Chapter 6

Discussion
The present study was taken between December 2004 to March 2007 to present the actual status and magnitude of *Taenia saginata* infection in Kashmir region, the various parameters that were studied include experimental trials to observe the actual route of infection in free living human population, epidemiology of the disease was of prime concern and another important and interesting study was carried pertaining to the disease treatment and management, in this regard an important milestone in the medical history was achieved with the drug trial of Nitazoxanide in the treatment of both resistant and non resistant (fresh) *T. saginata* infection which was a job of the demand from disease management point of view; so, here we discuss our observations with their respective justifications.

**Experimental trials in host and non host animals with eggs of *Taenia saginata* with distribution and concentration of *Cysticercus bovis* in host body organs**

The changes in the bio-physico parameters in infected calves were found in accordance with previous workers. Ershov (1933) in the same way observed manifestations of acute Cysticercosis in experimentally infected calves and adult bulls as we noted in this experimental trial. In all the experimental infected calves and bulls he found body temperature rose to 39.8 - 41.8°C on the 2\textsuperscript{nd} - 4\textsuperscript{th} day of infection, and remained high until 6\textsuperscript{th} - 7\textsuperscript{th} day. The general condition of these infected animals was impaired; the animal lay moaning; appetite was poor, rumination absent the proventriculus atonic, constipation present. According to Neumann, (1892), Zurn noted in an experimentally calf. the temperature rose 4°C. with accelerated pulse, abdominal distention, emaciation, and difficulty in standing up.
In this experimental study the maximum cyst concentration was found in heart 82 (33.74%) followed by skeletal muscles of trunk regions 37 (15.22 %), Front limbs and Hind limbs with 28 (11.52%) and (9.05%) respectively. These results resembles with the observations of (Fan et al., 1989, 1992; Smith et al., 1991; Kyvsagaard et al., 1991; Hayunga et al., 1991; Joao Carlos et al., 2002;). An experiment conducted by Fan et al. (1988) with infection in four month old calf that showed cysticerci were in the heart (16.67%) and the skeletal muscle (83.33%). Wanzala et al. (2003) found same results for distribution of cysts and found most of cysticerci in the heart. Walter and Koske (1980) found that only 60 of cysticerci infected bovines were detected through a regular inspection and the remaining 37 (61.7%) were identified only by the slicing technique. Data on the localization of cysticerci in cattle are varied; Borodin (1940) observed infection of the tongue in 48% of the cases. Of the neck muscles in 46%, of the heart in 42% and of the jaw muscles in 18%. The results of total dissection were in agreement with previous studies (Gallie et al., 1983; Purves et al., 1987; Kyvsgaard et al., 1990; Gracey et al., 1994). It presents low sensitivity when the infection level is initial or low (Murrel et al., 1986; Kyvsgaard et al., 1989; Wanzala et al., 2003). So, there remains every possibility to miss the detection of these little no of cysts thus humans remain susceptible; and unfortunately in Kashmir Valley where there is no concept of bovine cysticercosis in municipal and health departments and beef is being sold without prior inspection in the slaughter houses thus human infections due to Taenia saginata are endemic and in moderate levels (2.23 to 3.98\%), thus eradication is almost impossible.
From the total of 243 recovered cysts, 175 (72.01%) were considered live and 68 (27.98%) were found degenerated, the cysticerci may die in the cattle. Upon death, the cysticercus walls and fluid become opaque. The neck and scolex become yellow. The connective tissue capsule usually remains unaffected. Sometimes, on the other hand, caseous masses are observed in the capsule when the cysticercus is alive and seems transparent. Usually the cysticerci in the heart are subject to earliest degeneration. The same observations were found by Peel (1961).

As in the current experimental study the maximum cyst density was found in heart, thus may be attributed to the maximum number of deaths in cattle due to cysticercosis. As also reported by Gracey (1992) attributed heavy infestation by the larval of *Taenia saginata* in cattle to cause myocarditis or heart failure, responsible for heavy economic losses. The metacestodes were found to cause extensive damage resulting in infiltrative, degenerative changes, haemorrhages, necrosis and exudation mainly in the vicinity of cysts.

According to Moscow meat control stations (Katкова, 1957), cysticerci were found in the heart in 19.4% of the cases. In the jaw muscles in 15%, in the omancones muscles in 29.4%, in the lumber muscles in 8.7% and in the neck muscles in 0.9%. According to routine inspection few selected tissues or regions (predilection sites) are only partially investigated, therefore fewer slices are made. A more careful examination conducted in these tissues could result in the great economic loss. In routine inspections only a partial slicing up to 50% of the inspected tissues would make possible to find only 7.05% of the present cysticerci (Walther and Koske, 1980; Joao Carlos *et al.*, 2002; Wanzala *et al.*, 2003). The
limitations of the bovine cysticercosis are evident mainly if the infection is in a low level. Santos (1993) observed that 96.7% (4,222) of (4,366) infected bovines presented only one cysticercus; however other cysticerci must be present in skeletal muscles. While as, according to our results, 31% of the cysticerci were found in the routinely infected tissues, probably due to this limitation in the inspection the most efficient sanitary system could not interrupt the parasite disease cycles, particularly in Kashmir were beef inspection is almost absent. Thus in order to prevent the continuous parasite cycle, it would be necessary to encourage and improve the beef inspection. This could be achieved by extending the examinations to some other tissues or sites, therefore, it would be necessary to include some less important muscles simultaneously with an increase in the number and the depth of incisions, moreover the inspector's awareness of the correct identification and treatment of infected carcasses to prevent the development of new *Taenia saginata* infections.

Thornton (1951) reported that in Kenya after examining 5000 heads of infected cattle and never found young and old cysticerci simultaneously. However, young and old cysticerci were often found together. The author suggests that apparently there are two types of immunity in animals: temporary, caused by a short-term infection, which lasts for the lifetime of the parasite, and fairly permanent immunity. In present study where the single dose of *Taenia* eggs were given to experimental animals degenerated and live cysticerci were found together and immunity was felt playing an important role as found by Thornton (1951).

