

## CHAPTER II

# REVIEW OF LITERATURE

### 2.1. ECONOMIC SIGNIFICANCE

Hydatidosis is a condition caused by the larval forms of *Echinococcus* species. The definitive host for this parasite are carnivores, usually the Canidae, but the larval stage is found in a wide variety of animals including cattle and man. *Echinococcus granulosus* is cosmopolitan in distribution and in general the parasite is more important in temperate tropical and sub-tropical countries. *Echinococcus granulosus* is a tape worm measuring 2-6 mm in length. The last segment of the parasite is about half of its entire length and contains eggs in it (Plate 1). The segment detaches and is replaced by a new one. The eggs leave the segment, embryonate and develop to oncosphere which is ingested by the intermediate host. Metacestode is liberated and in intestine, penetrate the wall, and pass to the liver by hepatic portal system and is distributed in vital body organs e.g., liver, heart, lungs, spleen and kidneys. The metacestode migrate from venous capillaries to the parenchyma of the organ and grow to a bladder structure differentiating into outer cuticular and inner parenchymatous layer and vesicle develops. The cyst grows to 10 mm in 4-5 months. The brood capsule contains about 40 scolices. The final host gets infected eating infected organ and the cycle is repeated (Appendix-1). The age of animal at infection

appears to influence the sterility of the cyst (Nosik, 1953).

Hydatid cyst is typically a single chambered, unilocular, fluid filled and least complex structure. Hydatidosis exhibit first sign of bladder structure formation. The cyst consists of an inner germinal or nucleated layer supported externally by a rough elastic acellular laminated layer of variable thickness surrounded by a host produced fibrous layer (Appendix-2). In about four months time, the vesicle reaches 4-5 mm in diameter with an inner germinative membrane and the growth is expansive by concentric enlargement. The germinal layer (Plate 2) is similar in structure to the tagument of the adult worm (Bortoletti and Ferretti, 1978). In about six months period, the wall of the cyst grows to 1 mm and the brood capsule containing about 40 scolices form on the germinal layer (Plate 3) of the hydatid cyst. The cyst contains brood capsule and fluid (Plate 4) which is often termed as hydatid sand. The brood capsule enlarge, vacuolate and become stalked with numerous protoscolices to the germinal layer (Thompson, 1976). The cyst grows in a spherical form provided with hard structures. In cattle excess of fibrous tissue occurs and the growth is irregular. The life span of the hydatid cyst can be as long as 16 years in horses (Roneus *et al.* 1982) and 53 years in human (Spruance, 1974).

The incidence of hydatidosis has extensively been studied from the time of its recognition as one of the major health hazard among animals and human beings. Nelson (1986) reported a brief account of events for the highest incidence of

clinically recognized hydatidosis in man. He found 198 surgical cases per 100,000 people per annum in areas of Kenya bordering on the Sudan, Ethiopia and Uganda. He reported dogs and jackals were mainly the final host for *Echinococcus granulosus* from sheep, goat, cattle and camel. The unusually high prevalence in man was thought to be due to the close intimacy of the people with their dogs and to customs relating to the handling of dog feces.

The incidence usually varies from as low as 0.00092 per cent (Dada, 1977) to as high as 86.4 per cent (Deka *et al.* 1988). This parasitic problem is present in every continent. The importance of economic significance lies with the prevalence and the incidence of the disease. Information on the incidence of hydatidosis in cattle, on global basis, is presented as under in the tabulated form:

#### GLOBAL INCIDENCE OF HYDATIDOSIS

No. of animals examined	% incidence	Country	Reference
-	24.66	Baghdad Iraq	Senekijis and Beattic, 1940.
-	50.00	Newzealand	Barnett, 1941.
-	34.22	Santiago	Wilhelm, 1941.
39242	71.00	Queensland	Durie and Reik, 1952.
800	1.25	Mississippi	Ward & Bradshaw, 1956

Contd.....

