Research updates in small ruminant parasitology

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Abstract

For years, livestock farmers have relied on the use of anthelmintics as their sole means for controlling helminth infections; however, this strategy has proven to be unsustainable. The current high levels of anthelmintic resistance to multiple drug classes makes it difficult to control parasites using chemical means alone. Furthermore, the lack of new classes of anthelmintic drugs means that the drugs we have now will be all we have for quite a long time. Thus, parasite control needs to be viewed more holistically within an ecological context and practiced in a multi-pronged integrated manner. Here, we review some of the recent literature on parasite control in small ruminants that addresses these issues.

Key words: *Haemonchus contortus*, drug resistance, parasite control, ruminants

Introduction

The animal food production industry is facing the challenge to achieve sustainable, efficient ruminant farming systems in order to meet the growing demands for livestock products.[26] Furthermore, this challenge must be addressed in an increasingly complex scenario shaped by climate change,[21] and widespread anthelmintic resistance.[28] These issues are particularly relevant to small ruminant farms, where losses due to parasitic infections have a great impact on the overall flock health and thus, on the profitability of the system.[18]

For years, farmers have relied on the use of chemical compounds as their sole way to control helminth infections, but this strategy has proven to be ecologically unsustainable and untenable through time.[14] In recent years, new concepts on precision farming[10,12] have gained strength as a means to bring together the main benefits of genetics, nutrition, reproduction, thorough planning, and applied technology in order to maximize the production outcome, a concept that has long been used by the agriculture sector with successful results. Moreover, this approach could improve the flock welfare, reducing susceptibility to infectious diseases in general. In this review we briefly address recent advances in the following parasite control strategies: best practices for parasite control, targeted selective treatment including FAMACHA©, biological control, vaccines, copper oxide wire particles, use of tannin-containing forages, and selective breeding for host resistance. Many of these topics have been reviewed in detail, and the reader is suggested to see these publications for further information.[7,15,25]

Parasite Control Strategies: What is New?

Parasite control can be achieved through different methods: chemical control, general management, and biological strategies. A recent study[17] conducted in the United Kingdom, evaluated commercial sheep farms for 3 years, comparing SCOPS-managed farms (UK's Sustainable Control of Parasites in Sheep; https://www.scops.org.uk/), vs traditional ones. In conclusion, SCOPS managed-farms used less anthelmintic treatments and less frequently, without losing productivity or increasing worm burden in animals. Even so, lambs had higher daily weight gains, taking less time to arrive to greater finish weights. Best practices from the SCOPS program included use of effective quarantine drenching, selective targeted treatments (TST) of adult ewes around lambing or no treatment at all, selective treatment of lambs, avoidance of "drench and move" practices, correct use of anthelmintics depending on resistance status and nematode genera present, and proper delivery of anthelmintics, i.e., dosing by the heaviest animal and calibrating the dosing gun when treating. It is notable that TSTs were done by leaving the 20% heaviest animals without treatment, or based on diagnostics techniques like FAMACHA© or fecal egg counts.

What other strategies have been shown to be effective in recent years? First, regardless of the use of integrated parasite control strategies, effective anthelmintic drugs will still be needed to treat clinical disease, thus there remains a great need for new anthelmintic drugs.[8] However, the newest anthelmintic drugs (monepantel, derquantel), representing new drug classes that are sold as products for the sheep industry in many countries, are not currently approved or marketed in the US. While these new anthelmintics theoretically could be a valuable tool on farms in the US with multiple-drug resistance, it seems unlikely that these products will be approved and marketed in the US in the foreseeable future, if ever. Thus, alternative approaches are necessary. Very recently, a natural biological product containing the nematophagous fungi, *Duddingtonia flagrans*,[a] became available in the US. A recent study using this product including cattle, goats, and horses under different climatic regions in Australia, showed significant reductions in pasture larval contamination that ranged from 53% to 99%.[11] Other studies in sheep using *D. flagrans* (but not the marketed product), report larval reductions varying from 76.6% up to 100%, depending on the dose of spores that animals received per kg of live weight.[9,20,31] Though *D. flagrans* has been proven effective for many years, it was not marketed as a product because of cost-related and ease of delivery-related issues. Though the company has successfully addressed these issues, the product remains expensive since it must be fed daily for relatively long periods of time. Consequently, the cost-benefit of including 1 of these products in an integrated parasite control program needs to be carefully assessed for each farm.