Young calves are considered to act as an ideal host model for experimental studies of metacestode stage of *T. saginata* as also used in the current experimental
study. Calves have also been found to be very susceptible to *Cysticercus bovis* infection in their young ages and adult cattle are to some extent immune to this infection, this is worth to mention here that people of Kashmir region having common belief that Taeniasis is mostly due to the consumption of beef from older animals were as small calves if eaten even in crude form can not infect the masses. These results are also in accordance to the observations of Peel (1961) who established after many experiments that in West Africa calves are infected in the first weeks of their life, and subsequently become immune to the reinfection for several years. After 80 days the calves were immune to experimental infection. The author claims this is due to the acquisition of hereditary and individual immunity. Yet in Australia adult cattle were quite susceptible to infection. Peel suggests that the biological difference exists between the strains of *C. bovis* in Australia and in West Africa. The cysticerci may die in the cattle. Upon death, the Cysticercus walls and fluid become opaque. The neck and scolex become yellow. The connective tissue capsule usually remains unaffected. Sometimes, on the other hand, caseous masses are observed in the capsule when the cysticercus is alive. Usually the cysticerci in the heart are subject to earliest degeneration as also found in this experimental study. Generally, older cysticerci die, although the parasites may begin to degenerate in the fourth week after infection. Urquhart (1961), like peel, believes that in West Africa calves are infected with *C. bovis* in the first weeks and remain immune for a long period, even after the death and degeneration of the larvocysts.
Discussion

During the routine beef inspection during current study more than 5% of the slaughtered cattle were found infected with *C. bovis* with distribution of cysts in the same manner as in experimentally infected calves with slight variations it was found that cattle of every age group were found infected and usually get infection in summer and autumn. The reason attributed might be the conducive weather for the survival of eggs and easy access of animals to acquire infection while grazing as in Kashmir cattle move at their will and are always vulnerable to infection of *Taenia* eggs. These observations are favoured by the findings of Gracey (1981) who recorded the highest incidence in autumn and summer in some European countries. The reason he attributed was the conducive weather for the survival of eggs and easy access of animals to acquire infection with grass. Moreover other good reasons in the Epidemiology of *Taenia saginata* in cattle of Kashmir were the suitable temperature and high humidity during spring and autumn which prolong the age of the eggs, however age had no significant effect on prevalence in this study which suggested that once infected, the animals acquired life-long immunity to super-infection. Oryon et al. (1994) who carried out a study in a 3-year period. Of 9501 cattle examined, 736 (7.7%) were infected with cysticerci of *T. saginata*. The endemic foci were identified and prevalence was significantly higher (P<0.005), Kenarch (10.0%) and Shiraz area (8.5%) than elsewhere. The prevalence was significantly higher (p<0.005) during spring and autumn seasons. There was no variation in the infection rate in animals of different age groups, suggesting that immunity was acquired to super-infection. The most common sites were muscle of the shoulder (26.3%). Pharynx oesophagus and diaphragm showed
0.9, 0.5 and 0.4% infection, respectively. The metacestodes were found to cause extensive damage resulting in infiltrative, degenerative changes, haemorrhages, necrosis and exudation mainly in the vicinity of cysts. They also found that infection was the cause of condemnation of 34.6% of infected Carcasses. The rejected Carcasses and infected organs were valued at 100.1 million Rials over the 3-year period. Our results are also in accordance to Rickerd and Adolph (1977) who studied the prevalence of cysticerci of *Taenia saginata* in cattle reared on sewage-irrigated pasture and found the heart, masseter muscle, tongues and laryngeal muscles from 200 cattle aged 10 to 11 months, and 100 cattle aged 20-21 months which had been reared on sewage-irrigated pastures at Melbourne and Metropolitan Board of Works Farm, Werribec, Victoria, were examined for infection with cysticerci of *Taenia saginata* by slicing in the laboratory and the result obtained were compared with those recorded during normal meat inspection procedures at the abattoir, of the 10-11 month old cattle 51-5% were found to be infected and 8% of the total animals harboured viable cysticerci. Of the 20-21 month old animals 33% were infected, and even at this age. 8% of the animals still carried viable cysticerci. On line meat inspection at the abattoir detected significantly fewer infections then did laboratory slicing. Slonke (1978) reported 4.75% of the animals sent to slaughter from a Southern California-feed lot during a 9 month period were found to be infected with the *Cysticercus* of *T. saginata*. Dewhirst *et al.* (1978) reported that meat inspection is a useful for detecting heavily infected Carcasses. However, lightly infected Carcasses can easily be missed and
passed on for human consumption. The same results were observed by Walter et al. (1980).

During current study it was found that cysts of *C. bovis* were found in deep muscle layers suggesting that it is very difficult to detect these deeply embedded cysts during routine meat inspection thus increasing the chances of human infection if cooked in bigger cuts without proper heat treatment these observations can be justified also by Eystein Skjerve (1999) who worked on Monte Carlo risk assessment model to estimate the public health risk of importing prime cuts of beef infected with *T. saginata* to Norway from an endemic area in Southern Africa. The model predicted that 21 (lower 5%=1), (upper 95%=56) viable cysts would be present in domestic prime cuts during 1996 and 1997, with 8 (0-21) of them being ingested without sufficient heat treatment to kill the parasite. These cysts were expected to cause 2 (0-7) human infections.

There was no commercial serological diagnostic method available in Kashmir region which could be employed to detect pre-slaughter *Cysticercus bovis* cysticercosis in local and transported cattle and huge economic losses could be prevented and also sero epidemiological studies of cattle cysticercosis could be possible with sero diagnostics. This technique was used by Dorny et al. (1999) who conducted the sero-epidemiological study of *Taenia saginata* cysticercosis in Belgium cattle and found 3.09% serum samples were positive in the Ag-ELISA: while by meat inspection on the same animals cysticerci were detected in only three Carcasses (0.26%). The sero-prevalence found in this study was more than 10 times higher than the annual prevalence (0.26%) reported by Institute for
Veterinary Inspection. Echert (1996) in Workshop summary: Food Safety: meat and fish-borne Zoonoses in collaboration with WHO discusses Cysticercosis caused by *Cysticercus bovis* in cattle is still a significant problem in many parts of the world. In some countries, the infection rates of cattle with *C. bovis* have increased, for example under large-scale management conditions, sometimes reaching prevalence rates of about 50%. Jael *et al.* (1996) conducted sero-epidemiological study of *Taenia saginata* cysticercosis to determine the prevalence and distribution of the infection in three provinces of Kenya through serum samples and meat inspection records. They recorded the prevalence of *T. saginata* as 15.96% and 9.97% respectively for meat infection and serological samples. With highest prevalence of cysticercosis for North district as 31.47% and 80.42% of the animals were detected respectively. Only 9.09% of the animals were diagnosed by Ab-ELISA.