-	26.00	USSR	Davidov, 1963.
62	66.60	Lahore, Pakistan	Maqsood, 1964.
-	14.00	UAR	Abdou, 1965
1053	1.40	Kazan, USSR	Evranorva and Yashina, 1965.
27641	1.40	Crua Gora	Sekulvic, 1965
-	13.67	Eastern cape, Province	Verster, 1961.
36197	67.00	Uruguay	Portiel <i>et al.</i> 1967.
-	0.10	Belgium	DeRyeke, 1970.
-	20-40	South France	Thornton and Gracey, 1974.
-	34-41	Bulgaria	Thornton and Gracey, 1974.
-	28-41	Kenya	Thornton and Gracey, 1974.
208	53.84	India, Benglore	Hedge <i>et al.</i> 1975
-	21.00	Kampala	Owor and Bitakaramire, 1975.
116	8.90	Iran	Sobbaghian <i>et al.</i> 1975.
756	27.60	Kuwait	Behbehani & Hossounano, 1976.
984	32.50	Kuwait	Hossounano & Behbehani, 1976

Contd.....

3400	9.94	Iran	Mutkef <i>et al.</i> 1976.
941	83.74	India	Rao and Mohyuddin, 1976.
788	62.3	Banglore, India	Rao and Mohyuddin, 1976.
4844	14.70	Nigeria	Dada and Belino, 1978.
1439437	0.0009	Nigeria	Dada, 1977.
40	32.50	Kuwait	Hossounano & Behbehani, 1976
-	53.60	Bangladesh	Islam <i>et al.</i> 1977.
-	4.30	Tanzania	Masaba <i>et al.</i> 1977.
4000	0.10	Cario	Sedik <i>et al.</i> 1978.
2085	1.50	Nigeria	Dada <i>et al.</i> 1979.
770	4.00	Sudan	El-Badawi <i>et al.</i> 1979.
1300	33.00	Faisalabad	Munir, 1980.
266	5.00	Iraq	Al-Abbassy <i>et al.</i> 1980.
-	24.40	Kirgizia, USSR	Akmatov, 1980.
18224	21.96	Lahore	Siddiqui, 1980.
-	14.70	Kano, Nigeria	Dada, B.J.O. 1980.
107977	33.00	Italy	Leoni and Marceddu, 1982.
-	20.20	Ukraine, USSR	Artemenko & Chikunova, 1984.

Contd.....

-	16.40	Kazakhstan	Kaspakbaev and Kereev, 1984.
-	2.90	Formosa	Monzon and Mancebo, 1984.
280	11.40	North Japan	Al-Yaman <i>et al.</i> 1985.
-	14.70	Niger	Arene, 1985.
10412	2.40	Australia	Howkins, 1985.
729	9.70	Kenya	Macpherson, 1985.
10362	42.15	Bangladesh	Islam, 1985.
157	5.80	Jordan	Abdul Hafez <i>et al.</i> 1986.
1140	31.05	Rawalpindi	Pal and Jamil, 1986.
370	22.00	Andhra Pradesh	Kulkarni <i>et al.</i> 1986.
-	86.40	North East India	Deka <i>et al.</i> 1988.
9538	33.00	Faisalabad	Iqbal <i>et al.</i> 1989.
100000	0.27	Germany	Horchner, 1989.
495976	0.36	Brazil	Riccetti <i>et al.</i> 1990.
1023	5.4	Libya	Gusbi <i>et al.</i> 1990.
50	85.71	Sikkim	Ansari and Rai, 1991.
11467	8.88	Sicily	Virga, 1991.

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The incidence of hydatidosis varied greatly from time to time and place to place. It was reported that the prevalence of infection appeared to increase with age in all animal species. The cystic burden was found heavier in cattle than other animals (Dixon *et al.* 1973). An immunofluorescence technique for the diagnosis of human hydatidosis including egg identification of *Echinococcus granulosus* was developed by Craig *et al.* 1986. They used an anti-Echinococcus monoclonal antibody which identified oncospheres hatched from Echinococcus eggs. They also identified the eggs in the environment and in dog faeces. Their results revealed a successful attempt to hydatid control programme.

