

Review

Effect of nutrition on improving productivity and resistance of ruminants against internal parasites

Khaled Ganghish* and Abdelfettah Mohamed Shirif

Faculty of Veterinary Medicine, University of Tripoli, Tripoli, Libya

Corresponding author*Khaled Ganghish**

Department of Parasitology
Faculty of Veterinary Medicine
University of Tripoli
Tripoli, Libya

E-mail: ganghish@gmail.com

Received: May 30th, 2018

Accepted: August 13th, 2018

Published: August 15th, 2018

Citation

Ganghish K, Shirif AM. Effect of nutrition on improving productivity and resistance of ruminants against internal parasites. *Life Sci Press*. 2018; 2(1): 62-65. doi: 10.28964/LifesciPress-2-109

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ABSTRACT

Parasites are major constraint on animal productivity throughout the world. Ruminant parasites, especially gastrointestinal nematodes, alter food intake and cause a lower use of the absorbed nutrients which in turn decreases survival, live-weight gain, reproduction performance and wool and milk production. The usual mode of control of these gastrointestinal parasites is based on the repeated use of anthelmintics. However, there is a demand on alternative parasite resistance control methods due to the increasing development of resistance to anthelmintics. Among the alternative methods to anthelmintics currently available include the improvement of host nutrition which is important in moderating the severity of pathophysiological effects of ruminant nematode parasites (especially gastrointestinal nematodes).

KEY WORD: Ruminants, Nutrition, Productivity, Internal parasites, Resistance to anthelmintics

INTRODUCTION

A major effect of worms on sheep is to reduce nutrients that sheep would normally use to grow and to produce meat and wool. Parasites, especially gastrointestinal nematodes, can be considered one of the main threats for health and production of cattle.¹⁻⁴ They cause considerable losses in the production mainly in young animals and periparturient females worldwide.¹⁻⁵ The abomasal nematode causing the largest detriment to production is the barber pole worm (*Haemonchus contortus*) which poses particular risk to young animals due to their naïve immune system. Periparturient relaxation of immunity (PPRI) occurs in many mammalian species and plays a key role in small ruminant nematode parasite epidemiology.^{6, 7} It is characterized by increased fecal egg excretion and/or worm burden in periparturient ewes rendering ewes a main source of infection for their lambs. Small ruminants are more likely to have major disease problems with internal parasites but cattle can also be affected, especially calves.⁸

Under-nutrition in energy, protein and minerals/trace elements has all been implicated directly or indirectly in predisposing the animals to parasitic infection.⁹ Improved nutrition (i.e. extra protein intake) of sheep has been known to reduce production (meat and wool) losses and mortality and increase immune response rate against worm infection.¹⁰ Conventional soybean meal and sunflower meal appears to be less effective in reducing parasitism than supplementation with xylose-treated soybean meal.^{6, 11-14}

EFFECT OF PARASITES AND REDUCE PRODUCTIVITY AND RESISTANCE ON HOST

Gastrointestinal nematode infections reduce lamb productivity through anorexia but also through diverting resources to repair damaged tissues.^{15, 16} Ruminant nematode (specially gastrointestinal nematodes) infections cause decreases in survival, live-weight gain, wool and milk production, depressing the appetite, decreasing the digestion, reducing energy retention, increasing nitrogen losses, decreasing absorption of amino acids and reproduction performance.⁹

In the search for sustainable approaches to parasite control it has become clear that there is a strong influence between nutrition and the consequences to ruminants from exposure to gastrointestinal nematodes. Such exposure causes gut inflammation, damage of the cell layers in the gut, leakage of fluid, and an increase of mucus production. The repair cost to the animal can lead to a 50% reduction in growth for the same intake. However, this is not the only mechanism involved in anorexia induced by parasites as a reduction in appetite is also mentioned in sheep parasited by *Fasciola hepatica* and bovines with *Haemonchus placei* which are parasites not located in the small intestine.¹

During late pregnancy and early lactation the resistance of adult ewes to worm infection is usually lost or reduced, resulting in a rise in faecal egg count at the same time as nutrient requirements are increasing, around the time of lambing, particularly the need for extra protein for milk production. As a result, worm eggs from ewes are a major source of worm infection for young lambs.¹⁷ Very young animals are generally more affected by coccidia *Cryptosporidium* and *Giardia* than by gastrointestinal nematodes.^{1, 18} Economic losses are related to a decrease in fertility, in feed intake and in weight gain but also to lower milk production, to more expensive treatments and control methods and to the death of severely parasitized animals.^{1, 19} The nutritive status of the animals can influence their resistance to parasitosis.^{1, 20, 21}

EFFECT OF HOST NUTRITION TO DEVELOPMENT HOST IMMUNITY AGAINST PARASITES

The rapid and dramatic spread of parasitic resistance to anthelmintics as well as concern about their possible detrimental effects on the environment has encouraged researchers to initiate the development of alternative parasite control methods. Since the main method of controlling *Haemonchus contortus* has become relatively ineffective, although the initial field trials have shown potential, to date no vaccine has been developed to successfully prevent haemonchosis.^{22, 23}

Nutrition can influence the development and consequences of parasitism in three different ways: it can increase the ability of the host to overcome the adverse consequences of parasitism; it can increase the ability of the host to contain and overcome the parasitism limiting the establishment, growth rate, fecundity and/or persistence of the parasites population; last of all, it can directly affect the parasites population through the ingestion of natural antiparasitical compounds.^{1, 2}

