FASCIOLIASIS: A FLUKE INFECTION IS FOOD-BORNE PARASITIC ZOOLOSES AND CONTROLS THEIR VECTORS

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ABSTRACT

Fascioliasis disease was first recorded as early as 2000 BC. These are zoonotic trematode infects in animals which causes significant disease among cattle and sheep. Human fascioliasis is food-borne trematode infection, commonly acquired by eating encysted metacercaria on aquatic leaves which eaten as vegetables. Human fascioliasis cause significant illness and morbidity, mainly among low income communities. The infection of fascioliasis (fluke) are most common zoonoses in different cattle and in human beings, which affecting a large number of worldwide population in different regions. These fluke infections affect millions of livestock resulting in considerable economic loss in domestic animals. Controls of zoonosis in different part of world are use synthetic drugs which are very effective in curing fluke infection, but it’s also causes a number of side effects. This review attempts the major challenges in control of animals and human fascioliasis with valuable approaches from multidisciplinary integration. Snail is an important intermediate vector host for fascioliasis. The control of snail population by using biological control, plant derived molluscicides, chemotherapy of snail, bait formulation technique, may be effective in zoonoses control. The present reviews summarized the use of different molluscicides/techniques which control the host vector snail population in fascioliasis reservoirs area at certain threshold level of their population; it may be new strategic approaches. The review of literature leads to further evaluation of new researches in trematodes (fluke) control programs.

1. Introduction

The trematodes are causes zoonoses infectious in liver, lungs and intestine of human and cattle populations. Herbivorous mammals, especially cattle are the principal definitive host of trematode in East Asian, African countries [1-4]. These diseases are reservoirs in the wide range of domestic and wild animals [5-7]. The distribution of fluke infections is determined by local eating metacercaria encysted on aquatic edible plants leaves food habits as by the presence of obligatory freshwater crustacean, snail, fish or intermediate hosts [8]. These flukes can produce serious disease, especially when infections are heavy. The adult flukes mainly infect major vital organ such as liver, lungs and intestine which cause zoonoses disease. The food-borne helminthiasis is an important disease which included in the list of important trematodiasis with a great impact of human development [9, 10]. Freshwater vector snails are considered as intermediate hosts of food borne fluke infection which affecting the liver, lung and intestines of the animals [11], because these vector snails harbour the asexual stage of the parasite while humans harbour the sexual stage of the parasite [12]. Food-borne trematodes are an emerging serious public health problem, but remain largely neglected [13-17]. The several species of trematodes have medical importance which belongs to the liver flukes (Fasciola sps. Opisthorchis sps.) the intestinal fluke (Haplochis sps. Fasciolopsis sps. Echinostoma sps.), the lung flukes (Paragonimus sps.), the blood flukes (Schistosoma haematobium, S. Mansoni, S. Japnicum, S. Melongi and S. Intercaleatum) [13, 18, 19].

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The life cycle of the different species of fluke have common features. Adult flukes of trematodes in the mammalian host produce eggs that, when passed in feces and ciliated miracidium larva develop and penetrate in first intermediate host snail body, within asexual multiplication stage [5, 6]. The free swimming cercaria leaves the host snail body and attached [19-22] to the aquatic vegetation to encyst as metacercaria stage. The present reviews of literature were evaluating the control of trematode (fluke) infections disease with strategic control of intermediate host snail by uses of several groups of molluscicides/technique which are safer for non target and aquatic organisms.