The variation in incidence within the country had been reported by Maclean (1979) in Newzeland where it ranged from 14.7 to 60.8 per cent. Similarly it had been reported from India where hydatidosis was found to be 53.84 to 86.4 per cent in various parts of the country (Hedge *et al.* 1975, Deka *et al.* 1988 and Al-Abbassy *et al.* 1980) surveyed the prevalence of hydatid cysts in slaughtered animals in Iraq and found 5 per cent incidence in cattle. The reason for this low incidence was because of destruction of stray dogs and improved standards of meat inspection. Arru *et al.* (1983) conducted a study on relationship between hydatidosis of animals and man. Their data was based on eleven years observations from 1969 to 1980 and their personal studies of abattoirs over a four months period. They observed hydatid infection in 33 per cent cattle.

Ansari and Rai (1991) examined 50 yaks aging 1-8 years on post slaughter in Sikkim for the presence of hydatid cysts and found a direct relationship of the disease with age. The cyst being larger and more numerous in older animals. They reported 58.71 per cent incidence of hydatidosis. The livers (35 %) and lungs (5 %) were only involved in cyst

formation. The cyst was unilocular in 95 per cent of infected animals. Virga (1991) reported the incidence of hydatidosis in slaughtered animals in Sicily. His data was based on three years observations on post slaughter observations during meat inspection and found the incidence increasing every year. He observed that the incidence of hydatidosis in 1991 was higher than 1990 where it was 8.88 per cent and 2.67 per cent for the years 1991 and 1990 respectively.

### **2.1.2. ORGAN SPECIFICITY:**

Hydatid cyst has been found in various vital body organs like liver, lungs, spleen, heart, kidneys and even in brain and spinal cords of human and other animals. The larval form of *Echinococcus* species has different affinities in its localization and cyst formation. As the larval forms are carried over to various organs through the portal and general circulation, it settles and form bladder like structure, hydatid cyst (Morseth, 1967).

Ward and Bradshaw (1956) recorded the incidence of disease in 10 out of 800 cattle (0.125%) in Mississippi, USA and only the liver was found infected. Chabassol *et al.* (1960) carried out a survey in Tunisia on the prevalence of hydatid cyst in various organs of sheep and cattle and observed that out of total 886 cattle, livers were infected in 744, lungs in 583 and kidneys in 164 animals, while of 140 sheep, 80 were having only lung infection and 30 sheep showed liver infection.

Sharma and Chitkara (1963) examined 1095 sheep in Amratsar, India and reported that 13 sheep were having hydatid cyst in the lungs, nine in livers and 17 in both lungs

and liver. Gill and Rao (1967) reported the incidence of hydatidosis in various organs of buffalo at Bareilly abattoir. They found 75, 24 and one per cent of the lungs, liver and other organs infected with cysts respectively. Hedge *et al.* (1975) found an incidence of hydatidosis in various organs of cattle in Bangalore, India. They reported an incidence of cysts from lungs, liver, spleen and heart as 12.5, 85.9 and 0.8 per cent respectively. Masaba *et al.* (1977) conducted survey at Mwanza abattoir, Tanzania for echinococcosis in cattle and placed on record 4.3 per cent incidence of infection in liver.

Akmatov (1980) conducted a study on the prevalence of hydatidosis in Kirizia (USSR) in man and animals. He observed that the prevalence of the disease remained steady for 15 years with mostly farmers and their families. He found that 62.5 and 24.4 per cent sheep and cattle carried infection. Amongst cattle, liver was found mostly infected with hydatid cysts of various sizes.

