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Prophylaxis of helminths in cattle in Brazil

Profilaxia das helmintoses em bovinos no Brasil

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Abstract
Cattle ranching in Brazil has long been one of the main and most important sectors of the economy. Among the factors that negatively influence the rearing of production animals, the worm disease deserves prominence, because it is one of the most important problems of the Brazilian herd, being responsible for large losses in livestock activity. Worms are caused by helminths of different phyla, classes, genera and species, and can affect several animals, being extremely important in production animals. These parasites can cause losses and great economic losses due to the fall in animal production and costs with its control. The administration of anthelmintics in the correct dosage is of great importance, because its misuse is probably one of the causes that accelerate the emergence of resistant helminth populations. However, when done incorrectly and indiscriminately, it can lead to inefficiency of the drugs because with the wrong management of these drugs there is a selection of resistant parasites. In view of the above, the objective of this literature review was to gather information on ways to control helminthiases and some alternatives that have been studied to improve livestock production systems.
Keywords: Anthelmintics; Helminths; Nematodes.

Resumo
A pecuária de corte no Brasil é há muito tempo um dos principais e mais importantes setores da economia. Em meio aos fatores que influenciam negativamente a criaçao de animais de produçao, a verminose merece destaque, pois é um dos mais importantes problemas do rebanho brasileiro, sendo responsável por grandes perdas na atividade pecuária. A helmintose é causada por helmintos de diferentes filos, classes, gêneros e espécies, e pode acometer diversos animais, sendo extremamente importante em animais de produção. Esses parasitas podem causar prejuízos e grandes perdas econômicas devido à queda na produção animal e custos com o seu controle. É de grande importância a administração do anti-helmíntico na dose correta, pois seu uso de maneira errônea é provavelmente uma das causas que aceleram o aparecimento de populações de helmintos resistentes. Contudo, quando feito de forma incorreta e indiscriminada pode levar a ineficácia dos medicamentos pois com o manejo errôneo dessas drogas ocorre uma seleção de parasitas resistentes. Diante do exposto, o objetivo dessa revisão de literatura foi reunir informações sobre formas de controle das helmintoses e suas algumas alternativas que vem sendo estudadas para melhorar os sistemas de produção na pecuária.
Palavras-chave: Anti-helmínticos; Helmintos; Nematoides.

Resumen
La ganadería de carne en Brasil ha sido durante mucho tiempo uno de los principales y más importantes sectores de la economía. Entre los factores que influyen negativamente en la creación de animales de producción, la verminosis merece ser destacada, ya que es uno de los problemas más importantes del rebaño brasileño, siendo responsable de grandes pérdidas en la actividad ganadera. La helmintiasis es causada por helmintos de diferentes filos, clases, géneros y especies, y puede afectar a varios animales, siendo de suma importancia en los animales de producción. Estos parásitos pueden ocasionar pérdidas y grandes pérdidas económicas debido a la caída de la producción animal y costos con su control. Es muy importante administrar el antihelmíntico en la dosis correcta, ya que su mal uso es probablemente una de las causas que aceleran la aparición de poblaciones de helmintos resistentes. Sin embargo, cuando se hace de manera incorrecta e indiscriminada, puede conducir a la ineficacia de los medicamentos, ya que con el manejo incorrecto de estos medicamentos se produce una selección de parásitos resistentes. Dado lo anterior, el objetivo de esta revisión bibliográfica fue recopilar información sobre las formas de control de helmintos y sus alternativas que han sido estudiadas para mejorar los sistemas de producción en la ganadería.
Palabras clave: Antihelmínticos; Helmintos; Nematodos.

1. Introduction

Beef cattle breeding in Brazil has long been one of the main and most important sectors of the economy. According to the Brazilian Livestock Yearbook, Brazil has approximately 111,057,169 million heads of beef cattle, the second largest commercial herd and one of the largest producers of beef and beef by-products in the world (Anualpec, 2021).

Studies related to nutrition, management, genetics, facilities and sanitation with cattle on pasture were and are frequently performed, however, when it comes to health in confined cattle, specifically in the control of gastrointestinal helminths, there is a lack of research that correlates the performance of confined animals with parasitosis by helminths (Soutello et al., 2002; Pinheiro 1999; Nicolau et al., 2002).