2. FASCIOLIASIS

Fascioliasis is an important disease which caused by digenetic trematode species of the genus Fasciola Linnaeus, 1758 (Trematoda: Fasciolidae): Fasciola hepatica (Linnaeus, 1758) and F. gigantica (Cobbold, 1855). These parasitic flatworms of the class Trematoda, causes serious tropical fasciolosis. F. gigantica is one of the most important single platyhelminth infections of ruminants in Asia and Africa [23]. These fasciolosis caused by trematodes which belonging to the genus Fasciola (F. hepatica and F. gigantica) and causing considerable [5-7, 9, 24] economic losses due to mortality, liver condemnation, reduced production of milk, meat and wool [25]. Its infection is known to cause bile duct inflammation and biliary obstruction [26, 27]. Infection with Fasciola spp. occurs when metacercariae larvae are accidentally ingested through raw vegetation of food. The metacercariae exist in the small intestine, and move through the intestinal wall and peritoneal cavity to the liver where adults mature in the biliary ducts of the liver [23]. The acute phase is characterized by the migration of immature worms through the liver. The clinical symptoms are related to hemorrhage, inflammation, and are usually severe, including fever, abdominal pain, respiratory disturbances, and skin rashes. The chronic phase starts when the worms reach in the bile ducts. Symptoms are non-specific and usually mild to moderate [28]. The different shape and size of F. hepatica and F. gigantica from bovines has been achieved for the first time in natural allopatric populations [9, 28]. Hammond and Sewell, [29] has been reported that F. gigantica is more pathogenic and causes more production losses than F. hepatica. Fasciolosis disease cause pathological and necrotic lesions, which result from the parasites migration through the liver parenchyma and the bile ducts causing hemorrhage [30].

2.1. Human Fasciolosis

Human fascioliasis is a worldwide zoonotic disease that results from an infection by the trematodes F. gigantica and F. hepatica. The infection of fasciolosis in human beings was very sporadic until the last three decades when clinical cases and outbreaks were reported [27]. According to recent reviews [31], fascioliasis is probably the most widespread parasitic infection worldwide. Total estimated number of infected people are 71 million more than 60 countries the number at risk is more than 180 million throughout the world [13]. The infection was limited in the past to specific and typical geographical areas, but is now widespread throughout the world, with human cases being increasingly reported from Europe, America, Africa and Asia [9]. Human cases of fasciolosis have been reported from Mexico, Cuba, Costa Rica, Puerto Rico, Uruguay, Argentina, Chile, Peru, and Venezuela [32]. Human fascioliasis in India has been reported in state of Assam, Bihar, Maharastra, Uttar Pradesh, Arunchal Pradesh and West Bangal [33-37]. Humans are accidental hosts of fasciolosis as they consume infected water or food [38, 39]. This can be easily controlled and prevented by avoiding contaminated water and food [40].

The parasite induces a hepato-biliary disease, i.e. jaundice, hepatomegaly and bile duct ulcer [22, 31, 41-43]. With respect to public health, human fasciolosis was considered a secondary disease until the end of 1990s, with only around 2,000 cases being reported in the previous 1970-1990 period [44]. The studies on Corsica, Northern Bolivian Altiplano, were the first steps of against human fasciolosis [45]. Humans are infected by ingestion of aquatic vegetation that contain the infected metacercariae [46]. The infection is also possible through drinking of contaminated water or consumption of food items washed in such water. Fasciolosis were responsible for 54% of total liver condemnation [47].

2.2. Animal Fasciolosis

The animal fasciolosis occurs in worldwide [6, 48]. About 250 million sheep and 300 million cattle are potentially affected by the fasciolosis disease in worldwide. The common liver fluke Fasciola hepatica is a parasitic flat worm that can be collected in large number from the bile duct of infected cattle, sheep, buffalo, goats, horses, ovine, swines and other mammals [4]. In tropical regions the infection of fasciolosis is considered to the single most important helminth infection of cattle with prevalence rates of 30-90% in Africa, 25-100% in India and 25-90% in Indonesia [49]. Froyd, [50] has been reported in Great Britain, about 21% cattle and 7% sheep
were infected with liver flukes. In Gorakhpur U.P. India, 94% buffaloes are infected which observed in local slaughter house where carried heavy infection of *F. gigantica* [51-53]. Other significant losses in sheep due to fasciolosis are reduced production and quality of wool, reduced lambing percentages and poor growth rate of lambs. While in cattle, losses include reduced production and quality of milk and lower growth rates and lower feed conversion rates in fattening cattle inside their host, the liver flukes cause severe damage which may lead to the death of the animals [54]. Fasciolosis has been implicated as the cause of morbidity and mortality in the production of ruminants [55].