Hydatidosis of spinal cord has been reported in one 40 years old woman from Spain by Cardona *et al.* (1983). The case was initially diagnosed as tuberculosis and hydatidosis was discovered only during surgery when she had undergone operation for improvement of paraplegia.

Artemenko and Chikunova (1984) while conducting a survey on the hydatidosis in various ruminants in southern Ukraine of USSR observed that in Odessa region highest infestation was in sheep 39.4 per cent followed by cattle 20.2 per cent and then pigs 14.2 per cent. Seasonal variations in prevalence were also recorded and found that liver was commonest organ infected in cattle and pigs.

The cysts were seen throughout the year but protoscoleces were absent in winter months. The first fertile cyst started appearing in the month of April. Arene and Nweke (1985) could not find any cyst in spleen and heart while conducting survey studies on epidemiology of Echinococcus infection in Niger delta. They reported that 14.7 per cent cattle were carrying infection mostly in the lungs. Although lesser in number of livers were also found infected.

Deka *et al.* (1988) placed on record an incidence of 86.4 per cent hydatidosis in cattle. The cysts were predominantly present in lungs and livers. Howkins (1985) conducted a pilot survey on incidence of hydatid cyst in sheep and cattle of New South Wales, Australia. He examined lungs and livers from 18 abattoirs and reported 5.4 per cent cyst in adult sheep but none of the lambs were found infected. He also found infection in 2.4 per cent cattle. This low infection was due to draught and good management of the animals kept.

Abdel-Hafeez *et al.* (1986) examined 157 cattle in Jordan from March to May and recorded the prevalence of disease being 5.8 per cent. They further observed that only female cattle were harbouring the infection and the prevalence of the disease increased with an increase in age.

Lorenzini and Rughri (1987) while studying the distribution of echinococcosis in Italy, recorded an incidence from 0.5 to 0.7 per cent in cattle. They also observed that the liver was more frequently affected than the lungs and the spleen.

El-Sultan *et al.* (1987) examined a total of 5352 sheep and 2259 cattle for the presence of hydatidosis in sheep and cattle in Mosul, Iraq. They examined lungs and liver

separately. It was found that 644 (12.0 %) lungs and 325 (6.1 %) livers of sheep and 459 (20.3 %) lungs and 178 (7.9 %) livers of cattle were infected with hydatid cysts.

Wamae and Cheruiyot (1987) studied comparative distribution of hydatid cyst in bovine and on examination of 2406 cattle at an abattoir in Kenya, recorded a frequency of 14.3, 12.9 and 0.8 per cent hydatid cysts in livers, lungs and spleens respectively. Gusbi *et al.* (1990) examined 14 Libyan abattoirs to record the prevalence of hydatidosis in animals. A total of 4316 locally bred goats, cattle and camels were inspected for the presence of *Echinococcus granulosus* cysts. Of the 1023 cattle carcasses, mild infection with hydatid cysts were seen in 5.4 % and all cyst were sterile and confined to the livers.

### 2.1.3. ECONOMIC LOSS:

Only a few studies have been undertaken of the effects of very heavy cysts burden. Virtually the only reasonably reliable measurements of the economic costs of hydatid infection in domestic animals for any country concerns condemnation of organs, chiefly livers, and even these data are frequently incomplete. In ruminants cysts were found more frequently in lungs than the livers and were nonfertile.

Matossian *et al.* (1977) had expressed the view that hydatidosis was increasing in global public health importance and there had been many reports of incidence of hydatid disease in previously free countries. Cattle were appearing to be at higher risk of infection compared to sheep and goats in some areas of the world. There was a loss of weight gain and milk production which was not easy to be estimated.

There were poorly estimated costs of hydatid infections among domestic animals. Thompson and Smyth (1975) reported that annual losses solely from condemnation of offals from cattle, sheep, swine and horses in Great Britain, where hydatidosis regarded as a minor disease, were about 70,000 sterling pounds. In more highly endemic situations such losses may be much more. Neghme and Silva (1970) estimated a loss of 1.2 million Australia dollars per year through condemnation of the offals because of hydatidosis in sheep.