Kashmir being an agricultural state where livestock industry acts as a backbone for state economy, huge economic losses may be estimated due to cysticercosis of *C. bovis* in cattle and being a major public health problem. As Pawlowski and Schultz (1972) estimated the losses due to cysticercosis as US $ 25 per animal in developing countries and US $ 75 per animal in industrialized countries. Slonke *et al.* (1973) near Phoenix, AZ. reported an increased incidence of bovine cysticercosis. Approximately 10% of cattle sent to slaughtered from January to April, 1973, were infected with *Cysticercus* stage of *Taenia saginata*. One employer who worked at the feed mill and loaded hay in the feeds was also found to be infected with *T. saginata*. Onyango-Abuje and Harrison (1993)
estimated the loss due to *T. saginata* cysticercosis in cattle in Kenya as Ksh 56 million per annum or Circa £ UK million. Harrison, in his project dated April 1993 to March 1996 explains Tropical developing countries suffer huge losses (1.8 billion US $ in Africa annually) because of *T. saginata* as, current meat inspection methods were not sophisticated enough to identify all infected Carcasses. That makes eradication difficult as infected cattle populations remain undetected. The project develops new tests to identify *T. saginata* in live cattle. A MAb-ELISA antigen detection assay was successfully field-tested and will, after further refinement, accurately detect the parasite and thus allow identification pre-slaughter. This will reduce Carcasses rejection, facilitate exports and consequently boost farmer livelihoods.

These kinds of experimental studied could be excellently employed to devise control model as previously adapted by Wanzala *et al.* (2003) who devised control of *Taenia saginata* by post-mortem examination of Carcasses. The results confirmed that in spite of the time and efforts taken by meat inspectors looking for cysticerci at specified predilection sites of carcasses; this method is insensitive and inaccurate. To effectively improve meat inspection procedures, there is need to increase that area and number of predilection sites observed during inspection and vary them according to the nature of the animals, their husbandry history and the target human population for consumption. In addition, other control approaches such as vaccination, chemotherapy and immunodiagnostics should be developed and implemented to complement meat inspection procedures.
In the present work all the cysts found were considered as *Taenia saginata*, *Cysticercus*. As none of the cysts were recovered from non host experimental animals (n=7) including 3 young goats, 3 young sheep, and one non-infected calf after thorough screening through total slicing technique, so, we concluded from this experimental study that there is no association between goats and sheep with the larval developmental stage (*Cysticercus*) of *Taenia saginata*, and transmission of infection can not be through mutton but only beef being the source for this infection in Kashmir.

Two of the viable cysts of *C. bovis* obtained from the experimental calves which were fed to two human volunteers and the manifestation of symptoms i.e. passage of gravid proglottids were obtained between 85th and 93rd of infection, other symptoms included increased appetite, nausea and abdominal discomforts. These results were in accordance with Shtrom (1938) who proved by an experiment on himself that the separation of mature proglottids begins 91 days after ingestion. According to Shtrom (1938), in 1869 Oliver fed several cysticerci to two people and obtained adults after 12 weeks.

**Viability of *Taenia saginata* eggs in various media and to observe role of local fowl in the dissemination of infection**

The results can be correlated with Pawlowski and Schultz. (1972) as per them the eggs may remain viable for several weeks or months in sewage, in rivers, and on pasture. The results are also in agreement with Burger. (1984) with certain variations i.e., the first two media of NaCl (0.5 \%\%) and dextrose 5 \% have not been
reported till date for influencing viability of *T. saginata* eggs as reported in current study. This experimental study revealed that in spite of minor sewage and sludge treatments there remains every apprehension of infection of locally raised cattle due to *T. saginata* as if only one taeniasis patient exposes his faeces to the field, pasture or water body, thousands of bovines can get infected. This situation has been summarized by saying (Pawlowski and Schultz., 1972) that *T. saginata* is a problem both for poor countries because they are poor, i.e., with comparatively lower standards of hygiene, but it is also a problem for the rich countries because they are rich (and greedy), i.e., their sewage treatment facilities are overtaxed. It is significant to note that eggs have been shown to survive almost all stages of sewage treatment (Burger, 1984). Eggs may remain viable for 71 days in liquid manure, 16 days in city sewage, 33 days in river water and 159 days in open pastures (Jepsen and Roth., 1949). Australian workers, quoted by Seddon (1950), found that the eggs may remain alive on pastures for at least eight weeks and on dry sunny pastures for 14 1/2 weeks. Arundel and Adolph (1980) carried out a preliminary observation on the removal of *Taenia saginata* eggs from sewage using various treatment processes and evaluates by saying “It appears that modern sewage purification methods do not efficiently remove *Taenia saginata* from the final effluent and that prolonged setting is necessary before effluent is used to irrigate cattle pastures if *C. bovis* infection is to be reduced to very low levels.” Gemmel (1986) reported that the eggs of all taenids are sensitive to desiccation and temperature. In temperate zone, such as those where the summer and winter air temperature range from 10°C to 20°C and -20°C to -10°C respectively, survival as measured by infectivity, is in
the order of 100-200 days and >200 days respectively. Comparing our results with above mentioned authors it reveals that in Kashmir being a temperate zone where the weather and topographic conditions favour in longevity of the viability of eggs of *T. saginata*. This is attributed to be a good reason for the infection in cattle, as almost sewage treatment is negligible in this region. So, while devising control measures for *T. saginata* infection in Kashmir, Viability of eggs is to be considered for excellent strategy. The viability of *Taenia saginata* eggs attained in artificial media of Dextrose 5% and 0.9% saline solution under laboratory conditions suggest that in saline solution viability was attained maximum and more than three times than that of Dextrose solution thus evaluating that decomposition had occurred early in all other media other than saline medium where it got deferred due to saline concentration which invariably influenced to the longevity in the viability of eggs.