### 2.3. Diagnosis

A tentative diagnosis of fasciolosis infections is based on the observations of clinical signs, information on grazing history and seasonal occurrence. Confirmatory diagnosis however, is based on demonstration of Fasciola eggs through standard examination of faeces in the laboratory, post-mortem examination of infected animals and demonstration of immature and mature flukes in the liver, the lung, the intestine and the blood. Detection of eggs in animals stock samples is still considered the most conclusive diagnosis at the clinical level [2, 22]. The latter is helpful in deciding the intensity of fluke infection. Espinoza et al. [56] has been studied that Fas 2-ELISA is a highly sensitive immuno diagnostic test for the detection of *E* hepatica infection in human fascioliasis endemic areas and molecular techniques [57] have been developed and are the current hallmark of sound and scientific studies in the field. Serological assays are often used to detect infections due to immature forms where feacal egg output is often nil. Such tests allow the detection of substance like cathepsin L- proteases, excretory secretory products, detection of egg in milk, and ELISA [58-60] detection of antibodies against the fluke plasma concentration of Gamma-glutamyltransferase (GGT), which are increased within in the bileduct damage.

### 3. TREMATODE (FLUKE)

#### 3.1. Liver flukes

The main species of trematode in group of the liver flukes are *Fasciola gigantica*, *Fasciola hepatica*, *Opisthorchis felineus*, *Opisthorchis viverrini* and *Clonorchis sinensis*. [13, 15, 61]. The liver flukes in human are members of two families, the *Opisthorchiidae* and *Fascioidae*, which distinguished by differences in life cycle and pathogenesis [62]. In human *Opisthorchiidae* are major species such as *Clonorchis sinensis* (East Asia), *Opisthorchis viverrini* (Southeast Asia), *O. guayaquilenis* (North and South America), *O. felineus* (Soviet Union) and *Metorchis conjunctus* (North America). In the *Fascioidae* species, *Fasciola hepatica* is worldwide distribution whereas *F. gigantica* is in South Asia, Southeast Asia and Africa [63].

#### 3.2. Lung flukes

The lung flukes are members of the genus *Paragonimus* and while more than 40 species have been described, only eight are presently considered of human importance. Most of the 40 species are parasites of animals and some may be synonymous. Twenty eight are considered distinct species, with 21 from Asia, 2 from Africa and 5 from the America, most are in tropical regions [64]. One species, *Paragonimus kellicotti* is native to North America [65]. The best known species of *Paragonimus* westernani is found in animals and human throughout the East, from India to Japan and Philippines. *P. heterotrempus* is reported from China and Southeast Asia, *P. skrjabini* and *P. hueitungensis* from China, *P. miyazakii* from Japan, *P. uterobilateralis* and *P. africana* from central and western Africa, *P. mexicanus* from central and South America and *P. kellicotti* from North America [66-68].

*Paragonimus* species are lung parasitizing parasites of human and carnivores’ animals. Garcia, [21] has been reported that more than 10 species of lung flukes *P. westermanni*, *P. heterotrempus*, *P. maxicanus*, *P. africana*, *P. kellicotti*, *P. miyazakii*, *P. philippinensis*, *P. skrjabini*, *P. hueitungensis* and *P. uterobilateralis* are known which infected in human and mammals. The adult worms of *Paragonimus* spp. are plump, ovoid, reddish brown and encapsulate in the lung of humanoid and carnivores animals.

#### 3.3. Intestinal flukes

Intestinal flukes are a group of various trematodes that the adult stage inhabits in the intestinal tract [5]. The main species of this group are *Fasciolosis buski*, and species of the family is *Echinostomatidae* and *Heterophyidae* [69-71]. These intestinal flukes are thought to produce no symptoms except, when present in very large number, which is a rare occurrence. Few species of intestinal flukes cause serious disease, but community based and case-control studies have yet to be done. These are usually localized in area where there are freshwater vectors snail and animal reservoirs hosts and occur in people with particular dietary habits [72].

