae and macrophytes. According to Taylor et al., (2007), optimal development of fluke eggs to miracidia occurs at the start of the wet season and development within the snail is completed by the end of rainy season. Therefore, shedding of the certain coincides with dry season and more animals graze around streams and pond by that time, thereby predisposing them to infections. Ikeme and Obioha (1993) reported that herdsmen migrate in search of water and grazing during the dry season and thousands of cattle often converge on the few ponds, which fail to dry up.

Cattle and other herbage feeding ruminants are the common definitive hosts to the fasciola parasite and also humans (Funatsu and Bargnes, 2001). Elelu et al., (2016) reported the influence of age in the distribution of fasciolosis in cattle where he obtained adult cattle to be more susceptible than weaners Cattle. A similar report was given by Pfukenyi et al., (2006) in Zimbabwe and Nzalawahe et al., (2014) in Tanzania. This was attributed to longer exposure period to infection by the adults (Pfukenyi et al., 2006). Older cattle serve as constant source of F. gigantic infection for susceptible young ones (Pfunkenyi et al., 2005).

Epidemiology of fasciolosis is significantly influenced by management system (Keyyu et al., 2005). A work conducted in the Lake Chad area by Jean-Richard et al., (2014) reported high prevalence rate in cattle managed extensively in South Western Nigeria. Cattle usually come in contact with snail infected habitat during extensive communal grazing. However, under intensive can be supplied to the cattle thereby minimizing the likelihood of outbreak of fasciolosis.

There are varying reports on the seasonal infection rates of F. gigantic across globe. Umar et al., (2009) reported high infection rates in the beginning of the dry season in Nigeria. A similar report was obtained by Phiri et al., (2005) is Zambia who reported on bovine fasciolosis with higher fluke abundance in post rainy season. Also Pfukenyi et al., (2005) reported seasonal variation with increase during the end of the dry season. However, all year occurrence of infection was reported in Southern Nigeria by Gboeloh, (2012) and this was due to favourable climatic condition which favours the development of parasites and the increase in the density of snail intermediate hosts (Nzalawahe et al., 2014).

Human infection with Fasciola has been reported in various countries and this infection occurs mainly in rural areas where consumption of aquatic plants such as water-cress is high. A recent case-control study conducted in Pen, found fasciolosis to be positively associated with familiarity with aquatic plants, drinking Alfa juice and dog ownership (Marcos et al., 2006).

Epidemiology of Paramphistomosis

Paramphistomum is one of the common parasites in the rumen and reticulum and of sheep, goats, cattle and water buffaloes. Light infection with the parasites doesn't cause serious damage to the animals but massive number of immature Paramphistomum can migrate through intestinal tract causing parasitic gastroenteritis with

high morbidity and mortality rates in young animals (Urguhart et al., 1996). Paramphistomosis is widely distributed, but highest prevalence has been reported in tropical and subtropical regions particularly in Africa, Asia, Australia, Eastern Europe and Russia (Rolfe et al., 1991). The major epidemiological variable influencing worm burdens of animals is the infection rate from pastures and it is influenced by the climatic requirement for egg hatching, development and survival of the larvae in pasture (Melaku et al., 2012).

In Nigeria, rumen flukes are commonly seen in the abattoir among slaughtered cattle (Bunza et al., 2008). The snail vector of the disease (Lymnea, Plamorbis and Bulinus) has also been reported in Nigeria (Ndifon and Ukoli, 1989, Brown and Kristensen, 1993). The species reported to occur in Nigerian domestic livestock include Paramphistomum microbothrium, Carymyerius gregarious, Carmyerius spatiosus, Cotylophorom cotylophorum (Schillhorn Van Veen et al., 1975) and Paramphistomum cervi (Bogatko, 1975). Other species recovered in Nigeria as reported by Dube et al., (2013) include Cylonotyledicranocoelium microbothriodes. Conditions favourable for natural increases in the population of snail intermediate hosts usually occur at the beginning of and end of rainy season (Mukaratirwa et al., 1996). Shiff (1964) also reported that egg production and abundance of the juvenile snails was high during the beginning and end of the summer rainy season. Therefore, the snail intermediate host populations undergo marked seasonal variations in density with generally low densities during the rainy period and high densities in the post rainy periods (Pfukenyiet al., 2005). The numerical size of the population is greatly influenced by several factors like flooding, desiccation and temperature (Woolhouse and Chandiwana, 1989).