The viability of eggs demonstrated in experimental fowl by examining their faeces through methylene blue technique revealed that eggs obtained where 100% viable and suggest that birds act as good source for the dissemination of eggs. The idea of checking bird's role in the dissemination of infection struck to us when we were evaluating the drug trial in Kangan, Srinagar and found local fowl playing with *T. saginata* worms as 99% of the people from that area were using dry latrines where there was an easy access of cattle and birds, open defecation was also commonly observed so, birds and cattle being coprophagous animals acted as a good source of disseminator and infection respectively as also observed by
(Silverman and Griffiths, 1955) who found gulls playing role in the dispersal of *T. saginata* eggs.

**Sex wise prevalence in district Baramulla and Srinagar**

Over all in both the districts males were found more infected than females. This was due to the fact, observed in study sites of Baramulla district that males are continuously exposed to beef as n = 97 (48.26% males) were beef steak consumers and n = 23 (11.4%) were beef handlers and n = 11 (5.2%) were traditional cooks where as women were not exposed to beef steaks and usually get infection if poorly cooked beef is consumed by them at home occasionally; while tasting, grinding or kneading, etc or while preparing beef for different delicacies. On the other hand the additional reasons for Srinagar district subjects observed was that due to out door activities of males, they get exposed to infected beef, adapting low standard feeding habits of beef, including semi roasted, raw steaks, partial boiled beef in the forms of beef balls with variable sizes, if the size of beef chunk or balls is considerably big more are the chances of infection especially in case of a special delicacy of Kashmir like (gushtaba, which are boiled meat balls in curd) these kinds of beef preparations are raw from inside and ripe(cooked) from out side. All this they eat because of habit, availability and being cheap, as maximum people were having low socio economic status. Our results which are in agreement and can be justified with observations of Dada and Usman (1980) who found in Sudan and other northern Geneva zones the prevalence of human taeniasis by age and sex and found it prevalent in all the age groups but more prevalent in males and attributed the reason as males by habit eat more “suya” (half grilled beef) than females. They are
more likely to be exposed to *T. saginata* cysts. As for age factor, *Taenia* infection was more common in the age groups above 40 year. Ozcam *et al.* (1990) in Adana, *T. saginata* was noticed in 0.47% of women and 0.54% of men. King (1995) related the cause of *T. saginata* infection in humans with their feeding habits as these include raw steak or kebabs and steak tartare. Saygi *et al.* (1990-91) found in elementary school children, in municipal sanitary workers and meat handlers, *T. saginata* positivity were as 7.9% and 3.1% respectively.

**Prevalence as per age in district Baramulla and Srinagar**

The prevalence of *T. saginata* has been found prevalent in all age groups. However prevalence was found more in above 60 year age group, and the reason found was widespread consumption of beef in various forms, due to profession of beef handling, (butchers, and traditional cooks) and below mentioned reasons of eating improperly cooked beef. Since the number of children in the age group of less than 15 were found more infected (4.43%). The reason found was habit of chewing raw beef, animal fat., an important trend having been found influencing *T. saginata* infection in this area is that many people particularly children and old people were found using their "Kangris" (fire pots) to roast the beef, as the intensity of heat was insufficient to cook and kill *Cysticercus* in the beef, thus in this area this adapted trend may influence in increase of the infection rates. our results can be justified with observations of Sayyari *et al.* (2005) who found prevalence of *T. saginata* infection in the Islamic Republic of Iran with average of 0.2% with no significant variation in the age groups and 0.1% in urban and 0.2% in rural. Dada and Usman (1980) found in Sudan and other northern Geneva zones
the prevalence of human taeniasis by age and sex and found it prevalent in all the age groups. As for age factor, *Taenia* infection was more common in the age groups above 40. Gracey (1981) also suggests, age having no significant effect on prevalence in *T. saginata* infection. Habbari *et al.* (1999) also found that prevalence of Helminthic diseases was not influenced by factors such as sex, age, family size, and the educational level and profession of the parents of the children studied. Similarly, in India, no significant differences between males and females among sewage-farm workers were noted. We conclude by saying every body is susceptible to *T. saginata* infection. However, the habits and behaviour of eating, socio-economic status, profession may influence to the prevalence of this infection.

