Veterinary Parasitology 163 (2009) 229–234

Contents lists available at ScienceDirect

Veterinary Parasitology

journal homepage: www.elsevier.com/locate/vetpar

Parasite control in the age of drug resistance and changing agricultural practices

Marcelo Beltrão Molento *

Laboratório de Doenças Parasitárias, Departamento de Medicina Veterinária, Universidade Federal do Paraná, UFPR. R: dos Funcionários, 1540, Curitiba, PR, CEP: 80.035-050, Brazil

ARTICLE INFO

Keywords:
Parasite control
Anthelmintic resistance
Farm animals
Agroecology and holistic agriculture
Sustainable farming

ABSTRACT

The benefits of using antiparasitic drugs in farm animals are unquestionable. However, despite anthelmintic use as the predominant control strategy, extreme parasite infection cases are appearing in sheep and goat production; these impact productivity and have show mortality rates reaching pre-drug use levels. This was a predictable situation resulting from the loss of efficacy by all available products, particularly when some products were used as the sole intervention. The concepts of agroecology and holistic agriculture, which advocate the use of integrated management strategies, such as target selected treatment, herbal medicine, and the application of other parasite control alternatives, are not completely new, but are undergoing a resurgence because of their more sustainable appeal. The objective of this review article is to examine the problem of parasite control in the face of parasite drug resistance and to outline some strategies that may be used in parasite control programmes. Before they are accepted and recommended by the WAAVP, agroecological methods such as those listed above and described in detail herein should be validated based on scientific evidence of their efficacy for parasite control and should be tested for both host and environmental safety.

1. Introduction

The Green Revolution's objective was to increase food production and economic activity through the use of all available technology with a particular reliance on the use of synthetic chemicals. Although the results have been largely positive, particularly in combating hunger, the overall goals were only partially achieved and the gains have stalled after the initial three decades. However, even in the early stages, the approach was criticized; the classic Silent Spring (Carson, 1962), in conjunction with other works such as The Animal Machines (Harrison, 1964), and Troubled Skies, Troubled Waters: The story of Acid Rain (Luoma, 1980), provided strong cautionary notes that intensive production systems should be revised.

Since the beginning of the Green Revolution the use of synthetic chemicals, including insecticides, parasiticides, herbicides and fungicides, has increased enormously and has fostered a concomitant increase in the production of cereals, forages and animal protein. This, in turn, has produced significant elevation of intrinsic social benefits. The production advantages were most clearly demonstrated in developed countries because of their industrial prowess, but also produced positive impacts in developing countries (Delgado et al., 1999).

The increase in the efficiency of food animal production has arisen from the development and transfer of technologies, particularly in the area of animal health. Among the major constraints on animal production gastrointestinal (GI) parasitism is the single most important cause of production losses in small ruminants. On a global basis, GI

* Tel.: +55 41 3350 5618; fax: +55 41 3350 5623.
E-mail address: molento@ufpr.br.

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doi:10.1016/j.vetpar.2009.06.007

parasitism emerges as the highest global index for animal health constraint to the poor (Perry et al., 2002). Diversity and prevalence of parasites affecting livestock is high in tropical and subtropical countries all year round while damage is most significant in temperate climate areas during the summer pasture turnout. Effects of parasites on animal productivity arise from animal mortality and reduced live weight gains (Barger, 1982). Roger (2008) pointed out that parasites have also an impact on animal welfare of suffering and distress.

Drug use in livestock production systems, particularly intensive ones, has created a buildup of chemicals in the food chain and the environment. In the case of antiparasitic drugs there are only a small number of laboratories assessing their potential impact in the environment (Wardhaugh et al., 2001) and there is controversy. Martin et al. (2003) reported that there was a minor environmental contamination after 16 bovine animals were treated with abamectin twice during a 2-week interval. However, in Brazil, the macrocyclic lactone ivermectin is used in more than 200 thousand animals per month. Given the approximate amount of non-metabolized drug that is excreted via feces (96%), it may be calculated that close to 15 tons of this single compound is being released into the soil and watershed with largely unmeasured impacts. Although this figure is not highly accurate, it gives a meaningful demonstration of their potential adverse environmental effects (Molento, 2004).