Similar nature of loss has been estimated by Mutkef *et al.* (1976) to the tune of 3 millions U.S. dollars per annum in the sheep infected with *Echinococcus granulosus* slaughtered in Iran. Arru *et al.* (1983) reported a loss of 24 million lira in sheep due to hydatid infection in Italy. Vassalos *et al.* (1984) recorded a loss of 20 millions U.S dollars in animals slaughtered and found infected with hydatid disease per annum in Greece. They further reported that in addition to hydatidosis economic importance, the disease was also a great threat to humans and was responsible for serious illness necessitating surgical treatment. Iqbal *et al.* (1989) reported a loss of Rs.3,65,297 per year inflicted through condemnation of infected offals in animals slaughtered at Faisalabad abattoir. They did not mention about the parameters of measurement of economic loss as well as were not specific in types of animals of their studies.

Determinations of the effects of often heavy echinococcal infections in common domestic animals upon growth, meat quality, milk, wool and other product and quality were hard to determine. Apart from these losses, a loss of working potential in the bullock energy used for agriculture was never taken into consideration.

## **2.2. BIOMETRY OF HYDATID CYST**

### **2.2.1. SIZE OF CYST:**

Lapage (1938) first reported that the embryo of *Echinococcus* grew into a large vesicle measuring 5-10 cm or even more. He recorded the largest size of fifty cm in diameter. Runnels *et al.* (1967) observed hydatid cyst in various animals and found that most frequently cysts were of unilocular nature. Frankel and Rittman (1970) reported the smallest size of the cyst being 1 mm in diameter and maximum of a basket ball.

Afshar *et al.* (1971) observed cysts of variable sizes (from 1 to 10 cm) embedded in parenchyma of both liver and lungs. Munir (1980) recorded various sizes of hydatid cyst in liver and lungs of buffaloes at Faisalabad abattoir. He reported that smallest cyst was 5 mm and the largest was 30 cm in liver. The cysts were partially embedded in the liver parenchyma and partially bulged out of the surface of the liver. The average size of cysts in lungs was 1 cm and the biggest was sixty cm. Smaller cysts were usually found to be completely embedded in the tissue of lungs. El-Sultan *et al.* (1987) recorded the size of cyst being small measuring upto 2 mm in diameter while examining cattle liver and lungs for hydatid cyst presence at Mosul, Iraq.

### **2.2.2. FERTILITY/STERILITY:**

Dissanike (1957) reported the prevalence of hydatidosis in cattle of South Africa and recorded 96.8 per cent fertility rate of cyst found in cattle while Verster (1962) recorded 94.2 per cent hydatid cyst fertility in cattle infected with metacestode of *Echinococcus granulosus* in Belgium.

Hedge *et al.* (1975) conducted a study to assess the incidence of hydatidosis in animals in Bangalore, India and reported that out of 208 cattle, 120 were carrying cysts. Out of this total 31 were found carrying fertile and the rest sterile cysts.

Munir (1980) in Pakistan, recorded 15.6 per cent fertility rate of hydatid cyst in cattle. He further reported that lungs were the commonest organ infected with hydatid cyst alongwith liver, spleen and heart. Eckert (1981) studied the prevalence of hydatidosis in cattle and recorded 95 per cent cyst fertility in animals infected with metacestode of *Echinococcus granulosus*.

Thompson *et al.* (1984) studied echinococcosis in cattle of Switzerland and correlated the fertility rate of the cysts with cattle/dog life cycle. They reported that most of the cysts were sterile. The fertility rate ranged from 1 to 15 per cent. They also compared the fertility rate of cyst with other countries like S. Africa, Belgium and Sri Lanka where the fertility rate had been reported as high as 96.8, 94.2 and 79 per cent respectively.