#### 3.4. Blood flukes

*Trematodes* flukes of the genus *Schistosoma* (*Schistosoma haematobium*, *Schistosoma mansoni*, *Schistosoma japonicum*, *Schistosoma mekongi* and *Schistosoma intercalatum*) are the blood flukes parasitizing in human and mammalian animals [18, 73, 74]. Three species of these are considered as having an important public health impact, such as *S. haematobium*, *S. mansoni* and *S. japonicum* [75-77]. The infection of *S. mansoni* and *S. haematobium* occur mainly in the African continent and the Middle East. *S. japonicum* is endemic in China, Philippines, Indonesia and India [74, 76, 78]. *Schistosomiasis* is endemic in 74 tropical developing countries [79]. Steimnann et al. [74] have been reported that the 779 million people are at risk of schistosomiasis and 207 million people are infected worldwide. The epidemiology of schistosomiasis in Egypt is over a 5000 year period. Evidence from mummies demonstrates the presence of this disease in ancient Egypt [80].
Human Schistosomiasis cases have been reported in Indian subcontinent [81]. Schistosomes are different from other human trematodes such as distinct sexes, live in the blood vessels, have non-operculated eggs, and have no encysted metacercaria stage in the life cycle [21, 77]. The cercariae in the water penetrate the human skin, and then they develop into schistosomula and migrate to the final locations where they mature and produce eggs, mesenteric venules of intestine for S. mansoni, S. intercalatum, S. japonicum and S. mekongi and vesical plexuses for S. haematobium. Eggs circulated into the different host organs by blood stream and is trapped the tissues causing inflammation and chronic disease. A part of the eggs are discharged to environment via excretive system such as faeces and urine, then the eggs hatch on reaching water and liberating miracidia, which must penetrate a suitable intermediate host snail and produce the infective cercarial stage [21, 77, 78].

4. CONTROL AND PREVENTION

Several methods of fasciolosis (fluke) control are available and can either be used independently and as a combination of two or more of them. These methods involve reduction in the number of intermediate hosts snail by chemical or biological means, strategic application of antihelmintics, reduction in the number of snails by drainage, fencing and other management practices and reduction in the risk of infection by planned grazing management. Control of parasitic diseases is crucial to improve the productivity of the animals. The control of the intermediate host snail population offers a good opportunity for the reduction and transmission of fasciolosis, when combined with one or more other methods such as use of molluscicides or in vivo chemotherapy of vector snails or environmental sanitation. Although eradication of the snail hosts population is the most effective method of total trematodes fluke controls. However, is often very difficult in low-lying, wet areas with a mild climate conditions. Snails multiply extremely rapidly and hence eradication is almost very difficult in irrigation areas.

4.1. Snail control

One way to tackle the problem of fasciolosis infections is to destroy the carrier snails and remove an essential link in the life cycle of the flukes. Many experts accept that snail control is the best mean for the control of trematode infection [5, 52, 82-92]. The use of molluscicides for the control of snail intermediate hosts is a potential tool for the control of fluke infections because mollusc represent the weakest link in life cycle of trematode. The action to reduce the risk of transmission by controlling the snails is often necessary. Snail control by using molluscicide is an important preventive strategy against fascioliasis, associated with chemotherapy, ecological and biological control methods. In certain areas satisfactory results have been obtained at much less expense than with other means of control. Harmful gastropods may be control by different types of methods viz. biological control, plant derived molluscicides, chemotherapy of infected snail and bait formulation [2, 3, 52, 53, 82, 84, 93-99].

4.2. Biological control of snail

The biological control of snails through use of micropathogens, predators, parasites and competitors has been considered as an alternate method to the use of molluscicides [100]. Biological control is an appealing alternative snail management strategy because of its low cost, technology simplicity and potential for self-renewal [101, 102]. Biological control can be done by the snail Marisa communarietis which attacks Biomphalaria aleyandrina and Lymnea caullaudi. Marsh flies, is also known as snail killing flies (Sciomyzidae: Diptera) [103]. There are few examples of predators of snail such as ducks, frog, song thrushes, mistle thrushes, redwing, ground beetles, hedgehogs, parasitic nematodes, slow worms, centipedes and millipedes. Frog eat snail with their shell [82]. Potential of the nymph of Hemiandax ephippiger is a predator of the snail Lymnea natalensis an intermediate host of Fasciola gigantica [104, 105]. Predators of the snails, Gonaxis quadrilateralis [106] and Incillaria [107] are used for the snail control. Biological methods are especially involving the use of indigenous predator, traditionally perceived as environmentally friendly and have been the focus of research and management of intermediate host [108].