Nutrition has an important influence on the development and maintenance of immunity in sheep and on its performance, and thus, on the effects of parasites. The reduction of stress by feeding high protein supplements to lambing and lactating ewes has been shown a large reduction in worm burden fecal egg counts, thus eliminating the need for the use of anthelmintics. Withstanding parasite challenge, maintaining immunity, and normal animal performance, is directly related to a high protein intake.¹⁶

Susceptibility of young sheep to worm infections is a major constraint to sheep production. In young worm-infected sheep protein is diverted from muscle and wool growth to fighting the worm infection and repairing the damaged intestine. Research has shown the supplementary feeding of young sheep with a bypass protein and high quality pastures can increase their resistance to worm infection. Examples of bypass protein supplements are cottonseed meal, canola meal and copra meal.¹⁷

In ruminants resistance to both infective larvae and adult nematodes has been associated with the development of acquired immunity and expressed by increasing host ability to reject incoming larvae, to depress worm fecundity and to expel adult worms.^{9, 24} Diets with low phosphorus levels can also reduce immunity to intestinal parasites. Pastures that are not fertilised may have low phosphorus concentrations, especially during months when pasture growth is low. Cobalt deficiency can impair the immune function. sheep and make them more susceptible to worm infection.¹⁰

MINERAL, VITAMIN AND PROTEIN AVAILABILITY TO OPTIMIZE PRODUCTIVITY AND RESISTANCE OF HOST TO PARASITES

Early studies have shown that the administration of copper before the infection with *Haemonchus contortus* and *Ostertagia circumcincta* reduced the establishment of the nematodes by 96 and 56%, respectively, thereby alleviating the parasite infection by reducing the number of egg-laying nematodes in the abomasum.^{1, 19, 25, 26} Other studies have shown that multiple doses of copper oxide wire particles were as effective as levamisole in control of *Haemonchus contortus*.^{25, 27} Vitamin E supplementation of sheep infected with *Haemonchus contortus* resulted in a decrease in abomasal (stomach) worm burden and enhanced the immune response to gastrointestinal nematode infection. However, further investigations into the mechanism of action of vitamin E on parasitic infections are needed.²² Zinc is known to be an essential element that affects the development and integrity of the immune system.^{1, 2, 28}

Past studies reported the use of trace elements, such as selenium which is an important element that affects thyroid activity, immune response, defence muscle damage, reproduction, pregnancy and lactation in animals.^{25, 29} The body uses protein to rebuild tissues that are damaged by internal parasites, and supplementing animals with protein has been shown to improve immune response and overall health.^{6, 30, 31} The development and maintenance of immunity requires protein, energy and minerals in balanced proportions.

Poor nutrition increases vulnerability to pests and diseases. Providing browse or browse paddocks is a good worm control option for goats.^{32, 33} Browse may improve nutrition as well as reducing exposure to infective worm larvae on pasture. Keeping the grass in a more vegetative stage, and tall enough to provide the animal with adequate forage, will provide better nutrition to keep the animal healthier and strengthening the immune system to prevent the adult worms from producing eggs.⁸ The

tannins in the plants have both direct and indirect effects over the gastrointestinal parasites;^{1, 2, 30, 34} reduce the egg count, the adult burden and the fecundity of *Trichostrongylus colubriformis*.^{1, 35} Dietary supplementation of condensed tannins also improved nutrient utilization, productive performance, antioxidant status and immunological (both cell mediated and humoral immunity) response in small ruminants. Therefore, condensed tannins supplementation in the diets of small ruminants may act as natural dewormer without having any residual effect in animal products which is appreciated by consumers.⁶

The net outcome of maize supplementation is to increase the quantity of nutrients for the animals. Part of these nutrients can be used to improve resilience against gastrointestinal nematodes as suggested by other studies in browsing kids and hair sheep lambs.³⁶⁻³⁸ However, a reduction in fecal egg counts or gastrointestinal nematodes burden (resistance) has been less evident.³⁶⁻³⁷ In a four-week indoor trial feeding garlic supplementation to lactating meat goats infected with *Haemonchus contortus* reduced fecal worm-egg count.^{39, 40} Goats prefer shrubs and forages to grass. To reduce infestation from *Haemonchus contortus* goats should consume forages at least 6 inches tall. Also, to break the worm life cycle and prevent re-infestation the pasture should be used for hay cutting after grazing whenever possible.⁴¹ The diet with a supplement rich in omega-3 (fish oil) can influence the cellular mediators of the response to the parasitic infections. In the early age, omega-3 can stimulate a better immune response against the gastrointestinal nematodes. The weight gain in animals that consume omega-3 was greater than that of the controls in some experiments.^{1, 21}

CONCLUSION

Two of the various difficulties animal producers have to face in order to optimize their performance are nutrition and parasites. The resistance of parasites to anthelmintic drugs and the concern about the presence of residues in production animals is leading scientists to look for non-pharmacological means of control. Selenium and copper supplementation increased the total protein and gamma globulin concentrations and decreased the egg per gram and worm burden. Young growing sheep should be given priority access to high quality pasture. If this is not possible, supplement feeds rich in bypass protein could be offered to the sheep during critical period. Additional maternal protein supply from xylose-treated soybean meal based rations reduced the degree PPRI, suggesting that protein source may be an important issue to consider in non-chemical parasite control strategies in small ruminant production systems. Furthermore, improvement of host nutrition (include protein, minerals and vitamins specially vitamin E) is important in moderating the severity of pathophysiological effects of ruminant nematode parasites (especially gastrointestinal nematodes) and also influences rate of recovery from effects following chemotherapy. However, more studies are needed to define anthelmintic resistance, non-chemical alternatives to parasite control, modulation of immunity to parasites by nutritional factor and integrated parasite control strategy.

CONFLICTS OF INTEREST

The authors declare no potential conflict of interests.

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