REVIEW ON MAJOR RUMINANT CESTODES OF PUBLIC HEALTH IMPORTANCE, IN ETHIOPIA

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Abstract: Major cestodes and metacestodes, the larval stages of canid cestode parasites, are among the causes of morbidity, mortality and financial losses in ruminants in Ethiopia as a result of organ and carcass condemnation at slaughter. Several studies have been conducted over the years; however, these studies often had limited scope and coverage. Taeniasis and cysticercosis are the major parasitic infection of humans and animals caused by adult and larval stages of tapeworms, respectively. Among those, Taenia saginata (T. saginata) species are zoonotic importance. In the natural cycle of these tapeworms, adult tapeworms are found in the definitive host while the cysts (Cysticerci) are found in the intermediate hosts. The disease has worldwide occurrence especially where cattle sheep and goat are present. The disease has both public and economic importance by causing organ condemnation and cause economic loss by quality down grading of meat, cost of refrigeration, cost of human therapy and lowering productivity. In Ethiopia most Slaughtering practices are often carried out in the field in the absence of abattoirs. This allows the parasite to continue its life cycle in the coming future. Therefore avoiding the consumption of raw meat, slaughtering animals on the field and stop free grazing is the prevention measure of cysticercosis.
Among them keeping the definitive host in close association and lack of awareness of the people about the role of offal and raw meat in transmitting the disease from intermediate host to final host can be illustrated. Control and prevention is achieved by protection of cattle, sheep and goat from grazing on feces or sewage polluted grass, not using untreated human feces as fertilizer for pasture land, avoid eating of raw or under cooked meat and deep freezing. It is therefore important that sufficient emphasis should be given to this problem so as to improve health, quality and quantity of meat that may satisfy the domestic requirements and increase foreign export revenue.

Keyworeds: Cestodes, public health, Zoonotic Ethiopia.

1. INTRODUCTION

Ethiopia's estimated livestock population is often said to be the largest in Africa. In the country, there were approximately 57.8 million cattle, 28 million sheep, 28.6 million goats, 1.23 million camels and 60.5 million poultry (CSA, 2016). Ethiopia's great livestock potential is not properly exploited due to different factors such as traditional management system, limited genetic potential, lack of appropriate disease control policy and lack of appropriate veterinary services (Ayele et al, 2003). Apart from this foods of animal origin are often the preferred source of protein. However, if not properly prepared or handled, they can lead to food-borne infections (Karshima, 2012)
Moreover, these diseases are also known to cause public health problems as humans can be infected from accidental ingestion of parasite eggs/larvae passed into the environment with faeces from definitive hosts (Jenkinsa et al, 2005; Ashrafi et al, 2006).

Cestodes of the family Taeniidae infect dogs and humans as the definitive host and are transmitted to a wide range of intermediate host species where they cause Coenurosis, Hydatidosis and Cysticercosis respectively (Ahmadi and Badi, 2011). Infestations with the larval stage of some species of *Taenia* are not only of public health importance, but also of veterinary significance because they cause economic losses due to condemnation of infected offal or meat (Thompson, 1995). The infestation may lead to lower production and even death of the animals in cases of heavy infestations (Radfar et al, 2005).

Hydatidosis and Taeniosis are parasitic zoonoses that present major public health problems in lower income countries and some industrialized countries (Thompson, 1995; Mehrabani et al, 1999; Utulas et al, 2007; Dorny et al, 2000; Ahmadi and Badi, 2011). The prevalence is considered to be higher in developing countries because of poor sanitation, traditional cattle husbandry systems and inadequate meat inspection facilities (Cabaret et al, 2002; Dorny et al, 2000). As a result, the quality of human life, the aesthetic value of meat and the trading of meat and offal are compromised (Dorny et al, 2000; Conteh, 2010).

Hydatid cyst is the metacestodes of the tapeworm *Echinococcus granulosus*. Adult worms have been reported to be found in small intestines of dogs and wild carnivores like the wolf and fox (Abidi et al, 1989). Infested carnivores eliminate eggs with their faeces. Herbivores (intermediate host) become infested with the eggs on account of having fed on contaminated pastures (Craig et al, 2007).

Man is infected incidentally up on ingestion of infective eggs in contaminated water, vegetables and other food or through direct contact with dog. Possible intermediate hosts for *Cysticercus cerebralis* are sheep and goats, for *cysticercus bovis* are cattle and buffalo, and for *hydatid cysts*, domestic ungulates and man act as an intermediate host (Kumsa, 1994). Consumption of offal containing viable cyst results in infection of definitive host carnivores including dogs. The adult tapeworm in definitive host is harmless unlike the metacestodes in the intermediate host animals that is responsible for immense economic and medical importance in infected host (Azlaf and Dakkak, 2006; Bettelli, 2009; Ibrahim, 2010). The remarkable biotic potential of *E. granulosus* is known by the fact that a heavily infested dog may carry as many as 40,000 tapeworms, shedding approximately 1,000 eggs per 2 weeks (Schantz et al, 2006). Clinical hydatidosis is uncommon in animals, but hydatid cysts in the liver and other tissues at slaughter are widespread and cause condemnation and economic loss (Eichenberger et al, 2011).

Coenurosis, the bladder worm stage of *Taenia multiceps* predominantly develops in the brain and spinal cord of many mammal species, including human (Tafti et al, 1997; Ing et al, 1998; Sharma and Chauhan, 2006; Oryan et al, 2012). Coenuruses due to larval stage of *Taenia multiceps* can occur in both an acute and a chronic disease form. Acute coenuruses occurs during the migratory phase of the disease, usually 10 days after ingestion of the large number of tape worm eggs. Young lambs aged 6-8 weeks are most likely to show signs of acute disease. The signs are associated with an inflammatory and allergic reaction. There is transient pyrexia and relatively mild neurological signs such as listlessness and a slight head aversion. Occasionally the signs are more severe and the animal may develop encephalitis, convulse and die within 4-5 days (Oryan et al, 2012).

Cysticercus bovis infection is acquired in cattle by grazing on pasture contaminated with faeces of humans. The infection in cattle may not show any clinical disease and therefore goes un-noticed except during abattoir meat inspection. These larvae remain embedded in the tissues of cattle posing serious public health threats. The observations were reinforced by a probabilistic model developed by (Kyvsgaard et al, 1990). which showed that over 85% of infected animals may be missed during routine meat inspection.

Hydatidosis and taeniosis is of public health and economic importance not only in areas of endemicity but also in non endemic countries due to the migration of infected people and livestock exchange, their products, and potentially contaminated produce or other fomites which promotes emergence in previously free-disease areas (Mamuti et al, 2002). They are frequently reported from different corners of the country (Adem, 2006; Biluts et al, 2006; Kebede et al, 2009a), and the disease is much more common in rural areas of Ethiopia where dogs and domestic animals live in a very close association (Fromsa and Jobre, 2011). Additionally, where home slaughtering of cattle, sheep, goats and camels is still predominant and uncooked offal and carcass wastes are normally given for dogs and cats, peoples to eat the ingestion of raw or undercooked beef dishes such as ‘‘kurt’’ and ‘’kitfo’’ (Teka, 1997; Tembo, 2001; Kumar and Tadesse, 2011).

