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Fasciolosis -- Public Health and Economic Impacts: A Review

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Abstract: Fasciolosis is a disease caused by trematodes of the genus *Fasciola*. The parasite has worldwide distribution, and is commonly referred to as "liver flukes". The two most known species of *Fasciola*; namely, *Fasciola hepatica* and *F. gigantica* are the causative agents of fasciolosis. The lifecycle of *Fasciola* entirely depends on snails of the genus *Lymnaea*. The disease predominantly affects cattle, sheep and goats, and occasionally humans. In animals, the disease is characterized by gradual loss of condition, progressive weakness, anaemia and hypoproteinaemia with development of edematous sub-cutaneous swelling especially in the inter-mandibular space and over the abdomen. Fasciolosis poses significant economic losses due to carcass condemnations, loss of productivity and cost of drugs as a therapy each year worldwide. Fasciolosis is thought to infect about 17 million humans worldwide and a further 180 million at risk of infection. The disease is cured by administration of appropriate chemotherapeutics, especially, Triclabendazole (Fasinex), which is effective against all stages of *Fasciola*. Prevention and control of fasciolosis should be targeted on drainage of stagnant water bodies and snail control strategies.

Keywords: Fasciolosis, *Fasciola hepatica, Fasciola gigantica*, Public Health Impact, Economic Impact

Introduction

Fasciolosis is an economically important disease of domestic livestock, in particular cattle and sheep and occasionally man. The disease caused by digenean trematodes of the genus *Fasciola* commonly referred to as "liver fluke". The two species most commonly implicated as the etiological agents of fasciolosis are *F. hepatica* and *F. gigantica*. *Fasciola hepatica* has a worldwide distribution but predominates in temperate zones while *F. gigantica* is found on most continents primarily in tropical regions (Stuart, 1991).

In tropical regions, fasciolosis is considered the single most important helminthes infection of cattle with prevalence of 30-90% in Africa (Schillhorn, 1980; Fabiyi,

1987). Fasciolosis occurs commonly as a chronic disease in cattle and the severity often depends on the nutritional status of the host (Graber, 1975). It is responsible for the wide spread morbidity and mortality especially in cattle and sheep characterized by weight loss, anemia and hypoproteinemia. It is also expressed in terms of liver condemnation at slaughter houses, infertility, reduction in traction power and low weight at birth has been reported (Soulsby, 1986). The snails of the genus *Lymnaea* are mainly involved as intermediate hosts in the life cycle of Fasciola *Lymnaea natalensis*, aquatic snail is an important host of *F. gigantica* in Africa. *Lymnaea truncatula*, amphibious snail with a wide distribution throughout the world, is the most common intermediate host of *F. hepatica* (Hall, 1988; Radostit *et al.*, 2007). Both *F. hepatica* (the highland) and *F. gigantica* (the low land) liver flukes cause severe losses in parts of Ethiopia where suitable ecological conditions for the growth and multiplication of intermediate host snails are found. Areas with seasonally flooded pastures, grazing areas of lakeshores, slowly flowing water ways and banks of rivers are among the conducive environments for breeding of snail vectors of Fasciolosis (Graber, 1975). Mixed infections by both species of *Fasciola* may occur in areas where the ecology is conducive for replication of snail intermediate host (Radostit *ert al.*, 1994).

Infection of domestic ruminants with *F. hepatica* (temperate liver fluke) and *F. gigantica* (tropical liver fluke) cause significant economic loss estimated at over US $ 2000 million per annum to the agricultural sector worldwide with over 600 million animals infected (Gaafar *et al.* , 1985; Hillyer *et al*., 1997). In addition, fasciolosis is now recognized as an emerging human disease. World Health Organization (WHO) has recently estimated 2.4 million people infected with Fasciola and a further 180 million at risk of infection (WHO, 1995). High prevalence of human fasciolosis has been reported in Bolivia and Peru where fasciolosis is regarded as an important human health problem (WHO, 1995; Hillyer and Apt, 1997).

THE DISEASE: FASCIOLOSIS

Etiology

Liver flukes are parasitic flat worms, which infect the liver of various animals specially sheep and cattle. The disease is caused by *Fasciola hepatica* and *Fasciola gigantic* (Taylor *et al.*, 2007).

Morphology

The adult parasite *F. hepatica* has a flat leaf-like body typical of flukes, and measures 20 to 30 mm long and 8 to 15 mm wide (Dunn, 1998). It has an anterior elongation (at cephalic cone) on which the oral and ventral suckers, which are approximately of equal size, are located. The intestine of the adult parasite is highly branched, with numerous diverticulae extending from the anterior to the posterior of the body. The vitellaria are highly diffused and branched in the lateral and posterior region of the body. *Fasciola gigantica* is a parasite very similar to *F. hepatica*, its length may vary 25 to 75 mm long and 15 mm wide. In addition, the cephalic cone is proportionally shorter than that of *F. hepatica*, and its body even more leaf-like in shape (Soulsby, 1982).