Al-Yaman *et al.* (1985) recorded the prevalence of hydatidosis in North Jardon. They examined 280 cattle and other slaughtered animals and found that 11.4 per cent cattle were infected with the disease. Out of these infected animals 34.4 per cent were carrying fertile cysts and these cysts were present in lungs and livers.

Macpherson (1985) studied the epidemiological significance of cattle, sheep and goats in maintaining the life cycle of *Echinococcus granulosus* in Massiland, Kenya. He reported that out of 1499 cattle, 146 were found harbouring the hydatid cyst. Of 729 cattle cysts examined, protoscolices with an average viability of 71 per cent, 507 were

sterile and 151 were calcified.

Sasaki *et al.* (1985) reported that of 162 cattle slaughtered at Gifu, Japan immediately after import from Queensland, 28 were found infected with *Echinococcus granulosus* cyst. All the cysts found were sterile and degenerated.

Farah (1987) studied infection rates, cyst fertility and larval viability of hydatid disease of animals in Saudi Arabia. His postmortem studies revealed an incidence of 33.0 per cent hydatid cysts and 7.3 per cent viability (fertility) rate in cattle.

El-Sultan *et al.* (1987) examined 2259 cattle in Mosul abattoir, Iraq. They reported 20.3 per cent lungs and 7.9 per cent livers of cattle were found infected with hydatid cyst. The over all fertility rate was 5.3 per cent. However, viability of the cysts protoscolices was 53 per cent.

Singh *et al.* (1988) recorded incidence of hydatidosis in Uttar Pardesh, India and reported that 11.2% infected cattle had cysts in lungs, livers and spleen. The fertility rate of cysts was 15.6 per cent while the rest of the cysts were sterile.

Irshadullah *et al.* (1989) at Aligarh, India examined 1556 buffaloes and found 565 (36%) infected with *Echinococcus granulosus* metacestodes (hydatid). They further observed that the cyst fertility rate increased with increase in the cyst size.

Sakamoto *et al.* (1990) examined cattle slaughtered at four different towns of Australia. Hydatid cysts were found in 197 lungs and 426 livers from 5000 cattle in one town 9 lungs and 4 livers in 200 cattle, one lung only in 200 cattle and one lung and 4 livers out of 100 cattle in the other town respectively. Most of the cysts found were regressive aheading towards sterility. The fertility rate observed was one per cent. They

also reported that cattle do not play a significant role in the life cycle of *Echinococcus granulosus* in Australia. They also observed some cases of protoscolices presence in blood vessels of various organs.

### 2.3. CHEMICAL COMPOSITION OF CYSTIC FLUID

The hydatid cysts of *Echinococcus granulosus* is characterized by a pericyst (advential layer) and laminated layer surrounding the germinal layer from which develop the brood capsule and protoscolices (Morseth, 1967). Biochemically the laminated layer of cattle cysts was shown to be a carbohydrate-protein complex structure (Kilejian and Schwabe, 1971). The carbohydrate components were glucose, galactosamine and glucosamine. These findings have been confirmed by Richards (1984) who was working with the strain of *Echinococcus granulosus* of horse origin during studies on biochemistry of laminated layer of hydatid cysts.

Similarities between the composition of hydatid cystic fluid and the serum has been reported by many workers. Carbone and Lovenzetti (1957) reported a range of 17.3 to 227 mg of total protein per 100 ml of cystic fluid collected from hydatid cysts of livers and lungs of cattle.

Smyth (1969) stated that the difference in the composition of bile between species may influence host specificity. Apart from bile, there were likely to be many biochemical, nutritive and immunological factors which influenced the host specificity and speciation of the parasite. Sanchez and Sanchez (1971) carried out a very comprehensive study of the hydatid cystic fluid from the cysts of human, sheep and cattle

origins. They reported the presence of inorganic substances (Sodium, Potassium, Magnesium, Calcium, Iron, Chloride and Phosphorus, lipids (Cholesterol), glucose, urea, proteins and enzymes GOT and GPT. Many of these components differed quantitatively or qualitatively depending on the cyst location and host origin.