Although some reviews have been done on the cestodes of public health importance, there is limited information on the epidemiology and public health importance as most of the reviews are concentrated in reviewing single parasite other than the major cestodes of zoonotic importance. Thus, bonifide up to date

information is needed on cestodes of public health importance. Therefore, the objective of this review is to provide valuable information on the major cestodes of public health importance.

2. MAJOR RUMINANT CESTODES OF PUBLIC HEALTH IMPORTANCE

2.1. Etiological agents and taxonomy

Echinocuccus and *Taenia* spp. are segmented, parasitic tapeworms, belong to the kingdom of Animalia, phylum of Platyhelminthes, class of Cestoda, order of Cyclophyllidea, Family of Taeniida*e* and Genus of *Echinocuccus* and *Taenia* (Soulsby, 1982; Symth, 1994 and Urquhart et al, 1996).

The adults are found in domestic carnivores and man. *Cysticercosis, Hydatidosis and coenurosis* of farmed and wild animals is caused by the larval stages (metacestodes) of cestodes of the family Taeniidae (tapeworms), the adult stages of which occur in the intestine of humans, dogs or wild Canidae. *Bovine cysticercosis* (primarily in muscle) is caused by the metacestodes (*cysticerci*) of the human cestodes *Taenia saginata.* (Soulsby, 1982; Jabbar et al, 2010a) Cerebral coenurosis (gid or sturdy) is caused by *Coenurus cerebralis* cyst, which is a metacestode or larval stage of *Taenia multiceps* and particularly affects sheep and goats (Sharma and Chauhan, 2006; Varcasia et al, 2012; Miran, 2013).

At present, four species of the genus *Echinococcus* are recognized and regarded as taxonomically valid*: E. granulosus* (cystic hydatidosis), *E. multilocularis* (multivesicular hydatidosis), *E. vogeli* (polycystic hydatidosis) and *E. oligarthrus* (Soulsby, 1982). The definitive hosts of *E. granulosus* are domestic dogs and some wild canids. Intermediate hosts are sheep, bovines, swine, goats, equines, camelids (Asian and American), cervids, and man (FAO, 1982).

2.2. Morphology

2.2.1. Teania species

The scolex has an armed rostellum with a concentric double row of hooks (the important exception is *Taenia saginata* whose scolex is unarmed). The gravid segments are longer than they are wide. The intermediate stage is a *cysticercus, coenurus* or *hydatid cyst* and these occur only in mammals (Wanzala et al, 2003).

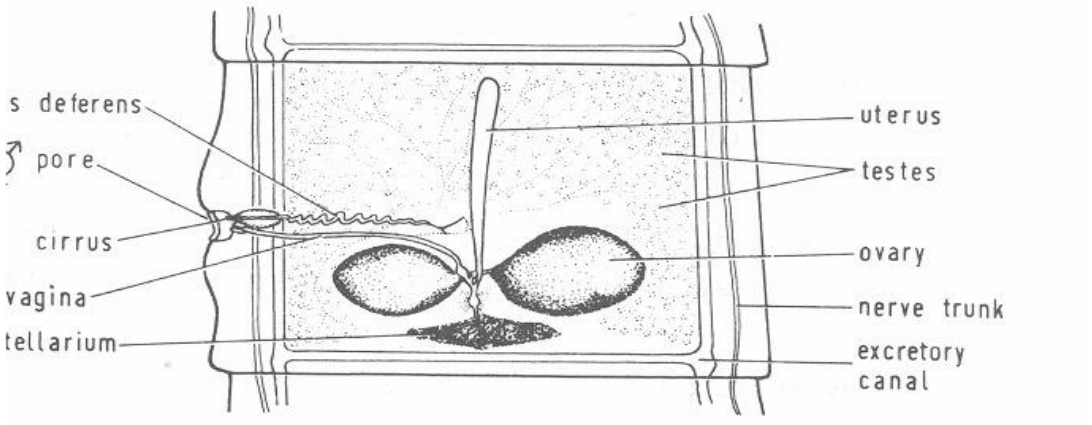

Figure1. Morphology of proglottids Source: Parija, 1996

Figure 2. Egg of Taenia species unsteand

2.2.1.1. Taenia saginata (the beef tapeworm)

The adult is large, 4–8 meters long and can survive many years, usually singly, in the small intestine of humans. The scolex (or head) has no rostellum or hooks. Gravid segments have >14 uterine branches. They usually leave the host singly and many migrate spontaneously from the anus (Soulsby, 1982; Khalil et al, 1994 and Loos-Frank, 2000).

The eggs are typical 'taeniid' eggs that cannot be differentiated morphologically from other *Taenia* or *Echinococcus* spp. eggs. *Taeniid* eggs measure about 25–45 µm in diameter; contain an oncosphere (or hexacanth embryo) bearing three pairs of hooks; have a thick, brown, radially striated embryophore or 'shell' composed of blocks; and there is an outer, oval, membranous coat, the true egg shell, that is lost from faecal eggs (Khalil *et al*., 1994; Loos-Frank, 2000).

Metacestodes (*Cysticercus bovis*) of *T. saginata* usually occur in the striated muscles of cattle (beef measles), but also buffalo, and various *Cervidae*. Viable cysts are oval, fluid-filled, about 0.5–1 × 0.5 cm, translucent and contain a single white scolex that is morphologically similar to the scolex of the future adult tapeworm. They are contained in a thin, host-produced fibrous capsule. Cysts occasionally are found in the liver, lung, kidney, fat and elsewhere (Soulsby, 1982).

2.2.1.2. Taenia multiceps

Adults, up to 1 meter long in the intestine of canids, have an armed rostellum. The metacestodes (*Coenurus cerebralis*) are large, white fluid-filled cysts that may have up to several hundred scoleces invaginated on the wall in clusters. Coenuri grow to 5 cm or more in size in the brain of sheep, the brain and inter muscular tissues of goats, and also the brain of cattle, wild ruminants and occasionally humans. The cysts induce neurological signs that in sheep are called 'gid', 'sturdy', (Attindehou and Salifou, 2012).

2.2.2. Echinococcus granulosus

Morphologically adult *Echinococcus* is only a few millimeters long (rarely more than 10 mm) and usually has no more than six segments (Soulsby et al, 1982). Anteriorly, an adult echinococcus possesses a specialized attachment organ. The scolex that has four muscular suckers and two rows of hooks, one large and one small; on the rostellum, the body or strobila is segmented and consists of reproductive units (proglotids), which may vary in number from two to six (Dorny et al, 2000).

The gravid proglottid, containing several hundred eggs, detaches from the strobila, Each egg contains an embryo (oncosphere) with six hooks (hexacanth).Metacestoe of E. granulosus is hydatid, it measures approximately 1 cm and it is apparent that its wall consists of two layers: an external, cuticular or laminar layer, formed by numerous thin nacreous lamina that resemble the cross-section of anonion, and another, internal layer, germinative or proligerous, which is a delicate cellular syncytium. The larval form of *E. granulosus* typically consists of a single cavity (is unilocular). The interior of the hydatid is filled with liquid (Alum et al, 2010).

2.3. Epidemiology

2.3.1. Distribution

Taenia saginata, Taeniosis occurs throughout the world with variable degree of prevalence (Harrison and Sewell, 1991). In the world there are 77 million bovine Taeniosis patients of which 32 million are in Africa, 11 million in Asia (excluding the former USSR) and about 3 million in the new world. Its prevalence could be classified into three groups (Frolova, 1982; Dorny et al, 2000; Minozzo, et al, 2002).