The egg of *F. hepatica* measures 150 µm x 90 µm in size and also very similar in shape to that of *F. gigantica* (Soulsby, 1982). The egg of the later is larger in size (200 µm x 100 µm) (Dunn, 1998). Fasciola eggs should be

distinguished from the eggs of other flukes, especially from the large eggs of *Paramphistomum*. Fasciola eggs have a yellowish brown shell with an indistinct operculum and embryonic cells whereas *Paramphistomum* egg has transparent shell, distinct operculum with embryonic clear cells, and possess a small knob at their posterior end (Soulsby, 1982).

Life Cycle

Adult fluke in the bile duct, shed eggs into the bile, which enter the intestine, egg passed in the faeces of the mammalian host, develop and hatch, release motile ciliated miracida.This takes 9-10 days at optimum temperature of 22-26 C and little development occurs below 10 C (Soulsby, 1982; Andrews, 1999; Taylor *et al*., 2007). The liberated miracidium has a short life span and must locate a suitable snail within 3 h if successful penetration of the later is to occur. In infected snails development proceeds through the sporocyst and radial stage to the final stage in the intermediate host, the cercaria; these are shed from the snail as motile forms, which attach themselves to firm surface such as grass blades, and encyst there to form the infective metacercaria. Infection of a snail with one miracidium can produce over 600 metacercariae. Metacercarae ingested by the final host encyst in the small intestine, migrate to the gut wall, cross the peritoneum, and penetrate the liver capsule. The young flukes tunnel through the liver parenchyma for 6-8 weeks, and then enter the small bile ducts where they migrate to the large ducts and occasionally the gall bladder, and reach sexual maturity. The preparent period is 10-12 weeks. The minimal period for completion of one entire life cycle of *F. hepatica* is therefore 17-18 weeks (Taylor *et al*., 2007).

Epidemiology

Fasciolosis is considered an important limiting factor for ovine and bovine production. This fluke's worldwide distribution occurs in areas where cattle, sheep and goats are raised and there is a niche for *lymnaeid* snail (Marquardt *et al*., 2000).

Fasciola hepatica is a temperate species and it is found in Southern America, Northern America, Europe, Australia and Africa, but found in the highlands of Ethiopia and Kenya (Yilma and Malone, 1998). It is the major cause of liver fluke disease in Ethiopia. Its tropical counterpart, *F. gigantica*, on the other hand is widely distributed in tropical countries, in Africa and Asia, parasitizing domestic ruminants and other herbivores in almost every continent. In Ethiopia, *F. gigantica* is found at altitudes below 1800 m.a.s.l. while *F. hepatica* is found at altitude between 1200-2560 m.a.s.l.. Mixed infections by the two species can be encountered at 1200-1800 m.a.s.l. (Yilma and Malone, 1998).

In tropical regions fasciolosis is considered the single most important helminth infection of cattle with prevalence of 30-90% in Africa, 25-100% in India and 25-90% in Indonesia (Spithill and Dalton, 1999) Direct loss in domestic animals results from chronic and acute fluke infection. Chronic loses are mostly in the form of reduced production of meat, milk and fiber. Direct losses include condemnation of livers at slaughter; buyer of livestock for packing plants pay less for animal from areas where flukes are endemic (Marquardt *et al*., 2000). Black disease of sheep and red water of cattle result in indirect

death losses from toxin produced by the anaerobic, spore forming bacilli, *Clostridium novyi* (*Cl. Oedematiens*) and *Cl. hemolyticum*, respectively, growing in fluke damaged liver (Bowmann *et al.*, 2003).

Snails of the genus *Lymnaea* are the intermediate hosts for genus *Fasciola*. *Lymnaea truncatula* snail is an amphibious with the wide spread in Europe, Asia, Africa and North America; *Lymnaea tomentosa* in Australia, New Zealand; *L. columella* in Central and North America, Australia and New Zealand; *Lymnaea humilis* in North America (Taylor *et al*., 2007). *Lymnaea truncatula* is the common intermediate host for *F. hepatica* in different part of the world (Njau and Scholtens, 1991) and in Ethiopia (Graber, 1975).