**Prevalence of *T. saginata* infection rural versus semi urban**

*T. saginata* infections were found endemic in both rural and semi urban subjects of Kashmir but surprisingly varied from 2.22% (rural Baramulla) to 2.36% (semi urban Baramulla) to 3.98% (rural Srinagar). Prevalence found were a little bit more by (0.14%) in semi urban people in Baramulla than rural subjects of same District. The cause found was wide spread consumption of infected beef steaks in semi urban areas where large number of subjects were found exposed and addicted to beefsteaks due to affordability, free availability in local markets, road sites, and local tourist places, and due to low cost and better taste; as most of the beef used in the preparation of beef steaks was from the head region, tongue and skeletal muscles which have been proved to be higher in the concentration of *C. bovis* cysts (Fan *et al.*, 1989; Smith *et al.*, 1991; Hayunga *et al.*, 1991; Kyvsagaard *et al.*, 1991; 1992; Joao Carlos *et al.*, 2002;) and source of beef being locally freely roaming...
coprophagous cattle which are susceptible to infection. However the people living in rural areas may have poor food hygiene, lack sanitary water supplies and latrines and there may be poor/primitive cattle farming causing frequent infection of *T. saginata*. This observation is supported by Japsen and Roth (1952) who reported that despite of high level of sanitation in any country, it still is possible for cattle to be exposed to eggs of this parasite and Mann (1983) who demonstrated life cycle and transmission of the parasite (*Taenia saginata*) occur most commonly in environments characterized by poor sanitation, primitive livestock husbandry practices, and inadequate meat inspection, management and control policies. So, we evaluate by our findings that *Taenia saginata* Taeniasis is a major public health problem for both rural and semi urban subjects of Kashmir region with varying trends in the transmission of this disease. However in purely urban subjects of both Districts and rural verses semi urban subjects of Srinagar District the prevalence could not be recorded due to some technical and scientific difficulties. It is worth to mention here that the overall semi urban verses rural prevalence’s show a significant difference from that of observed prevalence of Baramulla District, as prevalence in rural subjects have been found more than that in semi urban people. Our observations are in accordance to Saygi and Poyraz (1991) who found the difference in *T. saginata* positivity between urban and rural communities. In urban school children, *T. saginata* positivity was 1.2%, whereas this rate in rural children was 6.6%. Sayyari et al. (2005) who found prevalence of *T. saginata* infection in the Islamic Republic of Iran with average of 0.2% with no significant variation in the age groups and 0.1% in urban and 0.2%. Wandra et al. (2006) carried out an
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epidemiological survey of Taeniasis in one semi-urban and two urban villages in three districts of Bali, Indonesia. *T. saginata* prevalence was highly variable among three villages 1.1-27.5% Durmaz et al. (1991), in a city observed 5.6% positivity for *T. Saginata* meat handlers and their families

Comparative age wise prevalence of *T. saginata* in females for Tehsil Kangan and Sonawari.

The overall results reveal that there is no significant difference in the prevalence of *Taenia saginata* infection as per age groups in both recorded districts, so, every age group has been found susceptible to *T. saginata* infection. However the behavior feeding habits, socio-economic status, educational status, profession may influence to the prevalence of this infection. As also supported by WHO (1981) guidelines. The results were also same for both districts of Kashmir in respect of prevalence as per sex and in both the districts males have been found to be more infected than females the reason being same as discussed earlier for both the districts, the age wise prevalence has been found in similar trend for both the districts with their respective sexes. This significant difference is due to the fact that surveyed population of Kangan Srinagar were having low socio economic status and adapting extensive beef consumption with low hygiene and proper cooking. Other important difference found in these two districts was that Yak, deer meat was recorded for having been eaten by the people of Kangan since centuries. As yak and deer both act as an intermediate host for *C. bovis* development (Machulskii, 1941); (Shpilko, 1956); (Safronov, 1960); (Krotov, 1961).
The world health organization (WHO, 1983) has classified the prevalence of *T. saginata* in three different groups: highly endemic countries or regions with their presence in human population above 10%; moderate prevalence with infection rate between 0.1 and 10%; low prevalence with infection rate below 0.1% or total absence of the endemic organism. According to WHO classification, South American countries are included among the moderate prevalence of *T. saginata*. Jael et al. (1996) have disclosed the distribution of *T. saginata* infection as 1-10% worldwide.

In India where there was no conclusive data about the prevalence of *T. saginata* infection and cysticercosis in bovines, the same was true for Kashmir where there was absolutely no data available pertaining to *T. saginata* epidemiology including prevalence. So, current study is pioneering work involving multidimensional approaches of *Taeniasis saginata* in this part of the world. As per WHO (1983) classification the prevalence of this zoonotic disease in Kashmir can be placed under moderate scale and has been found 2.22 and 3.98% in Baramulla and Srinagar Districts respectively. The diagnosis of *Taenia* infected cases were purely made on the morphological and anatomical differences of recovered gravid proglottids from subjects harboring the adult parasite as given in the guidelines of WHO(1983); and adapted by King (1995) who suggested that as *Taenia saginata* are morphologically indistinguishable from *Taenia solium* eggs but specific diagnosis were adapted by the recovery of parasite gravid proglottids which are usually motile and have large number of lateral uterine branches in contrast to *Taenia solium* proglottids. The world wide recorded prevalence of *Taenia saginata*
vary as, Ramsay (1934) reported a prevalence of 10.18% in the plateau due to *Taenia saginata*. Fisk (1939) reported a prevalence of 50% in Northern Nigeria. Arfaa (1972) reported human infection due to *T. saginata* high (14-17%) in many parts of Iran. Collard (1962) reported a prevalence of 2.4% in both the natives and Fulani populations in Katsina province. Froyd (1965) surveyed 42,873 cattle from 18 districts of which 13,392 animals were found to be infected with *C. bovis*, an overall infection rate of 32.05% was recorded. Taeniasis in human was found to be in parallel with *C. bovis* infection in cattle. Plum (1935) reported that two-thirds of the human population was parasitized; only 14% of the cattle were found to have cysticercosis, a rate less than half the average for stock from African areas. WHO (1981) has noted that human behavior may influence the prevalence and intensity of intestinal infection. Cheruiyot (1981) recorded prevalence ranging from 0.74% in the coast province to 18% in Kisii District in Nyanza province. Heisch (1947) found that the Borana and Murille were frequently infected with tape worms. Bachigalupo and Bacigalupo (1950) in Argentina reported interesting observations of the possibility of human infection by *C. bovis* where beef was the staple meat diet. 20% of human taeniasis were caused by *T. saginata* and only 3 cases of *T. solium* were recorded. Meanwhile in 55 cases of human Cysticerciasis, only 4 were identified as *C. bovis* and the others were either *C. cellulosae* or possibly the larval cysts of other types of hooked *Cysticercus*. The authors observed that it was possible to expect a wider distribution of *C. bovis* in man because in 37% of *T. saginata* carriers, oncosphers of this *Taenia* were found in sublingual spaces. Nabiers and Dubrenith (1889) also found some cysticerci of *Taenia saginata*.
Plate 10: Above first four photographs depicting primitive animal husbandry practices with low hygiene thus increasing susceptibility of these cattle to *C. bovis* infection. Last three but one shows the various common delicacies of beef preparations in Kashmir. Last one are the recovered *C. bovis* from animal carcasses.
developed in man. However, we do not agree with the reports of development of meta cestode stage of *T. saginata* (*C. bovis*) in man and suggest that those might be miss identified for species specificity. The infestation of human by ingestion of *T. saginata* eggs is obviously very unlikely. We agree with the observations Japsen and Roth (1952) reported that despite of high level of sanitation in any country, it still is possible for cattle to be exposed to eggs of this parasite. One infected person who defecates in a pasture or cattle-feeding area can quickly infect an entire herd. The use of human faeces as fertilizer can have the same effect. Chandler and Read (1961) discussed that in India, where cattle roam at will; it is common for a cow to follow a person into the woods, in hopes of obtaining a faecal meal due to coprophagous nature. These observations were also common to see in current study sites of Kashmir region where many cattle when freed from their sheds/enclosures in the morning ran to locally situated dry latrines in search of human faeces.