Reports by Cabarat et al. (2002) indicate that global human taeniosis prevalence results from the last 25 years ranging from less than0.01 to 10% in Europe and up to 36% in Dagestan. It is unclear whether the data available reflects only *T. saginata* or also includes *T. solium* infections, since *Taenia* eggs of all species are morphologically alike.

Highly endemic areas include Central and East African countries (Ethiopia, Kenya, and Zaire), Argentina, Caucasian and South Central Asian republics of the former USSR and in the Mediterranean Region (Syria, Lebanon and Yugoslavia) (Florova, 1982). In some parts of Serbia and Montenegro, up to 65% of children have been reported to harbor *T. saginata* (Florova, 1982). Moderate prevalence is encountered in South East Asia (Thailand, India, Vietnam and Philippines), Japan as well as countries of Western Europe and South America while Canada, the USA, Australia and some countries of the Western Pacific have low prevalence (Harrison and Sewell, 1991).

Globally, *T. saginata* is the most widely distributed human *Taenia* tapeworm, with an estimated 60 million human infections worldwide (Craig et al, 2007). In developing countries, cattle are reared on extensive scale, human sanitation is of comparatively lower standards and the inhabitants traditionally eat raw or inadequately cooked beef. The prevalence of Taeniosis is over 20% in certain areas of these countries. Based on routine carcass inspection the infection rate of bovine cysticercosis is often around 30-60% although, the real prevalence is considerably high (Tembo, 2001).

Teania saginata infections also occur in developed countries, where standards of sanitation are high and meat is carefully inspected and generally thoroughly cooked. Taeniosis/cysticercosis spreads in developed areas of the world through tourists enjoying the consumption of lightly grilled meat, mass migration of labor and the export 10 of meat unreliably passed by ‘’eye or knife’’ inspection or from live animals imported from endemic areas (Mann, 1984).

Prevalence in these parts of the world is less than 1% occasionally; cysticercosis “storms” have been reported on particular farms. The cause of the storm has been attributed to the use of human sewage on pasture and the use of migrant labor (O.I.E., 2000). In developed countries, cattle of any age, are susceptible to infection since they generally posses no acquired immunity (Yoder et al, 1994).

A high prevalence of *T. saginata / Cysticercus bovis* occurs in Africa where cattle are kept in community grazing lands. The parasites appear to be specific to cattle, while wild animals play no part as intermediate hosts (Symth, 1994). The prevalence, economic and public health impact of cystic hydatidosis is higher in rural communities of developing countries where there is close contact between dogs, intermediate host species, and man (Romig et al, 1999; Ibrahim, 2010).

The most common production practices that increase the prevalence and the risk of exposure of domestic animals to cystic *echinococcosis* are traditional systems of raising animals (extensive or semi-extensive grazing), widespread backyard slaughtering of animals, absence of rigorous meat inspection procedures, improper disposal of dead animals, keeping a large number of dogs, failure to treat dogs with anthelmintics, habit of feeding dogs with condemned offal and the subsequent contamination of pasture and grazing fields, and grazing of animals in communal fields where stray dogs have free access (Romig et al, 1999; Garippa et al, 2004 and Ibrahim, 2010).

Human CE, which is the most common *Echinococcus* spp. infection, probably accounts for more than 95% of the estimated 3 million global cases, with human AE causing only 0.3–0.5 million cases (Thompson and MacManus, 2002). The annual incidence of CE can range from less than 1 to >200 per 100 000 inhabitants in various endemic areas (Pawlowski et al, 2001; Dakkak, 2010). Due to the wide geographical distribution and extent greater than previously believed, CE is currently considered an emerging or re-emerging disease (Thompson and MacManus, 2002; Torgerson *et al.*, 2003 and Grosso et al, 2012).

2.3.2. Host range

Cattle are the preferred intermediate hosts and humans are the only final hosts of *T. saginata.* Cattle of all ages are susceptible; however young age groups are more susceptible. Parasitism is sometimes observed in other ruminants (sheep, goats, antelops, gazelles, buffaloes) but *Cysticercus* development is unlikely. Man cannot spread taeniasis to his own species. Management of animals in their natural environment predisposes them to infection. Cattle grazing communally have a higher risk of picking up *T. saginata* eggs since they are frequently in contact with human feces compared to commercial herds, the risk of cattle coming into contact with *T. saginata* eggs is much higher when cattle are at pasture (Harrison and Sewell, 1991).

In developing countries cattle are reared on extensive scale, human sanitation is poorly developed which makes the incidence of *T. saginata* infection in humans very high. Calves are infected usually in early life, often with in the first few days after birth from infected stockmen whose hands are contaminated with Taenia eggs (Maedia et al, 1996).

For the case of Coenuruses, domestic and wild canids such as dog, fox, wolf and jakals constitute the definitive hosts; while dog is the most common definitive host for this parasite due to more exposure to the brain of sheep and goat. Wide range of herbivores including sheep, goats, cattle, buffaloes, camels, yak and equines are the intermediate hosts. Coenuruses is quite common in sheep and goat compared to the other animals. Human can get infected with this parasite if accidentally ingest the egg of the parasite (Sharma and Chauhan, 2006; Lescano and Zunt, 2013; Oryan et al, 2015).

Echinococcosis is a zoonotic disease caused by *Echinococcus* spp. tapeworms. The definitive hosts, which include dogs, other canids, hyenas and cats, carry the adult tapeworms sub-clinically. Dogs are particularly important in zoonotic transmission due to their close relationships with humans. Intermediate hosts are initially asymptomatic; however, the growth of the larvae, which form cysts in vital organs such as the liver and lungs, can lead to illness and death. Echinococcosis is a major public health problem in some countries, and it may be emerging or re-emerging in some areas. Approximately 2-3 million human cases are thought to occur worldwide (CDC, 2011).

2.3.3. Source of Infection and Mode of Transmission

Tapeworms of the family Taeniidae are transmitted from the definitive hosts such as carnivores to the intermediated hosts including herbivores or omnivores and human beings via oral-fecal cycle (Oryan et al, 2012). This family includes two major genera namely Taenia and *Echinococcus*. In many endemic areas the diseases caused by the genus Taenia in humans are often categorized as neglected tropical diseases (Jia et al, 2010). In general, the larval stages or metacestodes belonging to these tapeworms include hydatid cyts, *cysticerci* and *coenuri* (Oryan et al, 2012).

All Taenia species except for *T. hydatigena* (*C. tenuicollis*), *T. ovis* (*Cysticercus ovis*) *and T. pisiformis* (*C. pisiformis*), cause zoonotic parasitic diseases and thereby are of public health importance (Van et al, 2014). Humans acquire infection by inadvertent consumption of ova or larval stages (metacestode) present in undercooked meat (Jia et al, 2010). *Cysticerus bovis*, the metacestode of *T. saginata*, occurs only in beef and humans are only the definitive hosts and receive the infection by ingestion of the raw meat containing the *cysticeri* (Oryan et al, 2012; Nunes et al, 2013).