Among the factors that influence negatively, the worm disease deserves attention, because it is one of the most important problems of the Brazilian herd, which affects the production system, being responsible for large losses in livestock activity. In the conditions of central Brazil, it is estimated that animals infected by parasites perform 30 to 70 kg/year lower than animals free of infection (Pinheiro, 1985; Zocoller; et al., 1995; Bianchin, 1996; Soutello et al., 2001). Inefficient control of gastrointestinal nematodes can cause losses of $6,248 million a year (Grisi et al., 2013).

Over time, man has been seeking to know and control helminths and define the best treatment in production animals. The first citation on the use of an anthelmintic was identified in the papyrus of Ebers, dated probably 1550 BC, which reported the use of the infusion of pomegranate bark, Punica granatum, for the treatment of helminths common in ancient Egypt. Before the development of synthetic organic compounds, natural substances such as chenopodium oil, santonin and papain were used in the treatment of helminths. One of the first anthelmintics used was copper sulfate, in 1881, and later, in 1926, carbon tetrachloride for the treatment of liver fluke (Almeida & Aires, 2002).

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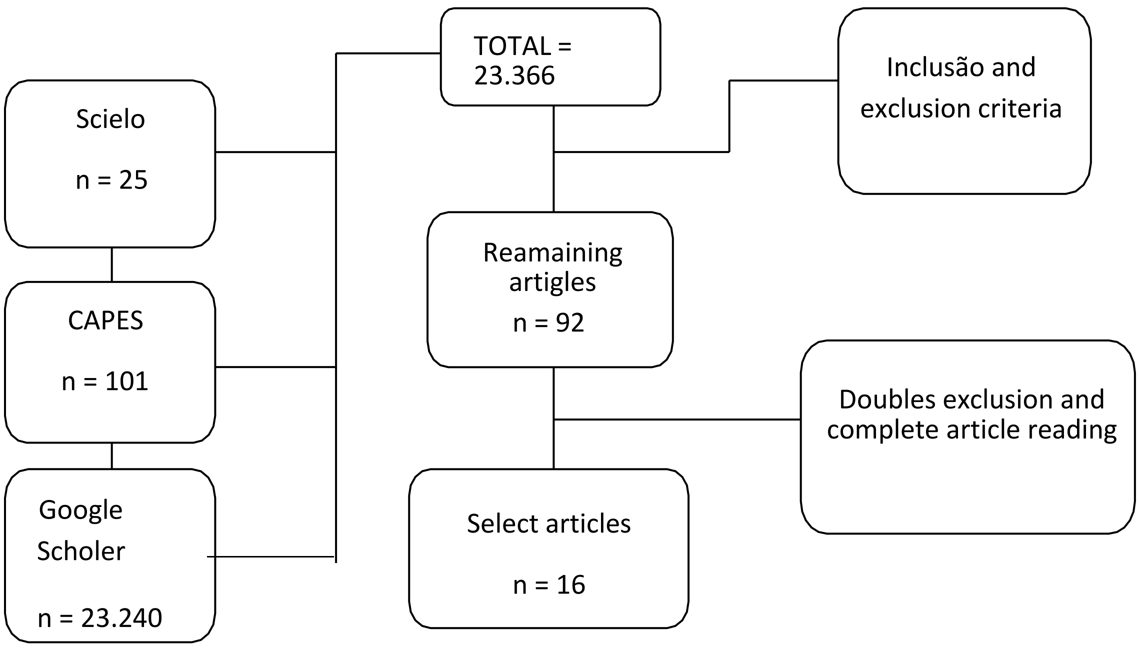
The most common form of parasite control is the use of chemicals developed to obtain maximum efficacy against the sensitivity of the helminths. Due to their applicability and affordability, these drugs have been widely used in recent decades (Leathwick et al., 2001). However, their indiscriminate use has led to a decrease in efficacy due to the selection of resistant parasites (Leathwick et al., 2001; Molento, 2004). Therefore, it is necessary to search for alternative and complementary methods for the treatment of helminthiases.

Therefore, the control of helminths is extremely important for animal production, and the use of anthelmintic drugs is the most widely used way to control parasitism. However, when done incorrectly and indiscriminately, it can lead to inefficiency of the drugs because with the wrong management of these drugs there is a selection of resistant parasites. In view of the above, the objective of this literature review was to gather information on ways to control helminthiases and their control alternatives that have been studied to improve livestock production systems.

