POSSIBILITIES FOR BIOCONTROLLING TRICHOSTRONGYLID NEMATODES OF RUMINANTS

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INTRODUCTION

Trichostrongylid nematodes are the main cause of ruminant parasitic gastroenteritis in tropical regions. Reduction of infective larvae in pasture is the main objective of the control measures of these nematodes. It is obtained through deworming animals at strategic times according to the epidemiology of the species for a specific region. In the known control measures, strategic deworming is applied when the environmental conditions are not favorable for the development of eggs and larvae of these nematodes. The objective of these anthelmintic applications is to decrease the adult population in the animals. Consequently, there will be a smaller population of worms present in the gastrointestinal tract of treated animals and a lower number of eggs will be passed to the exterior with the feces. These applications will therefore reduce the larval population in pastures (reviewed by Charles 1992).

Strategic deworming has been successful in decreasing losses due to parasitic gastroenteritis. However, there are real and potential problems associated with constant anthelmintic applications, such as development of nematode resistance to anthelmintics, presence of residues in animal tissue and secretions and the effects of some compounds on non-target organisms in the environment. These problems indicate the need to develop alternatives for worm control in which a minimal number of anthelmintic application should be stressed (Herd et al. 1993, Bjørn 1994, Donald 1994, Prichard 1994, Waller 1994).

TRICHOSTRONGYLID NEMATODES LIFE CYCLE

The various species of trichostrongylid nematodes parasites of ruminants have a similar life cycle which involves a free living and a parasitic phase (Figure 1). The free living phase lasts from the development of eggs deposited at pasture with the feces until the infective stage. The parasitic phase occurs after the infective stage is ingested by the animals with the pasture until it reaches the adult stage in the gastrointestinal tract (for review see Charles 1992).

The development of the infective stages in pasture starts when eggs reach the pasture with the feces of contaminated animals. In the feces, eggs develop into a larvae and hatch in the interior of the fecal deposits. The hatched larvae (first stage) go through two moultings before becoming infective. Hatched larvae and the first moulting larvae (second stage) feed on organic matter in the feces. Third stage larvae (infective larvae) originates after the second moulting, retain the cuticle of the second stage larvae and do not feed.

The development of eggs into infective larvae generally takes from five to seven days. In the Brazilian tropical regions, larvae are generally present in the pasture throughout the year. However, seasonal availability occurs (Honer and Bressan 1992). For example, in most Brazilian tropical regions during the drier months, the availability of infective larvae is lower due to desiccation. As a result, in the drier months, most of the worm population is present in the gastrointestinal tract of the animals. The same happens in Southern Brazil: in the colder months the temperature drops to levels at which the development of eggs and larvae is not possible. In this situation most of the worm population is also in gut of the animals (Honer and Bressan 1992).

After ingestion, infective larvae develop to the adult stage in 21-28 days, depending on the specie. During its development, the infective stage goes through two moultings before reaching the adult stage. Adults, male and female, mate and females start producing eggs. The number of eggs produced by each female is variable and depending on the species can be from hundreds to thousands each day (reviewed by Charles 1992).

It is important to note that each infective larva ingested by a ruminant develops to an adult worm, male or female. Each gravid female produces a large quantity of eggs each day. These eggs go to the pasture with the feces and develop to infective stages if environmental conditions are favorable. Consequently, most of the worm population is present in the environment (Barger et al. 1972).