The transmission cycle of infection by *T. multiceps* takes place between dogs and domestic herbivores. Man is an accidental host and does not play any role in the epidemiology of the disease. The main factor in

maintaining the parasitosis in nature is access by dogs to the brains of dead or slaughtered domestic herbivores that were infected with *coenuri* (Jia et al, 2010).

Taenia eggs expelled in the feces of infected dogs or other canids are the source of infection for man and for the other intermediate hosts. In general, the eggs are eliminated by the definitive host in the proglottids. Since these dry out rapidly and are destroyed outside the host, the eggs are released and dispersed by the wind, rain, irrigation, and waterways (Nunes et al, 2013).

The dog-sheep-dog cycle is the most important cycle for maintenance of the parasitism in the endemic areas of the southern part of South America and many other areas of the world. Sheep are the most important intermediate hosts of unilocular hydatidosis caused by *E. granulosus* for several reasons: the infection rate is generally high among these animals, 90% or more of their cysts are fertile, they live in close association with dogs, and, since they are often sacrificed for household consumption on ranches, the viscera are customarily fed to dogs (Jia et al, 2010).

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Sheep and other intermediate hosts contract hydatidosis by grazing on pastures contaminated with dog feces containing eggs of the cestode. Those eggs are deposited directly on the grazing land or are carried by rain or wind. The dogs in turn are infected by eating viscera that contain fertile cysts (with viable protoscolices). Man is an intermediate host and plays no role in the transmission of the parasite, unless he is eaten by a carnivore. Nevertheless, his sanitary habits make him the main agent responsible for perpetuating the infection by feeding dogs viscera that contain hydatid cysts (Oryan et al, 1998).

The adult cestode of *E. granulosus* can live in a dog's intestine for about a year, but it remains fertile for just 6 to 10 months. Therefore, theoretically the infection would die out if man ceased re infecting dogs by feeding them raw viscera. Domestic animals that serve as secondary hosts could still become infected for a time, since the eggs of *Echinococcus* are resistant to environmental factors, but the infection cycle would be halted if dogs were prevented access to the infected viscera (Oryan et al, 2012).

A gravid proglottid of *E. granulosus* contains a very small number of eggs (from 200 to 800) compared with those of other tapeworms, which contain many thousands. It is estimated that only one segment of *E. granulosus* is eliminated every two weeks (Lawson and Gemmell, 1983). This low biotic potential of *E. granulosus* is compensated for by the high rate and intensity of infection in the definitive host and by the asexual multiplication of the larva in the intermediate host (Fakhar and Sadjjadi, 2007).

The survival time and dispersion of the eggs are of great epidemiological interest. The eggs have little resistance to desiccation and extreme temperatures. In the laboratory, the eggs of *E. granulosus* can survive in water or damp sand for three weeks at 30°C, 225 days at 6°C, and 32 days at 10–21°C (Lawson and Gemmell, 1983). After 10 days, radial dispersion up to 80 m from the place the feces were deposited has been confirmed for eggs of other taeniids; they may be able to disperse even greater distances with the aid of mechanical vectors such as carrion birds and arthropods. The physical composition of the soil, its porosity, and the kind of vegetation cover also help determine the length of time that the eggs survive (Lawson and Gemmell, 1983).

As we have said, man is an accidental host, and his direct contact with dogs is important. The gravid proglottids are found primarily on the surface of fecal matter, and they can accumulate in the perianal region, where they disintegrate and release the eggs. The dog carries the eggs on its tongue and snout to different parts of its body, and a person's hands can become contaminated by touching the animal. Close contact with dogs and deficient personal hygiene practices, such as failure to wash the hands before eating, are important factors in the transmission of the infection from dogs to humans. Another important source of human infection can be vegetables and water contaminated with infected dog feces. Coprophagic flies may also serve as mechanical vectors of the eggs (Van et al, 2014).

2.4. Life cycle

All species of *Taenia* have similar life cycles. The adult tapeworm lives in the definitive host's small intestine. Proglottids, which contain eggs, break off the posterior end of the tapeworm, and these proglottids are either passed intact in the host's feces or they dissolve in the host's intestine and eggs are passed in the feces. When a suitable intermediate host ingests the eggs, the oncosphere larva is released and, with the aid of the embryonic hooks, penetrates the intestinal wall and enters the bloodstream. Upon reaching the liver the oncosphere begins to develop into a *cysticercus.* Bladder worms break out of the liver and attach to the mesenteries throughout the abdominal cavity. The definitive host is infected when it eats an intermediate host infected with *cysticerci.* Upon ingestion the scolex evaginates, attaches to the intestinal lining, the bladder disintegrates, and the strobila is formed by the budding of the neck region (Van et al, 2014).

As adults in the definitive host's small intestine, tapeworms rarely cause problems; in exceptional cases the tapeworms might physically block the intestinal tract, due to their large size, or proglottids might become lodged in the appendix and result in appendicitis. The proglottids of *Taenia* are large and muscular. Occasionally single proglottids or long chains of proglottids might crawl out of the anus of an infected human (Oryan et al, 1998).

Echinococcus species have an indirect life cycle and must develop in both an intermediate and the definitive host. In many cases, the parasite cycles through the specific predators, scavengers, and its preys. The dog-sheep cycle is most likely to result in human infections. Other cycles include dog-camel, dog-horse, wolf-deer and coyote-deer. The intermediate hosts which include cattle and humans are infected by ingestion of eggs within the faeces of the definitive host. Parasites can develop in a variety of organs in the intermediate host but are often found in the liver and lungs Larval/hydatid cyst stage from the embryo released from an egg develops a hydatid cyst, which grows to about 5–10 cm within the first year and is able to survive within organs for years (Palmer, 2011).