2. Methodology

This study is an integrative literature review, aimed at synthesizing the existing knowledge, which allows not only analyzing the studies already built, but also generating openings for new research (Souza et al., 2010). The articles were located by online search engines of the following platforms: Scientific Electronic Library (https://scielo.org); Journal Portal Capes (https://www.periodicos.capes.gov.br) and Google Scholar (http://scholar.google.com) in the period from September 2021 (Figure 1). The keywords used were: bovine anthelmintics; bovine gastrointestinal nematodes; bovine parasite resistance. Once located, the articles were classified according to the date of publication, where the articles published in the last five years (2017 onwards) were classified, aiming to obtain a database of works as updated as possible. We proceeded with the inclusion or exclusion of the paper in the article bank by reading each paper. The inclusion and exclusion criteria were techniques that have been studied in parasite control using anthelmintic drugs and alternative control due to parasite resistance in cattle. After applying the inclusion and exclusion criteria, the final sample was 5 articles.

Figure 1 – Flowchart.



Source: Flowchart regarding the data search.

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3. Results and Discussion

3.1 The Problem of Helminths

Helminthiasis is a disease caused by endoparasites, which cause metabolic alterations in the animal's body, and may cause a drop in performance. The disease is caused by helminths of different phyla, classes, genera and species, and can affect several animals, being extremely important in production animals such as cattle, sheep and horses. These parasites can cause damages and great economic losses due to the fall in animal production and costs to control.

Among the helminths that affect cattle, gastrointestinal nematodes have great prominence, because they are directly linked to reduced productivity in cattle farming. Animals affected by these nematodes may present diarrhea, anemia, lack of appetite, and greater susceptibility to disease. Consequently, it causes weight reduction, lower milk production, reduced feed conversion, lower reproductive performance, lower carcass yield, and lower zootechnical indices in general. Oliveira et al. (2017), surveying data on parasitic diseases in cattle and sheep in southern Brazil, observed that mixed gastrointestinal parasitosis in cattle represent 22.5% of all diseases caused by parasites. In a study with cattle in the northwestern region of the state of São Paulo, it was observed after a period of 18 months, that young animals that did not receive anthelmintic treatment weighed approximately 53kg less than those prophylactically treated with anthelmintics (Soutello, 2002).

Thus, to maintain the performance of the cattle herd is essential to use correct and effective measures of prophylactic control in order to minimize the effects of these parasites, keeping at acceptable levels and compatible with the intensity of the production system of animals (Molento, 2009).

The economic losses from helminthiasis can be higher than 50% in young animals and during the acute phase of the disease (Barger & Southcott, 1978). In addition, the expenses with anthelmintics represent 8% of the Brazilian veterinary market and 36.5% of the revenue of the Animal Health Products Industry (Gennari & Amarante, 2005). Thus, it is essential that correct and effective prophylactic control measures be applied to minimize the negative effects caused by parasitic diseases.

3.2 Anthelmintic Control

The first citation on the use of an anthelmintic was identified in the papyrus of Ebers, probably dating back to 1550 B.C., which described the use of the infusion of the bark of the pomegranate tree, Punica granatum, for the treatment of heltu, a common helminth disease in ancient Egypt. Before the development of synthetic organic compounds, natural substances such as chenopodium oil, santonin and papain were used to treat helminths. One of the first anthelmintics used was copper sulfate, in 1881, and later, in 1926, carbon tetrachloride, for the treatment of Fasciola hepatica (Almeida & Aires, 2002).

In the early twentieth century began the first tests and reports on the use of anthelmintics. The oil of chenopodium was recommended by Thum in 1915 and Woolridge in 1916 for the treatment of worms in horses (Hall, 1918).

Most of the anthelmintics available on the market were developed after 1960. After the discovery of thiobendazole, the first oral benzimidazole anti-helminthic, several other similar drugs belonging to the same group with excellent efficacy against internal parasites appeared. The main characteristic of this group of antihelminthics is their triple action, considering that they act on adult worms, larval forms and eggs of worms (Junior, 1998).

In the early 1980s, with the launch of avermectins, especially ivermectin, there was a revolution in the market for veterinary products for the control of parasites (Geary, 2005). However, with the end of the patent period of this drug, several formulations containing avermectins were released on the market with a reduced price, which resulted in their indiscriminate use and consequently the selection of resistant populations of ecto and endoparasites (Rodrigues, 2007). This form of use of antiparasitic drugs and the lack of knowledge about the epidemiological aspects of the parasitic agent by producers has caused the selection of parasites resistant to the action of drugs used, and may be one of the main health problems of the animal production chain (Paiva et al., 2001).