The most important intermediate host of *F. gigantica* is *Lymnaea. natalensi* and *Lymnaea auricularia* (Soulsby, 1982; Urqhuart *et al.*, 1996; Dunn, 1998). *Lymnaea natalensis*is the recognized immediate host for *F. gigantica*[17]. Other species serving as secondary host to this species are *Lymnaea rufescens*, *Lymnaea acuminate* (indo-Pakistan) and *Lymnaea rubiginosa* (Malaysia). *Lymnaea natalensis* is a true aquatic snail often found in Africa (Taylor *et al.*, 2007).

Clinical Signs

Several clinical syndromes may be associated with liver fluke infection, depending on the number and development of the parasite and categorized into acute, sub-acute and chronic forms. Acute fasciolosis occurs as disease outbreak following a massive, but relatively short-term intake of metacercariae (Urqhuart *et al.*, 1989). In heavy invasions the trauma inflicted the maritas tunneling about in the liver and consequently inflammation reactions results in highly fatal clinical illness characterized by abdominal pain with a disinclination to move (Bowmann *et al.*, 2003).

Sub-acute fasciolosis is caused by ingestion of a moderate number of metacercaria and is characterized by anemia, jaundice and ill-thrift. The migrating fluke causes extensive tissue damage, hemorrhage and in particular liver damage. The result is severe anemia, liver failure and death in 8-l0 weeks (Urqhuart *et al.*, 1989).

Chronic disease is associated with the presence of adult trematodes in the bile ducts and characterized by the classical clinical sign of liver fluke infection. There is gradually loss of conditions, progressive weakness, anemia and hypo-proteinaemia with development of edematous sub-cutaneous swelling especially in the intermandibular space and over the abdomen (Bowmann *et al.*, 2003). Cattles are able to mount a protective immune response, with partial acquired resistance to *F. hepatica*, being at 5 to 6 months of initial exposure. This and short life span of flukes in cattle typically lead a linear reduction of fluke numbers, with few surviving by the end of one year (Smith, 2009).

In addition to these diseases, a condition known as 'black disease' is a complication, which is usually fatal. Here, a secondary infection due to the bacterium *Clostridium novyi* Type B, proliferating in necrotic lesions produced by the young larvae migrating in the liver is responsible for the fatal outcome of chronic fasciolosis (Radostits *et al.*, 2005).

Pathogenesis

Pathogenesis of fasciolosis varies according to the parasitic development phases:

parenchymal and biliary phases. The parenchymal phase occurs during migration of flukes through the liver parenchyma and is associated with liver damage and hemorrhage. The biliary phase coincides with parasite residence in the bile ducts and results from the haematophagic activity of the adult flukes and from the damage to the bile duct mucosa by their cuticular spines (Urqhuart *et al.*, 1989).

Acute hepatic fasciolosis is caused by the passage of young *F. hepatica* throng the liver parenchyma. Clinical signs occur 5-6 weeks after the ingestion of large number of metacercaria. By this time, the migrating flukes are large enough to do subtial mechanical damage to liver and acute hepatic insufficiency and hemorrhage will result (Radostits *et al.*, 1994) quiescent spores of *Clostridium novyi* may become activated by the anaerobic necrotic conditions created in the liver parenchyma by migrating *F. hepatica*, causing infectious hepatic necrotic hepatitis (black disease) in sheep and cattle (Bowmann *et al.*, 2003).

Chronic hepatic fasciolosis develops only after the adult flukes establish in the bile ducts. Here they cause cholangitis, biliary obstruction, fibrosis and a leakage of plasma protein acrossthe epithelium. Although this protein can be resorbed in the intestine, there is poor utilization and retention of nitrogen leading to hypoalbuminemia. There is also a loss of whole blood due to the feeding activity of the flukes. This exacerbates the hypoalbuminemia and eventually gives rise to anemia. The severe reaction in cattle, which includes calcification of the bile ducts, appears to tinder the establishment and feeding of challenge infections (Marquardt *et al*., 2000).

Although the inflammatory process has an important role in protecting the host against severe consequences of liver damage by the flukes, perhaps by retarding the growth of the parasite and contributing to hepatic healing process, there is accumulated evidence, in rats, that the response also contributes to hepatic dysfunction. There is also evidence that the infected rat liver is underoxidative stress during the parenchymal stage of the infection. The liver plays a central role in the physiology of the body, being responsible for a large proportion of the body's amino acid metabolism, for carbohydrate and lipid balance, urea synthesis, detoxification, metabolism, ketogensis, albumin and glutathione synthesis as well as aspects of homeostasis. Therefore, it is to be expecting that many systemic changes will be induced by liver fluke infections that ultimately cause reduced productivity in livestock (Behm and Sangster, 1999).