Frayha and Haddad (1980) reported that with the exception of Calcium, Sodium, Magnesium, Phosphorus and Chlorides and their bicarbonates were also present in the protoscolices. RNA, DNA and ammonia present in protoscolices were almost absent in hydatid cyst fluid. The major protein in hydatid cystic fluid was albumin and globulin in ionized forms. In addition to GOT and GPT, lactic dehydrogenases and phosphotases exhibited high activities.

In contrast, soluble proteins have received special attention mainly because their study facilitates the identification of specific antigens for use in serological diagnosis and for study of the immune response in hydatid disease.

Despite a large number of studies, information concerning the precise nature of these proteins is very limited. Most attention has been paid to the hydatid cystic fluid proteins of sheep. Muntyan (1973) has recorded at least 20 components of protein in hydatid cystic fluid and purified thermolabile lipoproteins. similar results were obtained by Edwards (1982). The host serum components detected in hydatid cystic fluid included albumin and several different classes of immunoglobulins (IgG, IgG1, IgG2, IgM but not IgA).

An interesting protein, probably lipoprotein with a relatively large amount of cystine, has been demonstrated histochemically in rostellar gland secretions of *Echinococcus*

*granulosus* (Thompson *et al.* 1979). These secretions were thought to be hook forming and release of gravid segments in the final host. Njeruh *et al.* (1989) reported that antigen activity of lipoprotein resided in both the protein and lipid moieties. The disulphide bonds were not prerequisite for antigenic activity. The lipoprotein retained antigenic activity after treatment with various concentrations of EDTA. The antigen was not metallo-protein.

Cholesterol is the only sterol so far identified in *Echinococcus* and is present with layers of hydatid cyst. It is either obtained directly from the host or in an esterified form which is subsequently hydrolysed by an esterase. Bhar *et al.* (1979) demonstrated that simple diffusion and possibly exchange diffusion operate in esterified form and onward hydrolysis.

McManus (1981) observed that lipids were especially accumulated in different zones related to brood capsule insertions. In other zones the enzymes were active in lipid metabolism. Frayha (1971) stated that acetate could also be used as substrate which is oxidized to carbon dioxide and incorporated into saponifiable and nonsaponifiable lipids. Meduri *et al.* (1990) reported the presence of phospholipids in hydatid fluid obtained from hydatid infected cattle. In 21 infected cattle, the hydatid fluid contained 158.20 mg/100 ml of phospholipids. In 20 pulmonary hydatid cysts and 10 hepatic cysts, the values were 3.80 and 12.00 mg/100 ml of phospholipids respectively.

Hurd (1989) detected 28 components in the free amino acid (FAA) pool of hydatid fluid from primary and secondary equine cysts and host plasma. The data revealed that the majority of free amino acids were present in significantly greater concentrations in

secondary than in primary cysts. Values for total carbohydrates and glucose did not differ significantly but total protein contents were greater in primary cysts. His studies concluded that most free amino acids were more concentrated in hydatid cystic fluid than in the corresponding host plasma.

Jeffs and Arne (1988) observed that the glucose absorption by protoscolexes of *Echinococcus granulosus* was by passive diffusion and mediated transport which consisted of both sodium dependent and sodium independent mechanisms. The system recognized the structural configuration of D-glucose and D-galactose.

Meduri *et al.* (1990) reported Sialic acid and mucoproteins in hydatid fluid from infected cattle. In 32 infected cattle with hydatid cysts, Sialic acid and mucoproteins were 57.70 and 1.40 mg/100 ml respectively. The amount of sialic acid and mucoproteins were 2.23 and 0.09 mg/100 ml respectively in 29 pulmonary hydatid cysts. The same contents 4.40 and 0.20 mg/100 ml were found in 15 hepatic cysts.