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Efficacy of Plant Origin Molluscicides: Control of Fascioliasis

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ABSTRACT
Background: In the past, fascioliasis infection was limited to specific and typical geographical areas but is now widespread throughout the world. Human cases are increasingly reported from Europe the Americas and Oceania (where only *F. hepatica* is transmitted) and from Africa and Asia (where the two species overlap). Sheep and cattle are the most important definitive host. Several chemical molluscicides have been used for control of Fascioliasis and other snail-borne diseases over the last few decades. Among the most notable are copper sulphate and other copper salts which in the past have played major roles but largely have been discarded because of low efficiency and inactivation by various organic and inorganic matter in water. **Objective:** A new impetus to the study of plant molluscicides, which may be toxic to a specific vector yet harmless to non-target organisms. **Conclusion:** So control of snail vector population through plant origin molluscicides is a very effective and new tool of integrated vector management programme.

Key words: Fascioliasis, snail, cDNA, plant pesticides

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INTRODUCTION

Fascioliasis is a worldwide problem in ruminants. However fascioliasis has largely been overlooked as a public health problem. As a result, the plants that are contaminated with encysted metacercariae have not been well investigated. In an area of the Islamic Republic of Iran where a large outbreak of human fascioliasis occurred were recovered from the most commonly used vegetables. In countries in Asia where fascioliasis is endemic, the cercariae of *Fasciolopsis buski* encyst on the seed pods of the water caltrop (*Trapa natans*), the bulb of the water chestnut (*Eliocharis tuberose*), the roots of lotus water bamboo and other aquatic vegetation including *Valisneria* spp. *Salvinia natans* and *Lemma polyrhiza*[1].

The eggs then hatch to release the motile miracidium, which will then locates and penetrates the intermediate snail host. The need to find a suitable host to penetrate is an urgent one, for those miracidia failing to do so generally die within 24 h. After penetrating the snail, the miracidium loses its cilia and becomes a sporocyst. The sporocyst divide and forming redia (forum with sucker and primitive gut) and a fully mature redia showing redia and cercaria stages.

The cercaria of *Fasciola* spp. have a rounded body measuring between 0.25 and 0.35 mm long, with a long thin unbranched tail measuring approximately 0.5 mm long. The mobile cercaria snail generally leaves the snail 4-7 weeks after infection by migrating through the tissues of snails. This is during moist conditions when a critical temperature of 10°C is exceeded. On emerging from the snail the cercaria attaches to submerged blades of grass or other vegetation like watercress, the tail falls away and the cercarial body secretes a four-layered cyst covering from cystogenous glands located on the lateral regions of the body. The formation of the cyst wall may take up to two days.

The metacercariae (encysted, resistant cercariae) is the infective form to the definitive host. Generally, metacercariae are infective to ruminants such as cattle and sheep, but also to other mammals including human beings. One miracidium hatching from a fluke egg can produce up to 4,000 infective cysts (metacercariae) due to the vegetative multiplication at the sporocyst and redia stages. The metacercarial cyst is only moderately resistant, not being able to survive dry conditions. If however they are maintained in conditions of high humidity and cool temperatures, they may survive for up to a year[2,3,4] infection through has as a vehicle of infection in non-endemic areas. This is due to a reduction in available pasture, forcing the animals to graze in swampy areas or in areas where the water has receded, thus exposing them to vegetation heavily infected with metacercariae[5]. In the past, human fasciolosis was limited to populations within well-defined watershed boundaries; however, recent environmental changes and modifications in human behavior are defining new geographical limits and increasing the populations at risk[1].

The use of plants with molluscicidal properties is simple, inexpensive and appropriate for the local control of the snail vector[6]. Since the discovery of highly potent saponin in *Phytolacca dodecandra* (Phytolaccaceae) berries[6], naturally occurring molluscicides have received considerable attention and the number of reports on the use of plant-derived molluscicides has increased considerably[6,7,8,9,10].

Watercress, *Nasturtium officinale*, commonly supports the metacercariae of *Fasciola* spp. However, from the outbreaks of fascioliasis in Cuba and the Islamic Republic of Iran and in the endemic areas of Bolivia, there is evidence that a variety of plants may be sources of infection (Fig. 1a-c).

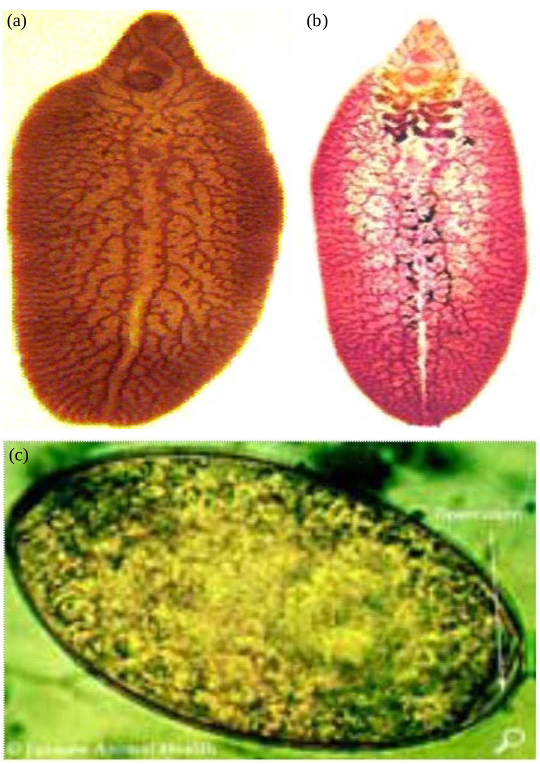

Fig. 1(a-c): (a) *Fasciola hepatica*, (b) *Fasciola gigantica* and (c) *Fasciola* eggs spp.