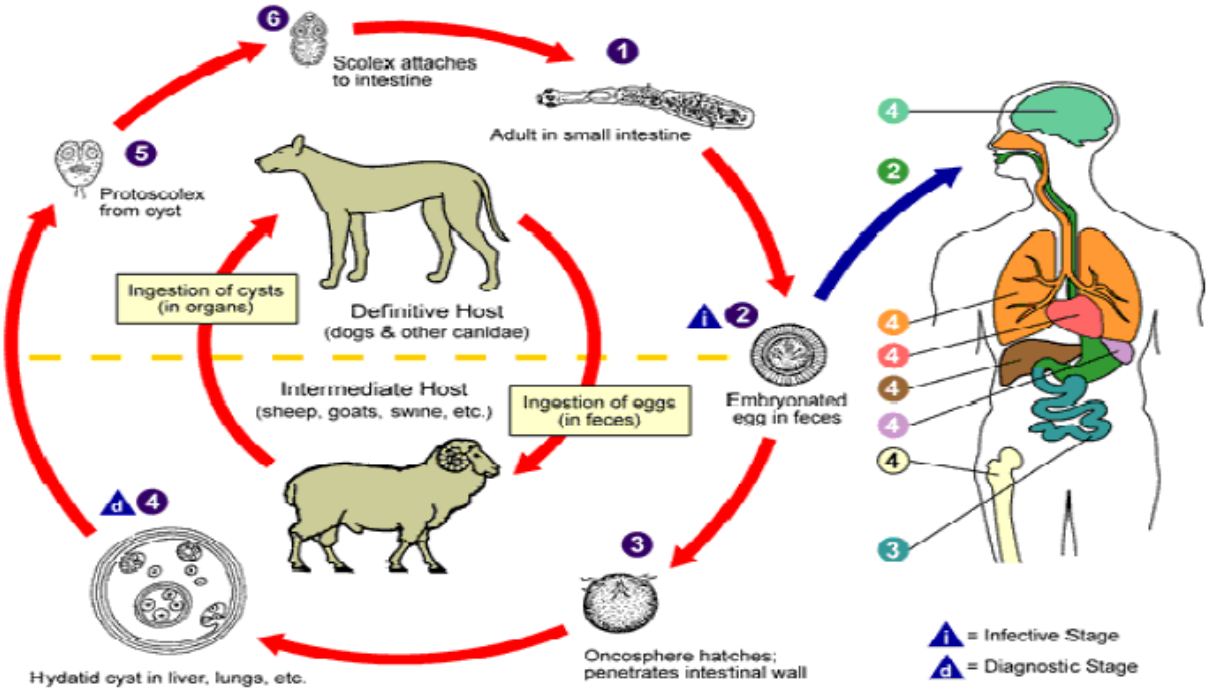

Figure 3 The Life cycle *of E. granulosus (Source;* CDC, 2009)

2.5 Clinical manifestations

The clinical manifestations in humans Teaniosis include abdominal pain, nausea, debility, weight loss, flatulence and diarrhea or constipation. A patient may have one or several of these symptoms and a high

percentage of patients experience gastric hyposecretion. Individual reactions to the infection differ and may be influenced by psychogenic factors, since patients often notice symptoms only after they see proglottids (Symth, 1994). Signs like those of epigastric discomfort, hunger sensations and irritability were also observed in infested individuals (Harrison and Sewell, 1991).

Light or moderate cysticercosis in cattle is not usually associated with any defined clinical picture. Heavy infections, those induced experimentally by 200,000 to 1,000,000 *T. saginata* eggs, may give rise to fever, weakness, profuse salivation, anorexia, increase heart and respiratory rate and a dose of one million or more eggs may cause death between 14 to 16 days due to a degenerative myocarditis (Oryan et al, 1998).

Clinical syndrome is based on location and size of the Coenurus cyst in the brain or spinal cord (Avcioglu et al, 2012). The time taken for the larvae to hatch, migrate and grow large enough to present nervous dysfunction varies from 2 to 6 months (Giadinis et al, 2012). The disease is known as gid or sturdy which disease primarily localizes in the central nervous system of sheep and goats mostly, but can also seen in camels, deer, pigs, horses, however rarely in cattle and humans (Yoshino and Momotani, 1988). While *C. cerebralis* initially causes purulent meningoencephalitis, later as the cyst grows, it leads to central nervous system symptoms resulting in death (Christodoulopoulos, 2007).

Infected animals showed sever nervous manifestations including circling towards the side of the cyst location, blindness, convulsions, cerebral atrophy, thinning and morphologic changes in the cranium (Yoshino and Momotani, 1988). Various reported human cases were infected with *C. cerebralis* in the central nervous system (Benifla et al, 2007) and the intraocular cavities resulting in endophthalmitis and retinal detachment (Inechukwu and Onwukeme, 1991).

The adult echinococcus is considered to be rather harmless to the definitive host, except when it occurs in large numbers, which may cause severe enteritis. The effect of the hydatid cyst on the intermediate host depends on the size and location of the cyst. There are few available data on the clinical effects of the cystic hydatid disease in animals since the cyst is slow in growing and animals are often slaughtered before it manages to create sufficient pressure on the tissue or organs. The hydatid cyst is normally well tolerated in humans until its development results in pressure on adjacent tissue or organs. The cyst may also burst into the peritoneal or thoracic cavity, which can cause anaphylactic shock or give rise to many new cysts (Yoshino and Momotani, 1988).

2.6. Diagnosis

2.6.1. In humans and animals

The metacestodes are readily visible in the organs or musculature at autopsy and therefore; diagnosis of C. *bovice*, hydatidcyst and C.*cerebralis* is usually made during postmortem examination in abattoirs and packing plants (Gracey, 1999). Individual countries have different regulations regarding the inspection of carcasses, which usually attempts to reconcile the interests of owners and those of the consumers (Eom and Rim, 1999**).**

Taenia saginata, *T.multiceps* and *Echinocccus* spp. also infect humans and, as taeniid eggs in dogs cannot be differentiated to species or genus level, in areas where these are endemic, the same safety precautions apply. While six other cestode genera are recorded occasionally in humans. These are described by Lloyd (2011) and all can be differentiated from *Taenia* spp. by egg/proglottid morphology.

In canids, *Echinococcus* spp. eggs cannot be distinguished from *Taenia* spp. eggs, but the presence of the former can be determined by tapeworm size and *Echinococcus* -specific antigen-capture enzyme linked immunosorbent assay (Ag-ELISA) (Allan et al, 1992).

Adult cestodes can be expelled from humans using an anthelmintic followed by a saline purgative and are identified on the basis of scolex and proglottid morphology. A self-detection tool was used in Mexico

(Flisser et al, 2011); medical staff in health centers is supplied with preserved tapeworm segments in a bottle and a manual of questions to ask patients to try to identify carriers (Flisser et al, 2011).

In animals, are coline purgation has been useful; again, the recovered tapeworms are identified morphologically. Arecoline is no longer available as an anthelmintic, but can be obtained from chemical supply companies. As it has side-effects, old, infirm and pregnant animals should be excluded from treatment. A dose of 4 mg/kg should result in purgation in less than 30 minutes, provided food has been withheld for several hours (Allan et al, 1992). Walking and abdominal massage of recalcitrant cases or enema for constipated dogs may avoid the use of a second dose (2 mg/kg), which should be given only sparingly. Fortunately, are coline purgation is being replaced rapidly by the coproantigen ELISA for *Echinococcus* spp. and perhaps in the future this will also be the case for *Taenia* spp. Tapeworms can be recovered after anthelmintic treatment, and require appropriate disposal (Flisser et al, 2011).

Loos-Frank (2000) has given descriptions of parasitic diagnosis of all the *Taenia* spp. of humans and animals, their hosts and geographical distributions. Keys for identification are given by Khalil et al. (1994). Loos-Frank (2000) gives methods for mounting, embedding, sectioning and staining the proglottids. Flotation can be carried out in commercially marketed qualitative or quantitative flotation chambers or by centrifugal flotation that includes a modified Wisconsin technique (faeces, diluted in water, are sieved and centrifuged, the pellet is resuspended in sugar or Sheather's solution and centrifuged at 300 ***g*** for 4 minutes). Eggs adhering to the cover-slip can then be detected (Yoshino and Momotani, 1988). .

Faecal egg examination will be less sensitive for *T. solium* than the other species. Species cannot be determined by egg morphology.(Cheesbrough, 2005; 2006) reports that *T. saginata* eggs can be differentiated from *T solium* on staining with Ziehl–Neelsen as used for acid-fast bacilli: the striated embryophore of *T saginata* is acid fast (stains red), that of *T. solium* is not acid fast.