Diagnosis

Diagnosis of fasciolosis may consist of tentative and confirmatory procedures. A tentative diagnosis of fasciolosis may be established based on prior knowledge of the epidemiology of the disease in a given environment, observations of clinical signs, information on grazing history and seasonal occurrence. Confirmatory diagnosis, however, is based on demonstration of *Fasciola* eggs though standard examination of faces in the laboratory (sedimentation). As *Fasciola* eggs may be confused with *Paramphistomum* eggs, addition of methylene blue in the faecal suspension will facilitate ease identification by providing a blue and contrasting microscopic field (Soulsby, 1982; Urqhuart *et al.*, 1989; Cornelissen *et al*., 2001).

At post-mortem examination, adult flukes are found in the gall bladder and in larger bile ducts of the liver. In death from acute fluke infections, tracks, where flukes have migrated may be seen, and it is sometimes possible to find juvenile fluke in the parenchyma of the liver (Marquardt *et al*., 2000).

The FAST-ELISA can also be used to confirm effective cure as antibody levels return to normal in 11-12 months after the cessation of infection. Ultrasound can be used to visualize the adult flukes in the bile ducts and a CT scan may reveal the burrow tracts made by the worms and dilation of the bile ducts (WHO, 1986).

Control and Prevention

1. *Chemotherapy*

Chemotherapy with drugs remains the most cost-effective way of treating parasitic diseases, and is usually at the heart of any major control campaign. Compared to environmental engineering, drug treatment is very cheap (Gassenbeek *et al.*, 2001). The drugs to be used against flukes should ideally destroy the migrating immature flukes as well as adults in the bile ducts. Several drugs are now available for the treatment of fasciolosis, which are against the adult flukes, and the parenchymal stages. These include rafoxanide, nitroxynil, brittanie, closantel and albendazole. Diamphentide kills all immature flukes even a day old and the triclabendazole is highly effective against all stages of flukes. It is one of the widely used d**rugs**wor**ld**wide for the control of fasciolosis (Spithill and Dalton, 1999; Gassenbeek *et al.*, 2001). Chemotherapy normally reduces the prevalence and intensity of infection as measured by faecal egg counts (Hansen *et al.*, 1999).

Triclabendazole, and anthelminthic agent long used in veterinary medicine, has recently been proven to provide substantial human benefit at much lower doses than bithionol. In 1990, the WHO and pharmaceutical company, Ciba-Geigy, partnered to conduct clinical trials of triclabendazole and found that 1-2 oral doses at 10 mg/kg b wt administered in a single 24h period results in virtually no side effect and has a success rate approaching 100%. Following this research, the Ministry of Health of the Arab Republic of Egypt registered triclabendazole for human use and the WHO Expert Committee on the Use of Essential Drugs has recommended that it be added to the WHO'S list of essential drugs. Tricla**b**endazole remains unavailable in most countries but its future both in terms of individual treatment and broad-scale public health measures appears very promising (WHO, 2002).

2. *Snail control*

Snail control program aredifficult to put in to operation under the best circumstances. Populations bloom when there is even a slight alteration in the ecosystem favoring their surviving and production. Some aspects of habitat attention are feasible in developed country. Snail typically blooms in relative restricted areas, flat or boggy areas. It is usually to fill, drain, or fence boggy areas ofa pasture at a modest cost (Marquardt *et al*., 2000).

The use of molluscicides for the control of snail intermediate hosts is a potential tool for the control of fluke infections. Before considering chemical control of snails, it should be noted that many habitats are topographically unsuitable for the use of molluscicides and it is often very difficult to

apply them effectively. They are toxic to the environment, cooperation between neighboring properties is required for effective cover and regular (at least yearly) application. Since these are not species-specific, may destroy snails which have highly valued as food in some communities (Hansen and Perry, 1994).

Researchers indicated that molluscicidal properties have been demonstrated in extracts from a variety of plants. A substance 'Endod' or "Lemma toxins" derived from the fruits of shrubs *Phytolacca dodecandra*. Substance such as 'Endod' might provide means of snail control less costly to developing countries than synthesized molluscides but the production of molluscides on a commercial scale has yet to be achieved (Hansen and Perry, 1994). Tadesse and Getachew (2202) indicated 'Endod' for the control of *Fasciola* transmitting snails particularly *Lymnaea. truncatula* and *Lymnaea.natalensis*.

3. Environmental sanitation and manipulation

Draining swamps, building sewage systems and providing clean water supplies are used to control water-borne including snail home helminthes, but it is very expensive compared to chemotherapy (Hansen and Perry, 1994; Gassenbeek *et al.*, 2001)

Strategies for the treatment and prophylaxis of infections with *Fasciola* are developed based on epidemiological data effective treatment during the prepatent period for an extended duration could eliminate *Fasciola* infection or reduce contamination of pasture to a very low level (Hansen and Perry, 1994; Yilma and Malone, 1998).