Outbreaks of disease generally occur in the dry months of the year when the receding water uncovers herbage contaminated with encysted metacercariae. Foster et al., (2008) reported that dispersal of snails by flooding events and changes in farm management practices may be responsible for the apparent emergence of the parasite in the U.K. Similarly, Pfunkenyi et al., (2005) reported that fecal egg count is seen towards the end of the dry season and during the wet months of the year (October to March) in Zimbabwe. Similar report on seasonal pattern of paramphistomosis was also obtained by Pfukenyi et al., (2005) who reported that the timing of the season pattern may vary based on location, length of the rainy season and grazing habits of the cattle.

Infections with Paramphistomum vary between altitudes (high and low). In Zimbabwe Pfukenyi et al., (2005), reported the prevalence of patent amphistome infections with spatial heterogenicity, varying from 0% to 19.5% on high veld and 0% to 20.5% in the low veld. This difference in patent infected snails in space is attributed to recent river conditions (flood and draughts) and patchy contamination of the water by excreta (Woolhouse and Chandiwana, 1989).

Cattle infection by Paramphistomum has been reported in Nigeria, with a highest prevalence of 56%. This may be associated with grazing of animals around river valley which provide suitable breeding sites for snail intermediate hosts off the parasites (Bunza et al., 2008). Overcrowding of animals at grazing sites due to scarcity of feed and watering sites may favour the establishment and spread of paramphistomosis (Ayalwa et al., 2016). Susceptibility to paramphistomosis may vary among cattle of different ages. This was reported to be more in older cattle than young ones according to Ayalwa et al., (2016) in Ethiopia. However, other workers reported no significant difference between age groups (Titi et al., 2010; Khederi et al., 2015). Peak infection of cattle with Paramphistomum is seen during October to November (post rainy season) (Ayalwa et al., 2016). During the dry periods, breeding of snails and development of the larval flukes slow down or stop completely and snails undergo a state of aestivation (Soulsby, 1982, Urquhart et al., 1996).

III. Prevalence of gastrointestinal trematodosis

Global prevalence of gastrointestinal trematodosis

The prevalence of trematode infections in cattle in some selected countries of the world is presented in Table 1.

Table 1: The global prevalence of gastro-intestinal trematodosis in cattle

Country	Species of parasites	Prevalence (%)	References
Turkey	Dicrocoelium dentriticum	23.6	Gargili et al., 1999
Sudan	F. gigantic	30.0	El-manan et al., 2001
Italy	F. hepatica	11.1	Cringoli et al., 2002
Algeria	F. hepatica	27.0	Mekround et al., 2004
Zimbabwe	F. gigantic	37.1	Pfukenyi and Mukaratirwa, 2004
Zambia	F. gigantic	48.9	Phiri et al., 2005
Argentina	F. hepatica	40.0	Kleiman et al., 2007
Spain	F. hepatica	71.0	Paz-silva et al., 2007
Iran	Dicrocoelium dentriticum	66.0	Ahmadi et al., 2010
Brazil	F. hepatica	21.3	Alves et al., 2011
Ethiopia	F. gigantic	45.3	Abebe et al., 2011
Australia	F. hepatica	17.8	Duscher et al., 2011
Portugal	Paramphistome	12.0	Arias et al., 2011
Tanzania	F. gigantic	23.3	Njoku-Tomy, 2011
Algeria	Paramphistome	45.7	Titi et al., 2014
Ethiopia	Paramphistome	51.8	Ayelew et al., 2016

Spain	Paramphistome	6.0	Ferraras et al., 2014
Belgium	Paramphistome	28.0	Malrait et al., 2015
Netherland	Paramphistome	15.8	Ankum, 2015
India	Paramphistome	75.6	Swarnakar et al., 2014
New Caledonia	Paramphistome	70.0	Cauquil et al., 2016

It can be seen that trematodosis is endemic in various countries of the world and has been cause of great economic losses in the livestock industry across the globe. India appeared to have the highest prevalence of 75.6% while the least prevalence of 6% was reported in Spain. Reports obtained from other countries are between this range.

Prevalence of trematodosisin Nigeria

The incidence of trematode infection in Nigeria is presented in Table 2.