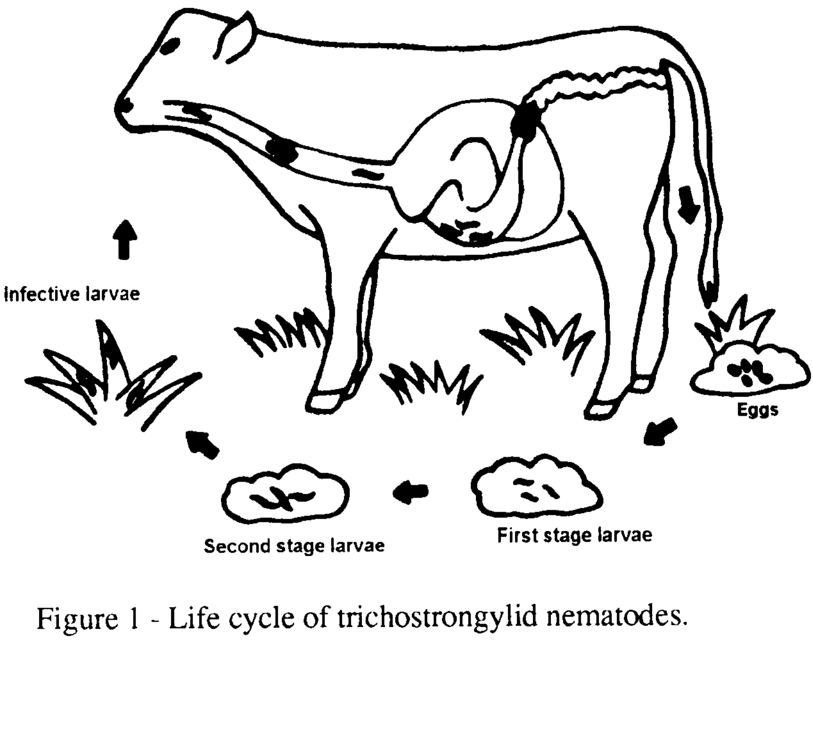

Figure 1 - Life cycle of trichostrongylid nematodes.

FREE LIVING STAGES AS TARGET

FOR BIOLOGICAL CONTROL

During their development in the environment, eggs and larvae are affected by various abiotic hazards such us temperature, desiccation, oxygen tension, soil type, etc. which greatly reduce their numbers (Levine 1963, Kates 1965, Schmidt et al. 1974, Levine 1978, Wharton 1978, Armour 1980). They are also affected by a variety of microorganisms (mites, bacteria, fungi, viruses and other pathological agents) which are present in the environment (Mankau 1980). In the search for alternatives to control gastrointestinal nematodes of ruminants, the identification of microorganisms effective against nematode free living stages in pasture is a promising possibility. These microorganisms would be applied to the pastures or given to animals at a strategic time when a high number of larvae was expected to occur in the pasture. Then, they would act on eggs and larvae, reducing the availability of infective stages through mechanisms which would cause mortality of free living stages, produce mechanical barriers to larval migration or would cause behavioral changes in the larvae.

A useful agent for biological control of trichostrongylid nematode should withstand gastrointestinal tract passage, grow rapidly on fecal deposits in pastures and reduce larval availability efficiently (Waller 1992, Waller and Larsen 1993). Biological agents with these important properties could then be incorporated into feed supplements, mineral salts or blocks or be added to intraruminal release devices bolus. By way of these formulations, the agent could be introduced in large numbers to fecal deposits in the pasture and rapidly control any rise in larval number. In this case, biological formulation would be applied at a strategic time when epidemiology of species in a given region indicates that larval numbers would increase or are in high numbers. Through the action of the biological agent, the number of larvae would then be reduced substantially and, as a consequence, clinical cases would be prevented. However, it is desirable that a small number of larvae persist, to promote the development of naturally acquired immunity in the animals.

Studies on microorganisms aimed at promoting pasture hygiene are being studied in several laboratories. Nematophagous fungi of the genus *Arthrobotrys* and bacteria of the genus *Bacillus* are the main microorganisms studied. Encouraging results with strains of *Bacillus thuringiensis* with larvicidal and ovicidal effects in fecal cultures as well as nematophagous fungi capable of destroying larvae in the fecal pats has been obtained (reviewed by Padilha 1996 and Padilha and Mendoza-de-Gives 1996).

Preliminary results of Brazilian studies are promising. A research program aimed at the identification of microorganisms capable of reducing the infective stage in pasture was initiated in 1990 at EMBRAPA-National Dairy Cattle Research Center. The studies aim at the identification of Brazilian bacteria and fungi. Bacteria studies are centered on the selection of *Bacillus thuringiensis* with ovicidal and larvicidal effects while studies on fungi aim at the identification of tropical species able to rapidly colonize fecal deposits in pastures, selection of species with high nematophagous activity and capable of withstanding gut passage and able to grow and act in a temperature range of up to 35°C. Four strains of *Bacillus thuringiensis kurstaki* have been identified as having ovicidal and/or larvicidal effects. More than 120 nematophagous fungi capable of colonizing bovine fecal pats deposited in *Brachiaria decumbens* pasture in the Mata Region of Minas Gerais State have been isolated. Sampling is being conducted in other regions such as in the Pantanal, South, North and Northeast Brazil. Strains with great nematophagous activity in Petri dishes are being tested on fecal cultures. Selected isolates are then submitted to *in vivo* bioassay.

CONCLUSION

Although results of studies aimed at biocontrolling gastrointestinal parasitic enteritis in ruminants are encouraging, it should not be considered a replacement for classical control based on chemical compounds. Treatment of clinical cases requiring rapid killing of the adult population in the animals have no alternative to anthelmintic. The practical use of biological control to promote pasture hygiene, when available, is most effectively expected to be applied in preventive programs. Before it becomes a reality, several studies need to be conducted. Long term research programs committed to the identification of these microorganisms and development of practical formulations to be used in ruminants kept on pasture should be incentivated.

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