Our findings are also in accordance with Gracey (1981) who recorded the highest incidence in autumn and summer in some European countries. The reason attributed might be the conducive weather for the survival of eggs and easy access of animals to acquire infection with grass and water. The suitable temperature and high humidity during spring and autumn play an important role in the epidemiology of this infection, age having no significant effect on prevalence in this study which suggested that once infected, the animals acquired life-long immunity to super-infection. We also agree with the findings and suggestions of Feachem *et al* (1983) that helminthic infections requiring an intermediate host can be prevented not only by improved excreta disposal practices, but also by proper cooking of beef.
meat and Mann (1983) who demonstrated life cycle and transmission of the parasite (*Taenia saginata*) occur most commonly in environments characterized by poor sanitation, primitive livestock husbandry practices, and inadequate meat inspection, management and control policies. Srivastava and Payday (1986) in India, only 0.9% of sewage farm workers were positive for Taeniasis. Yilmaz *et al.* (1989) noticed that 3.5% of school children had *T. saginata* in E. Lazing. They also found 3.5% positivity in municipal sanitary workers in this city. Pawlowski (1990) documented that *T. saginata* is highly endemic with a prevalence rate exceeding 10% in central and East Africa, New East and Southern Russia. Moderate (below 5%) infection rate occurs in Europe, Southeast Asia and South America. Pawlowski (1990) observed three main patterns of *Taenia saginata* transmission. Endemic, pastoral type characterized by high prevalence in human and bovine cysticercosis due to close spatial and temporal contact between nomadic, pastoral societies and their cattle. Endemic, urbanized type, characterized by small number of urban carriers and moderate bovine cysticercosis. Ramesh *et al.* (1990) performed epidemiological study of parasitic infestation in lower socioeconomic group in Chandigarh (North India) and found prevalence of *Taenia* as 0.8% through stool samples, but have not disclosed the species. Saygi *et al.* (1990) in a study performed with cellophone tape method found that *T. saginata* infestation rate was 7.7% in elementary school children. Saygi *et al.* (1991) in elementary school children, in municipal sanitary workers and meat handlers, *T. saginata* positivity were reported as 7.9% and 3.1% respectively. Habbari *et al.* (1991) reported in Beri Mellal, as in all Morocco, meat is generally well cooked, preventing the population
from acquiring *Taenia saginata*. Lorenz (1992) analyzed the distribution and changes in the incidence of *T. saginata* and found relationship between Taeniasis in humans and cysticercosis in cattle in the district of Halle (Saale). He found that both these infections were parallel to each other in their epidemiological perspective. Schantz *et al.* (1993), WHO (1983), estimates that *Taenia* infections afflicts approximately 50 million people annually and kill 50,000. One may assume all of these deaths to be the result of *T. solium* neurocysticercosis. *Taenia* infection also leads to the death of many cattle and swine and resulting substantial economic losses. The prevalence of *Taenia* is highest in rural areas of Latin American, Asia and Africa, but the parasites are vulnerable to eradication. Current strategies include long and short term interventions developed by the WHO and the Pan American Health Organization based upon the mass treatment of Taeniasis in existing transmission foci. Agridag *et al.* and Dogan *et al.* in 1993 and 1994 found *T. saginata* infestation rates were 9.7% and 0.5% respectively. We agree with Neva (1994) who reported both adult and larvae forms of *Taenia saginata* hazardously affect health of their respective hosts, either directly or indirectly accompanied with severe secondary infections, particularly in human hosts. The occurrence of the larval (*C. bovis*) in cattle musculature cause bovine cysticercosis while the adult worms in human small intestine cause Taeniasis. In humans, the infestation is accompanied with mild symptoms ranging from nausea, abdominal discomfort, epigastric pain, diarrhoea, vitamin deficiency, excessive appetite, weakness and loss of weight to digestive disturbances and intestinal blockage all these pathogenic symptoms were also observed during current epidemiological
study in subjects harbouring the adult worm in addition to this some rare cases in the medical history were encountered in this region due to *Taenia saginata* leading to cholecystectitis and later managed by cholecystectomy during surgery.

Xu *et al.* (1995) in China found prevalence of *T. saginata* as 17.2% and considered one of the most frequent causes of intestinal parasitic infections.

Asci *et al.* (1998) found 679 (2.3%) samples positive for *T. saginata* from a total sample of 25,077 faecal and 5066 cellophane tape preparations. Saygi *et al.* (1991) in epidemiological studies noticed that *T. saginata* positivity reached to 34.2% in women over 15 years old in Sivas where raw meat consumption was common. Putu *et al.* (1999) observed the community prevalence study of Taeniasis and cysticercosis in Bali, Indonesia and found prevalence of *T. saginata* infection upto 5.22%. Habbari *et al.* (1999) also found that prevalence of Helminthic diseases was not influenced by factors such as sex, age, family size, and the educational level and profession of the parents of the children studied. Similarly, in India, no significant differences between males and females among sewage-farm workers were noted. Habbari *et al.* (1999) evaluated that *Taenia saginata* endemic infection is common under European conditions where indirect transmission is the predominant mode. This is largely attributable to sewage. Nancy Malla *et al.* (2000) in a retrospective analysis of various intestinal parasites identified during the past decade reveal prevalence of *Taenia* species infection as 0.02 to 0.12% through fecal samples. Lawlor (2004) described epidemiology is the study on the distribution and determinants of health-related events in specified populations, and the application of this study to the control of health problem Fan (1997) estimated
the annual economic loses caused by *Taenia saginata* taeniasis in East Asia and
discuses while ill health caused by the adult worms in humans give rise to high
medical costs, with a total infestation rate of 2.0% together in bovines, and caused
an annual loss of US $ 428 million. Wanzala et al. (2003), have revealed the
reference of WHO, in the introduction of their work that *Taenia saginata* is a
worldwide zoonotic cestode whose epidemiology is ethnically and culturally
determined with estimates of approximately 50 million cases of infestation world
wide with 50,000 people dying from this problem annually.