DNA probes, the polymerase chain reaction (PCR) and PCR restriction fragment length polymorphism (RFLP), have proved useful for differentiation though largely used experimentally to differentiate faecal eggs of *T. solium*, *T. saginata* and *T. asiatica* (Gasser and Chilton, 1995; Gonzalez et al, 2004). While equally applicable to differentiation in dogs, the same examinations have not been done for *Taenia* spp. An Ag-ELISA to detect *Taenia* coproantigen is available from Cestode Diagnostics, University of Salford1 and can be developed independently if laboratory facilities are available (Allan et al, 1992).

This Ag-ELISA was developed experimentally by Allan et al. (1992) to detect coproantigen in dogs, and so, with appropriate controls, could be used to detect *Taenia* infection in this species. The technique, however, is only *Taenia*-genus specific. The test is a solid-phase, microwell assay with wells coated with polyclonal, rabbit anti-*Taenia*-specific antibody (TSA).

Sensitivity of serological tests for animals has not reached the stage where commercialization for individual diagnosis or large scale detection of infected carcasses in slaughter houses is possible. All assays tested – Ag-ELISA, antibody ELISA, enzyme-linked immunoelectro transfer blot (EITB) and tongue inspection – show low sensitivity in rural pigs infected naturally with low levels of *T. solium* (Dorny et al, 2005; Abusier et al, 2006). This finding is also true for *T. saginata* infections in cattle (Eichenberger et al, 2013).

Diagnosis of human hydatidosis is suspected based on the clinical symptoms and epidemiological circumstances. Imaging methods such as radiography, computerized tomography, ultrasonography, and scintigraphy are used. While they do not confirm the diagnosis, they are very helpful to the specialist. Ultrasonography is the first choice because it is economical, noninvasive, simple, and accurate and reveals developing cysts that generally cannot be found with Xrays (Suwan, 1995).

Numerous immunobiologic tests have been used in the diagnosis of human hydatidosis by *E. granulosus*, among them Casoni's intradermal test, complement fixation, indirect hemagglutination, latex agglutination, inmuno electrophoresis, electrosyneresis, and double diffusion to detect antibodies against the arc 5 antigen.

Practically all have been displaced by ELISA and the immunoelectrotransfer or Western blot test. Casoni's intradermal test is not very sensitive and isnonspecific for the diagnosis (Navarrete et al, 1995).

In the definitive host, a post-mortem examination is the most reliable method of diagnosis. Examination of the faeces after using arecoline as a purgative is less reliable, although proglottides in the faeces are conclusive. Egg counts are not specific because of the similarity of eggs from other tapeworms of the Taenia family (FAO, 1982).

Serological screening has recently proved to be a powerful tool in detecting infected dogs (Gasser et al, 1990) and is superior to the arecoline testing. In the intermediate host, diagnosing hydatidosis is possible through scanning, radiology, serology and postmortem examination. The post-mortem examination of sheep is usually an important component in monitoring the efficiency of control programs (Eichenberger et al, 2013).

Diagnosis of cerebral coenurosis in the intermediate hosts can be made by recovery and examination of the cyst (Acha & Szyfres, 2003). The disease can be diagnosed on the basis of history, clinical signs and on the basis of the postmortem examinations in the animals died due to this disease (Uphadhayas, 2005). Diagnosis of the cerebral coenurosis is dependent on the clinical manifestations, neurological examination, ultrasound examination and post-mortem examination (Godara et al, 2011; Biswas, 2013).

Animal cerebral coenurosis is usually diagnosed based on a clinical examination protocol and seldom includes imaging methods like radiology, ultrasonography and CT- scan which are mainly used in experimental situations. Immunodiagnosis tests such as skin test for immediate hypersensitivity, indirect haemagglutination antibody test, immuno-electrophoresis, gelldouble diffusion, ELISA tests have been used experimentally. Despite the availability of these tests which have their own practical challenges, post mortem findings of a thin walled cyst filled with transparent fluid and with numerous scoleces in the wall remain the definitive diagnosis (Afonso et al, 2011).

The presumptive diagnosis in man is generally made by establishing the existence of a lesion that occupies space; however, since coenurosis is much less common than hydatidosis, coenurosis is rarely considered before the parasite is recovered (Pierre et al, 1998). Because of the relative infrequency of human coenurosis, there has been no incentive to develop immunological diagnostic techniques.

2.7. Treatment

2.7.1. In humans and animals

For human there are a number of taenicidal drugs available in the market. However the drug of choice in treating Taeniosis is niclosamide (Niclocide, Yomesan). Adult dose rate of 2000 mg is effective in damaging the worm to such an extent that a purge following therapy often produces the scolex. Praziquantel (Bilitricide) at a dose rate of 5 to 10 mg per kg also has been reported highly effective (Doyle et al, 1997) but the scolex is partially digested and often not recovered (Symth, 1994). Other drugs used in the treatment of *T. saginata* are mebendazole (Soulsby, 1982; Doyle et al, 1997) followed by purgative, for example magnesium sulphate (MSO4) to expel the dead worms in to (Soulsby, 1982; Symth, 1994).

In animals treatment with compounds such as albendazole (50mg per kg), praziquatel (50mg per kg), mebendazole (50mg per kg) can be given but they are considered not to be fully effective (Soulsby, 1982; Symth, 1994). Praziquantel is effective at 50mg/kg/day for four days but this treatment is impractical because of its high cost (Reniecke, 1983). A number of anthelmintic drugs have proved to be effective against adult stages of *E. granulosus* in the final host. The best drug currently available is exterminates all juvenile and adult echinococci from dogs (Schantz, 1982; WHO 1983)

Unfortunately, surgery is the treatment of choice at present, but several of the benzimidazole compounds have been shown to have efficacy against the hydatid cyst in the intermediate host. Long-term treatment

with albendazole has a particularly marked effect on the cysts. While long-term treatment with praziquantel only has a limited effect with few changes in the germinal layer of the cyst (McManus and Smyth, 1986; Morris et al, 1990).

Recombinant vaccines have been developed using non-living antigens of the parasite, host protective responses can be induced readily in the intermediate hosts, may be used to control in cattle (Lightowlers et al, 1996).

Treatment based on surgical removal of the coenurus cyst after general anaesthesia of the animal, achieves a very good success rate, especially after accurate anatomic localization of the lesion within the brain (Scott, 2012). Surgery of the skulls and brains of Sheep with cerebral coenurosis would be effective up to 90%, if the brain and skull are first tested by magnetic resource imaging or ultrasonography (Manunta et al, 2012).

According to Ghazaei (2007) combination of fenbendazole together with praziquantel and albendazole is effective against the *cerebral coenurosis.* He has shown that praziquantel administration with dosage rates of 50 to 500 mg/kg resulted in successful treatment of this metacestode. Chemotherapy could be applied only inmigration stages of the parasite. The efficacy of the antiparasitic drugs such as albendazole, fenbendazole, and praziquantel against cerebral coenurosis was supported by other studies too; for instance, one study was done by Afonso et al. (2014).

Afonso et al. (2014) it's shown the response of coenurosis to the combination of fenbendazole, praziquantel and albendazole at a dose of 10 mg/kg for 3 days is effective in treating early infection of *T. multiceps* larvae in goats. The Taeniasis in the definitive host such as dog and wild calids can be treated with praziquantel, epsiprantel, mebendazole, febantel and fenbendazole (Scala and Varcasia, 2006).