Public Health Importance of Fasciolosis

The perception of human fasciolosis, caused by *F. hepatica* or *F. gigantica*, as a sporadic disease of low economic importance, is no longer tenable as the estimate of global prevalence is between 2.4 and 17 million human infections world-wide (Slifko *et al.*., 2000) and a further 180 million at risk of infection (Ramajot *et al.*, 2001).

The most common transmission route is the ingestion of watercress contaminated with encysted metacercariae, although, depending upon the geographical location, and a variety of edible aquatic plants can be vehicles of transmission. Water containing floating metacercariae has also been implicated in disease transmission, as have salads contaminated with metacercaria contaminated irrigation water. Among the risk factors are included the use of animal manure as fertilizers and wastewater effluent for irrigating aquatic or semi-aquatic vegetables (Slifko *et al.*., 2000).

Economic Importance of Bovine Fasciolosis

The prevalence and economic significance of fasciolosis in Ethiopia has been reported by several authors (Fiseha, 1983; Getachew, 1984) A rough estimate of the economic loss due to decreased productivity caused by bovine fasciolosis is about 350 million birr (Bahr und Ephraim, 1979). Infection of domestic ruminants with *F. hepatica* (temperate liver fluke) and *F. gigantica* (tropical liver fluke) cause significant economic loss estimated at over USD 2000 million per annum to the agricultural sector worldwide with over 600 million animal infected (Boray *et al.*, 1985; Hilyer and Apt, 1997).

In Ethiopia, a rough estimate of economic loss due to decreased production has been found to be over 300 million birr per year (Getachew, 1984). A prevalence of 77% of fasciolosis in cattle at Addis Ababa abattoir, and loss due to liver continuation was estimated to reach 631,320 birr per year (Getachew, 1984). Fiseha and Yilma (1983) have estimated an annual loss of 560,619.58 birr at Debre Zeit abattoir.

In addition, fasciolosis is now recognized as an emerging human disease: WHO has recently estimated 2.4 million people are infected with Fasciola, and a further 180 million at risk of infection (Anonymous, 1995). High prevalence of human fasciolosis has been reported in Bolivia and Peru where fasciolosis is regarded as an important human health problem (Hilyer *et al*., 1997).

Prevalence of Fasciolosis in Ethiopia

Several workers, based on the results of geographical and post-mortem examinations of livers, have reported the presence of fasciolosis in different parts of Ethiopia. Bahru and Ephraim (1979) have conducted a survey in eight administrative regions of Ethiopia and the survey displayed the highest prevalence of fasciolosis in Keffa (86%) and the lowest in Sidamo (42%). A preliminary survey made in Aressiadministrative region showed 53.72% of prevalence of bovine fasciolosis (Wondoson, 1990).

Getachew (1984) reported prevalence of 71% in cattle, 51% in sheep and 47% in goats slaughtered at Addis Ababa abattoir. Brook *et al.*(1985) made a study in four selected sites of Ethiopia on sheep and ascertained that Debre Berhan was the region with the highest prevalence followed by Assela and Awassa and nil in Debre Zeit. Forty nine per cent (49%) prevalence of bovine fasciolosis was reported by Yehenew (1985) in Gondar and around Lake Tana.

Post-mortem examination for fasciolosis at Gondar Municipal and industrial abattoir indicated a prevalence of 75% in cattle (Roman, 1987). A study conducted on the incidence and economic significance or fasciolosis in WolaytaWoreda revealed 23% in cattle, 20% in sheep, and 2% ingoats (Getu, 1987).

Fekadu (1988) reported an incidence of 84.7% fasciolosis at Bahir Dar municipal abattoir and 60.2% by coprological examination in Bahir Dar. A prevalence of 77.8%, at Denbidollo abattoir was recorded by Abera (1990). A mean infection rate of 34% in cattle, 33.5% in sheep and 12.4% in goats was reported in and Around Wolisso town (Rahemato, 1992).

Conclusion

Fasciolosis is a disease of animals and humans that has significant public health and economic impacts worldwide. The presence of numerous snail vectors and stagnant marshy water bodies has greatly contributed for fasciolosis to become endemic in almost all parts of the world. The disease in animals and human is controlled by administration of flukecide drugs such as Triclabendazole (Fasinex). Prevention and control strategy of fasciolosis should be focused on vector control techniques, and zero grazing of animals.

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