Clinton White et al. (2005) discussed the prevalence of *Taenia saginata* in all
countries where raw or undercooked beef is eaten, almost prevalent in sub-Saharan
Collection of Teaching AIDS for international Training Course, in its report say “In
Eastern Africa, prevalence of *T. saginata* is extremely high, up to 100% infection
has been recorded in some groups”. The larval stage of *T. saginata* (*Cysticercus
bovis*) occurs in almost all countries of the world. In European countries, it is said
to be found in 0.25-1.26% of slaughtered animals, however, these figures are based
on meat inspection reports, which may not give an accurate indication of the
prevalence. In general, prevalence of *C. bovis* parallels that of *T. saginata*.

The report also describes the longevity of adults and eggs of *T. saginata* as
viable eggs of *T. saginata* have been found in city sewage after 10 days, in river
water after 33 days, and on pasture after 159 days. While as *T. saginata* larval (*C
bovis*) undergo degeneration and calcification 9-12 months after infection, a small
number may remain viable for considerably longer periods. In East Africa, viable
A. An example of severity of Taeniasis in Kashmir, the rarest of rare case in medical history occurs in this region. A 32 year old male admitted (February, 2007) at Srinagar State Hospital after Cholecystectomy, which was done in emergency, the Gallbladder was found perforated and blocked with adult 2 meter long Taenia saginata worm.

B. Very common and frustrating symptom of T. saginata, gravid proglottids in trousers of a minor child which comes out spontaneously.

C. Largest tape worm of 13 meters during recovered current study

Plate: Showing symptoms complications and adult tape worm respectively
cysts may be found several years after the probable time of infection. There is evidence to suggest that cysticerci may live longer in animals that are infected when newly born.

*Taenia saginata* is a major public health problem having its prevalence between 2.22 to 3.98% and also a significant veterinary problem in Kashmir. It involves social, moral, mental, and physical aspects of life as evaluated after some encountered problems "It is shameful to face the condition when *T. saginata* gravid proglottids migrates to anus, irritates and finally comes out of under clothing causing frustrations". This was narrated by a good number of *T. saginata* patients who consider it a complex problem and notorious disease with perhaps no mortality but full of morbidities.

Local customs have profound effect on infection rates, as in Kashmir region on certain religious and social occasions beef is widely being used and the source of beef being locally raised cattle under primitive and low sanitary conditions. Particularly on Eid (The holiest festival of Muslims world wide) and marriage ceremonies the beef is being prepared in various delicacies and also back yard cookery of beef steaks is being practised. All these infections of taeniasis in Kashmir valley have been recorded in Muslim local population.

In India there may be a high rate of infection among Muslims, where as Hindus who do not eat beef, may be unaffected. This statement in India is supported by Chatterjee (1980). Where as for Muslims the trend is reverse in case of *Taenia solium* taeniasis as, Muslims do not eat; even touch the pork as a rule. So, *T. solium* Taeniasis may exclusively be found in non Muslims. However,
Cysticercosis can break any religious, social and geographic barrier which occurs usually through *Taenia solium* eggs if ingested through water, vegetables, fruits, other food articles or if the faeco-oro route is met by any means, the condition of cysticercosis is fatal particularly Neurocysticercosis (NCC) and is more prevalent in areas where pig population is more and people live in poor sanitary conditions as, many out breaks have been recorded in the recent past. So "people of Kashmir region must be thankful to nature for not having pig population present in this region". Taeniasis is best example among the parasitic diseases of the world which maintains religious barrier for two different species in human population at greater extent. Human infection is highest in areas of the world where beef is a major food and sanitation is deficient. Thus in several developing nations of Africa and South America, for instance, ample opportunity exists for cattle to eat tape worm eggs and for the people to eat a chunk of meat that is cooked in a campfire, charred on the outside and raw on the inside containing live cysticerci which are sufficient to infect a person (beef steak consumer).

The legacy of the tasty past, the local barbecue in Kashmir is flourishing these days. With even youth relishing to satiate their taste buds with the erstwhile tabooed cookouts, local barbecue popularly known in Kashmir as "Seekh Tuj" has not only become a formal addition to local menu but is riding a new employment avenue to more people. Besides the historic places associated with the trade, new places are now sprouting out as the hubs of the trade and has spreaded to every nook and corner of the Kashmir Valley and particularly tourist places and crowded markets. The beef being cheap, tasty and easily available due to local farming is
Photographs showing people busy in buying uninspected beef at two different study sites.

Plate 9: Beef steaks being enjoyed by every passing by, note the smoke with created ambience in surrounding atmosphere while blowing embers with a chunk of blubber on it to attract the people passing nearby.
usually being preferred for the preparation of these steaks, (beef steaks). It is very important to note here that the sellers while blowing embers on which he places a sizeable chunk of blubber to keep the embers aflame and to create appropriate ambience in the surrounding atmosphere. The whiff emanating from the fire makes even dry mouths water. Thus compelling every passing-by to consume the raw steaks. Earlier the trade was identified with a particular low standard people, but now even rich and high standard people have been observed enjoying these beef steaks at roads, shops, and tourist spots. "I shall wonder if this spreading trend in the consumption of raw steaks would not increase the prevalence of T. saginata in this region". As, the beef used for the preparation of these steaks belong to locally raised cattle, which are usually raised under poor sanitation conditions with primitive animal husbandry practices and beef inspection being very far from being practised, as most of the beef being sold in the selected population sites of current study was found infected during our routine inspection at local shops and people waiting in queue to buy this infected beef.