The commonly used medical herbs in decreasing order of preference based on toxicity, higher potency and shorter worm expulsion time are: *Cucurbito pepo, Thymus serrulatus, Maesa lanceolata, Cynodon dactylon,, Glinus lotoides, (*Desta,1995; Tembo, 2001).

2.8. Prevention and Control

Lack of and improper use of latrine or open field defecation leads to contamination of grazing lands. The use of latrine reduces spread of *T. saginata* eggs. Controlled grazing, avoiding use of sewage effluent to fertilize pasture, prevents infection in cattle (Symth, 1994). Adequate meat inspection, abstinence from eating raw or inadequately cooked beef (thorough cooking of meat at a temperature of 56 - 600c) and freezing the infected carcass at -100 c for 10 days prevent human infection. Chemotherapy in humans reduces the spread of eggs and infection in cattle (Solusby, 1982).

Control of coenurosis in livestock relies on the same measures as those used to prevent other metacestodoses (Varcasia et al, 2009). Cerebral coenurosis can be controlled by regular anthelmintic treatment of dogs at 6–8 week intervals, by using an effective taenicide, and correct disposal of sheep and goat brain after slaughtering or death of animals to prevent scavenging by dogs belonging to the general public, which may not receive regular anthelmintic treatment (Scott, 2012).

Echinococcosis can be controlled through preventive measures that break the cycle between the definitive and the intermediate host. These measures include dosing dogs, inspecting meat and educating the public on the risk to humans and on avoiding feeding offal to dogs, as well as introducing legislation. None of these measures will work in isolation (Van et al, 2014). However,the disease can be controlled successfully through health education and appropriate legislation only when people understand the life cycle of the parasite. It is of the utmost importance that the government be involved, through the Ministries of Health, Agriculture and the Interior, for example. So far, the only successful control programs have been those where the Ministry of Agriculture has been the responsible control authority (Van et al, 2014).

Therefore, dogs should be considered as the main source of infection and the major risk factor. The big problem for control of these diseases is reducing the risk factors including access of the stray dogs and other wild carnivores to the infected carcass wastes, consumption of raw meat and unwashed vegetables, poor sanitation, use of human feces as fertilizer, and inadequate meat inspection (Oryan et al, 2012; Van et al, 2014).

Regular deworming of carnivorous pets and repeated treatment of dogs (the major final host in most cases) with anti-parasitic agents, public awareness of different ways of parasite transmission, accuracy in carcass inspection, health education for dog owners, proper condemnation of the infected carcass to reduce the stray dog population, all can be useful in reducing the prevalence and incidence of these zoonotic parasitic diseases (Oryan et al, 2012; Van et al, 2014).

2.8. Zoonotic importance and risk factors

Man is the only final host where the adult *Taenia saginata* resides in the small intestine. The size reached by the adult worm is related to the number of worms present (Maeda et al, 1996). In a single worm infection, a worm can develop longer and produce large number of proglottids (Symth, 1994). Multiple infections up to 20 tapeworms in one host have often been reported in developing countries. The effect on human health is generally slight and symptoms may be vague or absent. However, taeniosis has a debilitating effect on people who live on protein deficient diets and those who suffer from iron deficiency and infected by hookworm (Mann, 1984).

Taeniosis causes various symptoms, which probably depend very much on the psychological and physical characteristics of the host. Some patients lose their appetite and thus lose weight while others tolerate the infection. Sometimes the gravid proglottids of *T. saginata* migrate to different organs appendix, pancreatic duct, nasopharyngeal pathways and bile ducts producing obstruction and inflammation of the affected organs (Florova, 1982).

Tapeworms can also cause intestinal obstruction (Doyle et al, 1997). *T. saginata* in the small intestine of man absorbs digested food. From the day the Cysticercus is ingested it may take 2-3 months for the parasite to produce ripe segments. As long as the scolices are attached to the intestinal mucosa of the victim new segments will continually grow to replace those, which are being detached from the worm (Teka, 1997).

The prevalence of Taeniosis is associated with different risk factors. The potential risk factors of Taeniosis are: habit of raw meat consumption, age, sex, religion, educational level and presence and usage of sanitary facilities especially toilets. Different scholars have controversies regarding to disease prevalence in association with such risk factors. Most researchers underline that there is higher prevalence of Taeniosis in those who consumes raw meat than those having cooked meat dishes, in Ethiopia (Hailu, 2005; Endris and Negussie, 2011; Dawit, 2004 and Tesfaye et al, 2012).

Cystic echinococcosis is a public health problem in different geographical areas of the world, particularly in Asia, South America, Central America and Africa (McManus and Smyth et al,
1986). Spain and other Mediterranean countries are considered as hyper endemic areas (McManus and Thompson et al, 2003). *E. granulosus* of carnivores and its metacestode in herbivores and man have been recognized as the most important helminth zoonosis and of great economic and public-health significance in developing countries (Eckert et al, 2000).

Echinococcosis due to *E. granulosus* which occurs at high prevalence in both dogs and livestock and also accounts for the highest number of condemned lungs in slaughterhouses is of major public health concern in Zambia (Pandey and Sharma, 1987). Dogs are the most successful canids adapted to human habitation world-wide (Robertson et al, 2006; Ugbomoiko et al, 2008; Dohoo et al, 2009).

They have contributed to physical, social and emotional well-being of their owners, particularly children who are often at greatest risk of exposure. However, despite the beneficial effects, close bonds of dogs and

humans (in combination with inappropriate human practices and behavior) remain a major threat to public health, with dogs harboring a bewildering number of infective stages of parasites (including *Echinococcus*) transmissible to man and other domestic animals (Molyneux, 2004; Ugbomoiko et al, 2008).

Certain deep-rooted traditional activities have been described as factors associated with the spread and high prevalence of the disease in some areas. These factors include; the wide spread backyard slaughter of animals, the corresponding absence of rigorous meat inspection procedures, the long standing habit of feeding domesticated dogs with condemned offal and the subsequent contamination of pasture and grazing fields (Getaw et al, 2010). This can facilitate the maintenance of the life cycle of *Echinococcus granulosus* which is the causative agent of cystic hydatidosis and consequently the high rate of infection of susceptible hosts (Biffa et al, 2006).

Risk factors for human hydatidosis include: a pastoral occupation, a history of dog ownership, poor education background, eating habits, age, sex and drinking water source (McManus et al, 2003).

Coenurus cerbrallis in human beings diagnosed for the first time in 1913 in Paris, when a man presented symptoms of CNS nerve degeneration. He had convulsions and trouble speaking/ understanding speech. During his autopsy, two coenuri were found in his brain. Recently (within the last 25 years), human cases have been recorded in Uganda, Kenya, Ghana, South Africa, Rwanda, Nigeria, Italy, Israel, Mexico, Canada and the United States, and animal cases have been found in many other countries as well. In 1983, a 4-year-old girl in the USA was admitted to the hospital with progressive, generalized muscle weakness, inability to walk, rash, abdominal pain and deteriorating neurological ability (McManus et al, 2003).

The presence of shepherd (dog used as sheep keeper) dogs on grazing land as well as in paddocks, greatly contributes to the existence of the disease. Dogs are frequently fed on viscera, trimmings, and heads of butchered animals, and they are not treated for parasitic diseases, thus maintaining *C. cerebralis –T. multiceps* life cycle. Introduction of dog or sheep with *taeniamulticeps* or *coenorus cerebralis* in to an area where the disease is less prevalent, could pose a considerable risk for the introduction of coenuruses into the new area (Gicik et al, 2007; Jibat et al, 2008).