Until recently, there were only three groups of broad spectrum anthelmintics, benzimidazoles, imidazoles and macrocyclic lactones. A new molecule, called monepantel, was recently developed (Kaminsky et al., 2008) and is already being marketed in Brazil. Another molecule, derquantel, marketed in association with abamectin, was recently launched in some countries (Little et al., 2011).

Table 1 - Mentions some chemical groups of anthelmintics and their respective active ingredients prescribed for cattle.

CHEMICAL GROUP	ACTIVE AGENT
BENZIMIDAZOLES	Albendazole
	Oxfendazole
	Praziquantel
IMIDAZOTHIAZOLES	Lavamisole
ORGANOPHASPHATES	Trichlorfon
SALICYLANILIDES	Clorantel
AMINO ACETONITRILE DERIVATIVES	Monepantel
MACROCYCLIC LACTONES	Ivermectin
	Abamectin
	Doramectin
	Moxidectin
	Eprinomectin

Source: The author herself.

Thus, it is evident that the control of parasitic helminth infections is essential for the success of ruminant production systems and should be based on a good knowledge of the basic epidemiology, regional particularities, management techniques and types of production system (Cezar et al., 2008). It is of great importance to administer the anthelmintic in the correct dose, because its use in an erroneous manner is probably one of the causes that accelerate the appearance of resistant helminth populations. The animals should be weighed before being treated, otherwise there is the risk of the producer under- or overestimating the weight in visual evaluations. Reducing the amount of annual treatments can also be a strategy, because the more frequent the treatments with anthelmintics, the faster the emergence of resistant parasites. Laboratory tests such as egg counts per gram of feces (OPG) to verify if there is a need for the application of anthelmintics can also determine the effectiveness of the drug when performed pre and post treatment (Amarante, 2014).

3.3 Anthelmintic Resistance in Cattle

In Brazil, the intensive use of anthelmintics, incorrect diagnosis and the wrong choice of pharmacological bases have caused a serious problem of gastrointestinal helminth resistance to drugs. This phenomenon is defined as the hereditary ability of a parasite population to reduce its sensitivity to the action of one or more drugs (Fiel et al., 2003). In the early 80's, with the launch of avermectins and ivermectins there was a revolution in the veterinary market. However, with the end of the patent of these drugs, several formulations of avermectins were released on the market with reduced price, which led to the indiscriminate use of these drugs and as a consequence has been selecting resistant populations of gastrointestinal helminths (Rodrigues, 2007).

Acuña and Paiva (2000) identified resistance of gastrointestinal parasites in cattle by performing a field experiment with egg count reduction test (FECRT) for comparison of two commercial formulations: moxidectin and ivermectin, in a study conducted in Caraguatatuba-SP. On the 14th day post-treatment, they verified a reduction of 82.5% in the group treated with ivermectin, while the group treated with moxidectin showed no eggs until the 14th day post-treatment. Later, Mello et al. (2006) evaluated the anthelmintic efficacy of different avermectins in cattle in the municipality of Santa Maria/RS, and found resistance of Trichostrongylus spp. and Cooperia spp. to all formulations.

In a study carried out in 25 rural properties in the northwest region of São Paulo, where the efficiency of ivermectin, moxidectin, albendazole sulfoxide and levamizole phosphate was evaluated, resistance to ivermectin was found in 23 properties out of 25 studied, no cases of moxidectin resistance, 5 cases of albendazole sulfoxide resistance and two cases of levamizole phosphate resistance in the 25 properties studied (Soutello et al., 2007). However, Condi et al. (2009) reported resistance to moxidectin in the state of São Paulo, using the FECRT method, with reduction percentages for the treated group of 88, 85, 88 and 92% after 3, 7, 10 and 14 days of treatment respectively compared to the control group. The predominant genera in the coprological examinations after treatment were Cooperia and Oesophagostomum. In the controlled anthelmintic test, moxidectin was 100% effective against Haemonchus and Trichostrongylus, and 81.4% effective for Trichuris, 65.2% for Cooperia (C. punctata and C. pectinata) and 44.8% for Oesophagostomum radiatum.

Most parasitic nematodes have characteristics for the development of resistance, this was described by Mottier and Lanusse (2001), such as decreased number or affinity of receptors to which the drug binds, modifications of enzyme systems that degrade the drug, structural changes that reduce uptake of the active ingredient, increased enzymatic metabolism or flux. This causes it to compromise the maintenance of refugia and the effectiveness of treatments (Soutello, 2010). Becoming even more important with the launch of several endectocidal products on the market, this drug has actions on several internal parasites of animals (Nascimento, 2003).