4.3. Plant origin molluscicides

Molluscicides of plant origin have gained more importance because they are less expensive and less hazardous and culturally more acceptable than synthetic ones [93]. Several groups of compounds are present in various plants and their different parts have been found to be toxic to snails. These saponins, tannins, miscellaneous alkaloids, alkyl phenols, glycoalkaloides, flavonoids, sesquiterpenes lactones, terpenoid and phorbol esters have been found to be poisonous to snails at acceptable doses ranging from <1-100 ppm [109-111]. The screening of plants for molluscidal activities have been greatly expanded with more than 1400 species studied for [109, 112-122] control of different species of snails.

4.4. Chemotherapy of host snail

Effective control of most trematode infections is based on strategically applied chemotherapy [123]. Combination of chemotherapy, intermediate host control, sanitation and environmental manipulation are believed to be more efficient but very expensive. The drugs to be used against flukes should ideally destroy the migrating immature flukes as well as adults in the host. Several drugs are now available for the treatment of fascioliasis, which are against the adult flukes, and the parenchymal stages. Phyro-chemotherapy of Fasciola infected snail by the use of plant derived active compounds is one of the most effective methods to control of fascioliasis without killing the host vector snails [124]. To develop effective and sustainable control programmes against helminth parasites, it is important to have a good knowledge of their life cycle both within and outside the host animal [125, 126]. In vivo and in vitro phyto-chemotherapy of Fasciola larva by the use of Zingiber officinale (citral), Ferula asafoetida (feralic acid, umbelliferone), Azadirachta indica (azadirachtin), and Allium sativum (allicin) have effective larvicidal activity against different larva of Fasciola gigantica [3, 124, 127-129]. It is a new therapy to reduce incidence of the fascioliasis without killing the intermediate host snail, which is one of the important components of the aquatic ecosystem. These control techniques will be achieve the goal that is without killing host snail we can reduce the incidence of fascioliasis.
4.5. Bait formulations and snail control

Bait is commonly foodstuff, such as asugar, protein hydrolyzate, or cereal products, which may be mixed with a toxicant. Bait was usually applied in clumps but not always with success, because insufficient attention was paid to behaviour, learning capacity, habituation and activity rhythm of the slugs and snails. Food preference and their attraction vary from species to species in snails. So, various types of attractant are used inside the snail attractant pellets. The bait formulation technique can be used for the control of the vector snails [130]. One of the main advantages of baits is that, if used properly, there is practically no release of pesticide into the environment. The bait may either be food, which is then eaten by the target animal (as in vertebrates and molluscs) or an attractant. Bait will generally include an attractant that attract the target pest and a pesticide [131]. Attractant comprises of cellulose, a sugar component, a plant starch, instant non fat dry milk, dried egg yolk, a sterol compound, uric acid and a plant based oil [132, 133].

The selective molluscicides are also mixed inside the snail attractant pellets, which attract the target snail population. Few works has been done in the bait formulation against harmful snails. It has been reported that snails are attracted towards some chemical compounds such as carbohydrates, amino acids, dead animal matters and decaying plants wastes [53, 90, 98, 134-141].

Barnes and Weil, [142] tested that the carbohydrates such as wheat bran, fruit pulp, boiled potatoes and their attractiveness in mixture with molluscicides. Different types of carbohydrates are used in snail attractant pellets with molluscicides [132, 136]. Machnis et al. [143] show that Bloomp haliana glabrata, the molluscan vector of S. mansoni, contributes amino acids to the aqueous environment, and that these, and possibly other substances elicit chemotactic and chemokinetic responses by miracidia of this parasite. For the success of bait formulation it is important to study the feeding behaviour of the host snails, to ensure this strongest attractant should be mixed with particular molluscicides and then bait formulation was applied in the infested area. It is clear from review of literatures that zoonosis infection disease can be control by delink the life cycle of the vector snail.

5. CONCLUSION

The traditional use of commune drugs and wide variety of different plant derived anthelminthic products are not more efficient but rate of zoonotic infection constants in certain region of the world. The control of intermediates host snail of trematodes flukes may be helpful and leads to new strategic approaches for control parasitic zoonosis among large population of human and cattle populations. The present review of literature indicates the screening of certain molluscicides/technique in control harmful vector snail, which can ultimately, reduces the fascioliasis in worldwide and its leads for new approach to research in fluke control strategy.

AUTHOR’S CONTRIBUTION

All the authors involved in conception and design, drafting the review article. The final manuscript has been approved by all authors.

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