EPIDEMIOLOGY

Fasciolosis is considered an important limiting factor for ovine and bovine production. In general, infection of domestic ruminants with *F. hepatica* and *F. gigantica* causes significant economic loss estimated at over US$ 200 million per annum to the agricultural sector worldwide, with over 600 million animals infected[11]. In developed countries, the incidence of *F. hepatica* ranges up to 77%[12]. Evidence suggests that sheep and cattle may be considered the main reservoir host species, pigs and donkeys being secondary99)[13]. In tropical regions, fasciolosis is considered the single most important helminthes infection of cattle with prevalence rates of 30-90% in Africa, 25-100% in India and 25-90% in Indonesia[14].

CLINICAL SIGNS

The clinical features of fasciolosis can have acute, sub-acute and chronic forms. Acute fasciolosis occurs as disease outbreak following a massive, but relatively short-term, intake of metacercariae[15]. The high fluke intake is often the result of certain seasonal and climatic conditions combined with a lack of appropriate fluke control measures. It typically occurs when stocks are forced to graze in heavily contaminated wet areas as a result of over stocking and/or drought. Animals suffering from acute fasciolosis especially sheep and goat, may display no clinical signs prior to death; while some may display abdominal pain and discomfort and may develop jaundice[3,15].

GENETICS

Fasciola spp. is the most comprehensively studied of all the trematodes. *Fasciola gigantica* is generally diploid (20 chromosomes) and *Fasciola hepatica* is triploid (30 chromosomes). Many complementary DNA (cDNA) libraries of *F. hepatica* and *F. hepatica* cDNA clone of 2 kilobases which is highly repetitive, has been expressed in *E. coli* and the antigens produced may be useful in immunodiagnostic tests. The DNA sequences in *F. hepatica* encoding glutathione S-transferases.

PATHOLOGY AND PATHOPHYSIOLOGY

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[15]. Sheep and goat are very susceptible to acute fasciolosis and the damage results from the immature flukes tunneling through the liver parenchyma with extensive tissue damage and hemorrhage that culminate in severe clinical disease and high mortality in the grazing sheep in Africa[16].

Therefore, it is to be expecting that many systemic changes will be induced by liver fluke infections that ultimately cause reduced productivity in livestock. Both anorexia (inappetence) and the quality of the diet of infected sheep contribute to hypo albuminaemia during the infection[17].

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 through standard examination of feces in the laboratory; postmortem examination of infected animals and demonstrations of immature and mature flukes in the liver. The latter is helpful in deciding the intensity of infection. There are other laboratory tests (enzymatic and/or serological procedures used to qualify the infection mainly for research purposes. Serological assays are often used to detect infections due to immature forms where fecal egg output is often nil. Such tests allow the detection of substance like cathepsin L proteases, excretory secretory products, detection of Ag in milk and ELISA detection of antibodies against the flukes plasma concentration of Gamma-Glutamyltransferase (GGT)[3,15,18].

ECONOMIC LOSSES IN THE AGRICULTURAL SECTORS

Acute *Fascioliasis* is an important cause of morbidity in cattle and sheep mostly in young animals. The parasites actively feed on parenchymal cells and blood and their effects on animal growth and productivity can be serious. These effects are related to the number of parasites presents. In cattle approximately 200 flukes per animal cause sub acute or chronic clinical diseases and significant production losses may occur in herds with infection prevalence greater than 25%. In experimental trials calves with 40 or more adult *F. hepatica* worms gained 8-28% less weight than uninfected calves. Infection in adult cow adversely affects both milk production and milk quality and reduce milk yield on calving.

NATIONAL STRATEGIES FOR CONTROL

The national strategies for control of the trematode infection have four components (1) Development of national plans, (2) Mechanism of coordination between different national and international sectors, (3) Training and (4) Monitoring and surveillance.

In developing countries where food borne trematode infections are endemic, the human and financial resources of the individual sectors involved in a coordinated intersectoral control activity may not be adequate to set up and support a "vertical" control programme for food borne trematode infections alone. The planning process and management are unique for each country. There are several important features. Overall economic planning should include input from the private sector as well as from all the government ministries whose responsibilities will have an effect on food borne trematode infections including the ministry of health. Implementation of a plan of action will require trained staff with the skills needed to accomplish their task. Among the control approaches, two phases, implementation and maintenance, can be identified, for which appropriate training will be required.

CONCLUSION

The expense of available synthetic molluscicides and oral anti fascioliasis drugs prompted the search for plant molluscicides. Synthetic molluscicides are expensive and in addition, may lead to problems of toxicity to non-target organisms and deleterious long-term effects in the environment. The possible development of resistance in fascioliasis transmitting snail is another important factor. The use of plants with molluscicidal properties is a simple, inexpensive and appropriate technology for control of the snail intermediate host. Bioactive compounds of plant products use as molluscicides can using local labour and simple technology and if these metabolites are sufficiently toxic, as ecological sound, their, it should be possible to develop culturally acceptable and inexpensive molluscicides.

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