There has long been an understanding that the dramatic production responses achieved with modern antiparasiticides were likely to be transitory as their targets were exposed and selected for resistance to these compounds. The high levels of efficacy and large production responses give producers a false impression, which makes them reluctant to adopt other management strategies. Thus, the objective of this article is to examine the problem of parasite control presented by drug resistance and describe some strategies that may be used in more sustainable parasite control programs.

2. Chemical warfare and the genetic selection process

Parasitism is an important limiting factor in livestock production and, although the history of the broad-spectrum anthelmintics started in early 60s with a strong empirical knowledge and superior outcomes, the present situation is not tranquil and it is clearly worsening, with alarming consequences arising from the development of multidrug resistant parasite populations (Yue et al., 2003; Wolstenholme et al., 2004; Hughes et al., 2007). While Geary (2007) pointed out that chemotherapy will continue to provide cures for most of infections and infestations, there is also the need to provide a new set of methods to allow their effect to be extended if we want this to hold true.

Geneticists in all fields have suggested that natural selection is a matter of survival fitness, with a collection of eventually new translated genes. Axelrod and Hamilton (1981) have emphasized that an important trait for a gene, if it wants to continue in the game, is to have a stable evolution strategy, even after being dominant in the population. And it may be explained from other models of population divergence (Price et al., 2003), selection pressure through the continuous usage of antiparasitic compounds would reduce phenotypic plasticity, producing a completely different genetic result in an entirely new population. The shortcoming of this is that even if one stops overexposing or restrict treatment to its lowest, it may be inevitable that drug resistant individuals will be prevalent in the population some day soon, making it almost impossible to return to initial susceptible levels applying the Dollo's Law.

Apart from the direct impact of genetic selection for parasite resistance, there are other constrains, including the cost of medication, extra labor, reduced animal production, and the death of animals. This situation was confirmed where farmers have reported that treatment interval should be as short as 1 week during any tick or worm season (M. Molento, personal information).

3. The need for transition in agricultural systems

Although a difficult task, measuring the impact of drug resistance across all livestock husbandry systems would reveal the extent of the struggle that producers face in order to maintain optimal animal production. Parasite control methods are in a state of crisis in many countries and there is an urgent necessity for significant action. As pointed out by Van Wyk et al. (1997) and Stafford et al. (2007), anthelmintic resistance requires that new strategies for nematode control be developed in order to sustain both the South African and UK sheep industry. We consider that the geographic distribution of this situation is much wider!

Abbott (2003) reported that UK horse owners receive worm control advices from many sources, but rarely from the veterinarian. Molento and Almeida (2004) reported that only 35% of sheep and goat farmers got this information from veterinarians in Brazil; drug treatment was practiced more than 12 times a year and 100% used a short drug-alternation scheme. The importance of drug resistance was evident to 90% of the farmers and they adopted pasture rotation, drug rotation and winter grazing as alternative management strategies to control the spread of parasite infections. Similar surveys performed in many other countries reveal similar opinions regarding the importance of anthelmintic usage and the difficulties in parasite control.

There is sound evidence that preventive/suppressive parasite control depending solely on chemotherapy is no longer a viable option (Mello et al., 2006), and the impact of management under an integrated set of strategies relies on a single question: Are we parasitologists able to develop and disseminate appropriate and reliable methods that may be applicable to most circumstances, while taking into consideration both their benefits and risk factors?

4. Eradication and refugia

Parasite species may be unintentionally driven to extinction through the use of a drug-based suppressive strategy (Le Jambre, 2006). Dash (1986) reported that the elimination of *Oesophagostomum columbianum* was a consequence of the overuse of benzimidazole and leva-