Farmer or the owner often facilitate the contamination of the environment by opening the skull of infected sheep leaving the Coenurus cyst free to be eaten by dogs or, feeding them direct1y with the definitive host (Scala and Varcasia, 2006). The higher percentages of ecological variables (rainfall, relative humidity and air temperature) are considered to be the influencing factors for coenurosis. In rainy season, rain causes spread of feces of dog, fox (Final host) over the grasses and these contaminates are responsible for the increased occurrence of gid during rainy season (Hashim et al, 2000). According to Gicik et al, (2007) selling of sick animals to abattoirs or market by owners as soon as they noticed the coenurosis without informing the local authorities leads to the high prevalence of *Coenurus cerebralis* in the area.

2.10. Economic importance

Attempts to reduce the prevalence of *T. saginata* in humans and their *cysticerci* in cattle may have a considerable impact on the economics of meat production industries. Cysticercosis in domestic animals is a significant food safety problem and causes economic loss in food production. This will be particularly important where export industries are involved, since most importing countries have stringent regulation designed to prevent the importation of infected meat (Harrison and Sewell, 1991).

The cost implication can be broken down into those involved in treating human taeniosis and cattle carcasses (costs of freezing, boiling) or condemned, as well as the costs involved in the inspection procedures that amounts to millions of dollars (Mann, 1984). An annual loss due to treatment in USA was USD 100, 000 (Robert, 1985).

Similarly, different reports have shown that losses due to treatment of human taeniosis are significant, Megersa et al. (2009), reported 4,913,346 adult taeniacidal drugs doses worthing 72,190,21 Eth, Birr

(820,343 USD) in Jimma. Carcasses shall be considered excessively infested and totally condemned if incision in various parts of the musculature exposes on most of the cut surfaces (Budke et al, 2005). In this regard, findings so far reported in Ethiopia have demonstrated losses due to partial condemnation of carcasses and edible internal organs. Examples are: - liver, kidney, heart.

Echinococcosis in humans and animals is both an economic and public health problem in many parts of the world (Budke et al, 2005; Moro and Schantz et al, 2006). For example, in the North African countries, the cost to human health treatment and animal losses was estimated at US$ 60 million per year (Budke et al, 2005; Moro and Schantz, 2006). In Jordan alone, a more recent estimate was reported at an equivalent of twenty one million US$ dollars (Conteh et al, 2010).

Hydatidosis in animals is equally an economic problem and results in growth delays; the qualitative and quantitative production loss of meat, milk, wool; the fall in fertility as well as the seizures of viscera (offal) during meat inspection (Torgerson et al, 2002; Torgerson and Budke, 2003).

The economic importance of echinococcosis in livestock is due to the condemnation of the whole edible carcasses and offal such as liver, lung and heart (Torgerson et al, 2002). In severe infection, the parasite may cause retarded performance and growth and reduced quality and yield of meat and milk (Getaw et al, 2010).

Cerebral coenurosis is an economically important disease as it causes serious problems especially in the sheep industry and breeding (Scala and Varcasia, 2006; Varcasia, 2009*;* Kheirandish et al, 2012). The disease has 100% mortality rate which cause severe economic losses in small ruminants (Upadhayay, 2005). Gicik et al. (2007) reported that as coenurosis is one of the major contributors to sheep mortality, especially in young sheep of the region in Kars province in Turkey.

Miran (2013) show that Coenurosis ranked amongst the most important sheep and goats diseases in Tanzania, where 58.8% and 47.9% of respondents ranked it as the disease of most concern in sheep and goats respectively in terms of mortality and all have felt the effects of the disease. Among the direct losses arising from cerebral coenurosis are emergency sales or slaughter of affected animals once the clinical disease became apparent and sometimes death occur.

In Ethiopia, according to Deressa et al. (2012) total annual financial loss due to brain/animal condemnation estimated at 8330 Ethiopian Birr (490 US$). Main causes of brain condemned is due to brain with a higher *coenures cerebralis* cyst. Though brain is not a common dish for Ethiopians, there is a higher demand in the Middle East countries

3. CONCLUSION AND RECOMMENDATIONS

In conclusion, hydatidosis is prevalent and causes considerable economic loss in livestock production in Ethiopia. Therefore, proper meat inspection and disposal of condemned organs are essential to reduce the financial losses and safeguard the public. In addition to this, the construction of well equipped abattoirs and enhancement of awareness of people about the economic and public health importance of the disease are also crucial. They also emphasize the importance of maintaining or reinforcing current control measures to consolidate the progress achieved and to reduce human and animal infection rates. Further work is required to evaluate the cost–effectiveness and cost–benefit of any control programmes implemented, and to guide decision makers and stakeholders on the best approach to take with the resources available. Better coverage and accuracy of the current surveillance systems are needed, as are improvements in the cooperation between the central and regional administrations, and the institutions responsible for collecting, providing and epidemiological relevance.

Conventional meat inspection technique, which is less sensitive, was practiced in the study area and the detection of bovine cysticecosis was influenced by minimized number of cuts in inspected predilection sites, lack of transportation facilities and lack of equipments and level of qualification offered to the meat inspectors. By conventional meat inspection techniques infected carcasses can be easily missed and passed for human consumption thus favoring the infection transmission.

Cysticercosis is an important zoonotic disease that affects both human and animals in Ethiopia. The prevalence of the disease both in human and animals is high and economically significant. Nowadays, since there are accustoms of eating raw meat, lack of knowledge about ways of disease transmission, backyard slaughtering of animals especially during holydays, ignorance incision of meat by meat inspectors and lack of sanitation can give a great favor for continual existence of the parasite within the human and animal population.

Based up on the findings of the present study, the following points are recommended:-

- There should be public awareness about the health and economic importance of the disease through social and public media.
- Infected meat and meat products must undergo the proper process of freezing, boiling or destruction based on the intensity of infection with cyticerci.
- Avoid eating of raw meat *(Kurt*, *lebleb* and *kitffo*) that is not inspected by well experienced meat inspector.
- Offals found infected with the cyst must be properly disposed via through burying or incineration.
- There should be strong and close collaboration between medical and veterinary professionals to reduce impact of the disease both in humans and animals.
- The community should use latrines to improve personal as well as environmental hygiene.
- Untreated human feces should not be used as fertilizers.
- Strict routine meat inspection of slaughtered animals should be carried out.
- Further researches should be conducted on the epidemiology and control strategies of cestode in Ethiopia.
- Improve the working conditions of meat inspectors and up-grade their skills.

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ABBREVIATIONS

Ab- ELISA	Antibody- enzime linked immunosorbent assay
AC	Alveolar Echinococcosis
Ag-ELISA	Antigen-enzime linked immunosorbent assay
CSA	Central Statistic Authority
CE	cystic echinococcosis
EITB	Enzyme-Linked Immunoelectro Transfer Blot
FAO	Food and Agricultural Organization
IHAT	Indirect Haemagglutination Antibody Test
MOA	Minister Of Agriculture
OIE	Office International des Epizootics
PCR	Polymerase Chain Reaction
RFLP	Restriction Fragment Length Polymorphism
WHO	World Health Organization

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