Another alternative treatment is copper oxide wire particles (COWP), which has demonstrated high levels of effectiveness against *Haemonchus contortus* in multiple studies.[3,4,27] COWP can be combined with anthelmintics[6,24] or even with other biological approaches like bioactive forages, for obtaining major benefits.[5] A further strategy is the use of bioactive forages. The most studied of these in the US is the use of the condensed tannin containing plant sericea lespedeza, which has exhibited good activity against gastrointestinal nematodes (GIN) when included in the diet either directly grazed or as hay/pellets.[16,19,22]

Breeding for resistance and even resilience against GIN shows moderate heritability, representing another long-term sustainable approach. Fecal egg counts and FAMACHA scores are methods used to evaluate and select animals, though more information on decision making tools can be attained through the National Sheep Improvement Program[b] (NSIP). Data from Australian and New Zealand sheep farms obtained from the MERINOSELECT[c] database were analyzed, concluding that relatively rapid selection response for worm resistance could be achieved without negative impact on other genetic traits.[2] Moreover, selective breeding of the maternal line could represent a powerful tool to reduce selection pressure for anthelmintic resistance, considering future climate change scenarios.[29]

Some good news in the fight against *H. contortus* is the development of a vaccine[d,23] that is now available in Australia, New Zealand, South Africa, and England. This is the first vaccine that works against a GIN in livestock, and its success is due to a novel alternative strategy. This vaccine uses hidden antigens in the gut of the worm that the sheep immune response typically does not see. However, following vaccination the sheep produce antibodies that are then ingested with the blood meal and attack the gut of the worm. The now marketed vaccine has been shown to reduce fecal egg counts by up to 82% when used in yearling sheep trials.[23] In a vaccination trial conducted in a flock from Louisiana, egg-shedding in vaccinated ewes was reduced by 65%.[13] A study from Brazil concluded that pregnant or lactating ewes that were provided a supplemented diet along with the vaccination protocol received less treatments and showed more resilience to *Haemonchus* infections than the vaccinated group without supplementation.[1] Though this vaccine is reasonably effective, because of its mode of action there is no anamnestic response, and thus multiple doses must be given each grazing season. Additionally, this vaccine uses native proteins, as multiple attempts at making a recombinant version have repeatedly failed. The need for native antigens (extracted directly from worms) means the cost is high and the supply is limited. Consequently, unless researchers can figure out how to make the vaccine effective using recombinant proteins, it seems highly unlikely that this vaccine will ever become available in the US.

Lastly, modelling and forecasting methods are making their way into parasite control. Decision support systems that integrate environmental data along with host-parasite dynamics, while modelling and predicting different scenarios, are now offered mainly in Australia and the UK (e.g. Flyboss, Liceboss, SCOPS' *Nematodirus* alerts, among others).[30] This allows farmers and veterinarians to be made aware of high risk of infection in particular geographical regions and seasons for different parasites, in order to plan accordingly. It is noteworthy that these initiatives in Australia and the UK were supported with significant funding from government sources, a mechanism sorely lacking in the US. Without substantial long-term financial support, these types of initiatives are not possible, thus it is unlikely that similar tools will be available in the US any time soon. Two modelling tools designed specifically for analyzing fecal egg count reduction test data are available on the internet and can be used by veterinarians in the US.

Endnotes

[a] BioWorma®, and Livamol® with BioWorma (International Animal Health Products, Huntingwood, NSW, Australia; https://www.bioworma.com/)

[b] National Sheep Improvement Program (NSIP; http://nsip.org/)

[c] http://www.sheepgenetics.org.au/Breeding-services/MERINOSELECT-Home

[d] Barbervax® (http://barbervax.com.au/)

[e] (http://shiny.math.uzh.ch/user/furrer/shinyas/shiny-eggCounts/; https://mdenwood.shinyapps.io/fecrt_bnb/)

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