Table 2: Prevalence of gastrointestinal Trematodosis in Nigeria

City/State	Spp of parasite	Prevalence (%)	References
Borno	Dicrocelium	18.3	Nwosu and srivastava, 1993
Plateau	Fasciola	71.6	Fabiyi and Adeleye, 1982
Sokoto	Paramphistome	56.0	Bunza et al., 2008
Zaria	Fasciola spp	23.4	Raji et al., 2010
Abia	Dircocoelium	3.1	Amadi et al., 2012
Adamawa	Fasciola	21.8	Ardo et al., 2012
Maiduguri	Fasciola	14.8	Biu et al., 2013
Edo	Fasciola	11.5	Odigie and Odigie, 2013
Ebonyi	Fasciola	37.9	Ngele and Ibe, 2013
Ibadan	Dicrocoelium	2.5	Olubukola et al., 2014
Portharcourt	Fasciola	1.7	Uduak, 2014
Kogi	Dircocoelium	39.0	Iyaji et al., 2018
Kwara	Dicrocoelium	7.3	Elelu et al., 2016
Plateau	Dicrocoelium	22.3	Omowaye et al., 2012
Benin city	Paramphistome	2.2	Edosomwan & Shoyeni 2012
Ebonyi city	Paramphistome	18.8	Nwigwe et al., 2013
Kwara	Paramphistome	16.1	Elelu et al., 2016
Kaduna	Paramphistome	41.7	Nnabuife et al., 2013

Apparently, trematode infections are widespread in the country because there has been report from all the geopolitical zones. The highest prevalence of 71.6% was recorded in Plateau northcentral Nigeria and least prevalence of 1.7% was reported from Portharcourt, southsouth Nigeria. All the other areas recorded values that are between these two extremes

IV. Diagnosis of trematode infections

Diagnosis of dicrocoeliosis

This is commonly achieved based on coprological examination for eggs and necropsy findings which is similar to that of fasciolosis since they have common predilection site. Sotiraki et al., (1999) examined the effect of stress on the intensity of egg excretion in sheep where they reported that stressed animals excreted more eggs. Campo et al., (1999) also reported higher excretion of Dicrocoelium dendriticum eggs in faecal samples collected in the afternoon than those collected in the morning from dame animals.Presence of fluke eggs in liver, faeces and bile were compared by Braun et al., (1995) and they found significant differences among them with highest intensity reported in the bile. Thienpont et al., (1979) reported of a modified technique for analysis of bile sample. Postmortem diagnosis is carried out on the basis of postmortem findings at the point of slaughter. Thickening and extension of the biliary ducts as well as hepatic indurations are the most significant macroscopically observable changes in the liver in dicrocoeliosis. In the thickened biliary ducts there are numerous flukes of various sizes, which are sometimes located in the gall bladder (Duchacek and Lamka, 2003). However, Klimas et al., (1994) reported that not all cases of dicrocoeliosis can be recognized at slaughter inspection of meat.

Serological tests for the detection of dicrocoeliosis in sheep and goat was estimated by Jithendran et al., (1996). Counter-current immunoelectrophoresis was reported by Duchacek and Lamka (2003) as most sensitive in the diagnosis of Dicrocoelium dendriticum. This specific and rapid test of epidemiological examination of sheep and goats makes it possible to diagnose dicrocoeliosis already in the prepatent period. The antibodies are detectable with the help of ELISA test (Haralabidis, 1987). High antibodies titer against Dicrocoelium parasite was reported by Ambrosi et al., (1980) to be detected in 4-8 weeks before the appearance of eggs in faeces. Otrando and Traversa (2002) reported that the use of ELISA in detecting dicrocoeliosis is important for

epidemiological studies and also help in early diagnosis leading to treatment and decreasing economic losses. Sandoval et al., (1999) reported on the use of restriction fragment length polymorphism (PCR-RFLP) of mitochondrial genes using common restriction enzymes to study genetic variability of Dicrocoelium species.

Diagnosis of fasciolosis

The most common method of diagnosis is by faecal egg counts and pathological lesions in the liver during post mortem examination at the abattoir. Thienpoint et al., (1979) reported a modified technique for diagnosing fasciolosis using bile sample.A survey of cattle fasciolosis in Kwara state as reported by Elelu et al., (2016) showed that fecal analysis had higher prevalence rate than liver examination and this revealed lack of sensitivity of the abattoir method of diagnosis as positive samples are likely to be lost. Therefore, multiple stool sampling or the combination of different diagnostic tests should be considered to enhance diagnostic accuracy (Johansen et al., 2010). Indeed, a single FLOTAC (new multivalent flotation method) can show a considerable higher sensitivity for Fasciola hepatica diagnosismultiple Kato-Katzes thick smears, McMaster or sedimentation slides (Duthaler et al., 2010).In the sub-tropical and tropical countries with distinct wet and dry seasons, optimal development of fluke eggs to miracidia occurs at the start of the wet season and development within the snail is completed by the end of rains (Taylor, 2007). The dry season therefore coincides with the snail shedding of cercariae and more animals grazing closer to streams and ponds thereby predisposing them to infection.