In conclusion, our study indicates that T. saginata has been and is still a public health problem in our region. The preventive approaches to T. saginata infestation is to change eating habits of regional population, especially, raw beef in the form of beef steaks, tasting while preparing various delicacies of beef should be reduced to minimum thus to ensure safety, beef should always be eaten after thorough boiling. The concerned agencies need to take responsibilities of beef inspection and condemnation of infected carcasses and if found low infection in
the carcasses then it should be treated (deep freeze for ten days, boiled for 30
minutes in smaller cuts etc) then should be rendered fit for human consumption.
Other preventive measures include proper / scientific method of cattle rearing, ban
on uncontrolled animal slaughter, proper disposal of human waste, use of human
waste as fertilizer only after complete decomposition. The key aspect of any public
health campaign is, to make people understand the importance of the campaigning
itself. Thus the relevant authorities should concentrate their attention on the aspects
of public awareness and other steps needed to be taken to bring the prevalence of
taeniasis at low levels as researchers we have informed the concerned health
authority of the state for the other remedial measures to be taken at government
level, as there were no records of *T. saginata* taeniasis before current research
study.

**Chemotherapy in diagnosed cases of *Taenia saginata* with Nitazoxanide**

*Taenia saginata* infection is endemic in Kashmir region and due to resistance
against commonly used Taenicides, a good number of subjects had suffered worst
for decades together and were found frustrated multidimensionally and in hopeless
situation, but with the exercise of our efforts by working on drug Nitazoxanide as
an alternative taenicide, it gives us immense pleasure to discuss the results of this
marvellous drug which brought smiles on the face of hundreds of upset people

The present study demonstrated that 3-day course of Nitazoxanide with a
dose of 500mg twice daily for three days in those above 15 years and 20 mg/kg
body weight/day in children aged 5-14 years in resistant cases of *T. saginata* and
cured 69 of 70 cases with cure rate of (98.57%) and a single dose of 15-20 mg/kg body weight was administered in patients who were fresh to chemotherapy and had not taken any taenicides before (n = 225), 221 of 225 were treated with a success rate of (98.22%). The chemotherapy in all the cases was given with food without prior fasting or laxative use.

Nitazoxanide was safe and well tolerated, however adverse events reported by patients were mild and include mild gastritis, nausea and malaise and resolved easily without any treatment. There were no abnormalities in the laboratory parameters [Serum chemistry (liver function tests, glucose, urea, sodium and potassium), haemogram, urine and electrocardiogram].

Our results are in accordance with previous two clinical studies. Rossignol and Maisonneuve (1984) who for the first time in world discovered drug Nitazoxanide and tested it in 22 patients infected with Taenia saginata and 18 infected with Hymenolepis nana. A single 25mg/kg body wt. dose was effective against T. saginata, while twice this dose level (50mg/kg body weight) also as a single dose was required for treating H. nana infection. 21 of 22 patients successfully cured i.e. 95.5% having T. saginata infection and 100% for H. nana. Tolerance of the drug was found good at both dose levels. In this publication Rossignol suggested that “Nitazoxanide” could be an interesting alternative for the treatment of T. saginata and H. nana like cestodes if further clinical trials confirm its safety and effectiveness, which acted as strong stimuli for us to work on this drug as a better alternative taenicide. Clinton and White (2003) evaluated Nitazoxanide, as an important advance in anti-parasitic therapy and a remedy to treat varied parasitic infestations including T. saginata resistant parasitosis.
Elvia Diaz et al. (2003) evaluated overall efficacy of Nitazoxanide with cure rate 84% for the protozoa and 95% for helminthes, with good tolerance and no serious adverse effects. Alain Bricart-See (January 2000) reported treatment of *Enterocytozoon bieneusi* Microsporidiosis in a patient with AIDS with drug Nitazoxanide. Juan et al. (2000) conducted randomized clinical studies to evaluate the efficacy of Nitazoxanide paediatric suspension compared to albendazole in the treatment of ascariasis and trichuriasis and praziquantel in the treatment of hymenolepiasis in children from Cajamarea, Peru. Nitazoxanide was administered at a dose of 100mg (age 1-3 year) a 200 mg (age 4-11 years) twice daily for 3 days Albendazole as a 400 mg single dose and praziquantel as a 25mg/kg single dose. Post treatment parasitological examinations were carried out on 3 faecal samples. Each collected on a different day between 21 and 30 days following initiation of treatment. Nitazoxanide cured 89% (25/28), 89% (16/18) and 82% (32/39) of the cases of ascariasis, trichuriasis and hymenolepiasis respectively compared with 91% (32/35), 58% (11/19) and 96% (47/49) for the comparator drug. Romero Cabello et al. (1997) presented treatment of 5 *Taenia saginata* patients with Nitazoxanide with 100% successful cure rate. Tesfa-Micheal and Tesfa-Yohanues (1990) evaluated effectiveness of praziquantel against *Taenia saginata* infection in Ethiopia all twenty six individuals either harboring one or two worms were successfully treated with a cure rate of 100%. In current study the viability and effectiveness of drug viability was ascertained by methylene blue method similarly as Knaus and Launge (1987) observed the effect of anthelmintics on the viability of *Taenia saginata* oncospheres.

*We conclude that* *T. saginata* infection is endemic and prevalence varies from 2.3 to 4% (moderate) in Kashmir Valley, India. Niclosamide and Praziquantel
are safe and effective drugs for its treatment but therapeutic failures with these drugs are encountered. Nitazoxanide is a broad spectrum anti protozoal agent, with varying results. Nitazoxanide as a taenicide in this current clinical trial, proved effective against Niclosamide and Praziquantel resistant beef tape worm infections with an efficacy rate of 98.5% and for fresh cases, the efficacy was achieved 98.22%, thus suggesting Nitazoxanide is safe, cheapest and better alternative taenicide in the present world. However further clinical trials need to be performed in order to find safety of this drug in pregnant/lactating women and renal failure patients harbouring *Taenia saginata* parasite as were exempted during current drug trial.