Serological diagnostic method to detect antibodies, such as indirect ELISA (Ardo 2013; Aliyu et al., 2014) and direct ELISA (Fagbemi et al., 1997) has been reported in Nigeria. Testing of precipitating antibodies by the use of Agar Gel precipitation test (AGPT) was also reported by Adedokun et al., (2008), this method has been shown to detect more positive cases than faecal and bile egg counts. A polymerase chain reaction technique (PCR) has also been used to detect Fasciola gigantica infection status of snail intermediate host (Velusamy et al., 2004, Kaset et al., 2010). Amplification of specific fragment of mitochondrial DNA in fecal samples in sheep by the use of PCR technique as reported by Martinez-Perez et al., (2012) can be of importance in the early detection of Fasciola hepatica infection.

Diagnosis of Paramphistomosis

Provisional diagnosis is usually made on history and clinical signs of the disease (anorexia and projectile diarrhea) and the presence of immature Paramphistomes in fluid faeces or at postmortem examination. Faecal examination for eggs at this stage is usually unrewarding as the disease is in the prepatent phase (Urquhart et al., 1996). The immature flukes are conical, pink in color and 1-5 mm long (Soulsby, 1982). The faecal sedimentation technique is the most suitable for identifying the eggs in faeces. The eggs are oval and operculated, resembling that of Fasciola gigantic but they are larger and transparent (Zojac and Conboy, 2006). The eggs of the two species are easily distinguished by the addition of a contrast stain like methylene blue. At postmortem there is marked hemorrhagic enteritis with large numbers of immature flukes embedded in duodenal mucosa. Marked fall in total plasma proteins due to increased leakage of plasma albumin as a result of pluck feeding habits of the immature flukes (Kusiluka et al., 1996). Adult flukes are found in the rumen and reticulum during postmortem, they are pear-shaped and red in colour, approximately 1cm long with a sucker at the tip of the cone and another ventrally at the posterior end (Waal, 2011).

The diagnosis of paramphistomosis could be influenced by season as snail intermediate hosts predominate in the monsoon and post monsoon season and this coincides with the season where majority of cases are reported (Swarnakar et al., 2014, Titi et al., 2014). Similarly, Rangel-Ruiz et al., (2003) reported that livestock infected with Paramphistomum cervi occurred more frequently during the rainy season. Few cases may be encountered during the dry periods due to interference of the snails breeding and development which slow down or even stop completely (Urquhart et al., 1996).

Enzyme linked immunosorbent assay (ELISA) is being practiced as the most effective diagnostic technique for detection of anti-parasitic antibodies (Shabih et al., 2006).Indirect plate ELISA was also able to demonstrate the antibody titer at different week post infection in experimental cattle as reported by Estuningsih et al., (2004). A similar report was obtained by Kaur et al., (2009) who reported variation in immune response at weekly intervals in all groups of experimental cattle. The use of molecular technique in the identification of paramphistome species has been reported in Asia and some African countries (Lofty et al., 2010). Ankhum (2015) reported that modified Dorsman technique is effective in faecal diagnosis of paramphistomosis.

Control and Prevention

Instituting control against trematodes in ruminant involve the use of various techniques which could be independent or integrated approach (Santos, 2012). These techniques aimed at reduction of the number of the snail intermediate hosts through biological or chemical means, environmental manipulation and grazing management practices (Asrat, 2004). A number of chemotherapeutic agents are in use for the control of trematode infections.

The control of human infection may be achieved by strict control of water cress and other metacercariae carrying aquatic plants for human comsumption especially in endemic areas (Mas-coma et al., 2005). Drinking water must be boiled or purified. Intergrated control approaches and inter-sectoral collaboration between public health and veterinary medicine has also been suggested for control (Keiser and Utzinger, 2009).

V. Conclusion

Gastrointestinal trematode infections are a significant limiting factor in cattle and other ruminant production, therefore development of reliable diagnostic techniques and sustainable strategies for their control is a priority. In order to develop sustainable control, gap in knowledge must be identified to guide researchers. The outcome of such research would provide useful information that will aid in the disease control and this will optimize the production efficiency in order to meet the growing population of Nigeria. Therefore, integrated approach towards the successful control of these infections is required. Thus, it is recommended that farmers should adopt modified grazing practices and government should develop national control policies that will curb this menace.

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