The maintenance of refugia, a group of larvae that remain in the pasture without suffering the action of anthelmintic drugs, contributes to the dilution of genes that encode for anthelmintic resistance in the next generations, delaying the selection process (Wolstenholme et al., 2004; Kenyon et al., 2009). Adult parasites or immature stages harbored in untreated animals act as refugia populations, playing an important role in antiparasitic treatments of cattle (Vam Wyk et al., 2006; Molento, 2009). This is due to the fact that the greater the portion of the parasite population exposed to therapeutic or non-therapeutic doses of antiparasitic agents used in the herd, the greater the selection pressure for the survival and proliferation of parasite genotypes with greater resistance to the active ingredients used.

The need for new epidemiology research is feasible, especially in the states of Mato Grosso, Minas Gerais, Goiás, Mato Grosso do Sul and Pará, where the largest herds in the country are located and together account for 54.36% of the national herd (Sidra, 2014). Borges et al. (2013) evaluated 15-month-old Nelore calves, raised extensively, grazing on Brachiaria spp. on a property previously diagnosed with ivermectin resistance. After administration of a drug with efficacy of 81%, it was observed an average daily gain (ADG) of 106 grams/day more than the untreated group, during a period of 112 days.

However, for the realization of these it is necessary to train technicians for the correct identification of the species. Another important factor to emphasize is that in cattle parasitism presents a subclinical evolution, differently from sheep. It can also be said that compounds that present percentages of effectiveness between 50% and 70%, control the adverse effects caused by parasites making the resistance to anthelmintics is diagnosed less easily than in sheep (FAO, 2004).

Because anthelmintic failures are not clinically evident and can be detected only with investigation, the emergence of resistant parasites is underestimated, not only by producers, but also by experts in the field (Prichard, 1994; Waller, 1994). However, once resistance is installed, it will not be reversed even by stopping the use of the anthelmintic class (Martin, 1998); because resistance genes are present in very high frequency in the parasites and this assures them metabolic mechanisms that overcome or avoid the critical or lethal effects of the drug (Gill & Lacey, 1998). However, these losses along with the inefficiency of anthelmintic treatment may be greater in intensive cattle raising systems, either due to lack of consistency in the application or resistance of gastrointestinal nematodes. Thus, it is observed an economic damage of gastrointestinal parasitoses in production animals associated with low expectations for the emergence of new antiparasitic drugs, mainly due to anthelmintic resistance to active ingredients of the group avermectin / milbemicins, benzamidazoles and imidazotiazois, leaving few pharmacological alternatives (Echevarria et al., 1996; Mello et al., 2006; Cezar et al., 2010).

3.4 Phytotherapy

The name Phytotherapy is of Greek origin and means phyto/phyton = plant and therapy/ therapeia = treatment, i.e., it is the use of medicinal plants to prevent, attenuate or cure animal and human diseases (Alves; Silva, 2002).

Therefore, medicinal plants are understood as an alternative used in the treatment of diseases, used as raw material for the industrial production of herbal medicines, aiming to eliminate the problem of microbial contamination, and standardize the amount and form of correct use for consumer safety (Catalan et al., 2012).

Conventional drug residues have a serious impact on the environment and only become apparent after extensive use. In some cases, residues can enter the human food chain and cause public health problems (Padilha et al., 2000).

Many centuries ago, humans used various medicinal plants for the treatment of diseases (Gomes, 2011), including diseases that affected animals. In this way, people learned about the properties intended for healing, and for hundreds of years have been disseminating this knowledge to the new generation (Oliveira et al., 2009).

Phytotherapy can bring enormous benefits to producers, consumers, and the environment. However, even medicinal plants need recommendations because they can intoxicate animals if not taken in the correct dose. In this case, the safety of their use must be scientifically proven. Medicinal plants have been emerging as an alternative to the use of synthetic anthelmintics because they contain phytochemicals with anthelmintic properties, such as saponins, flavonoids, and tannins (Mengistu et al., 2017; Oliveira et al., 2017). In Brazil, research with several plant species with anthelmintic effect showed that only 17% of 106 species were shown to be effective. Among the species studied, 18% of the compounds can be used for the treatment of gastrointestinal nematodes of ruminants (Krychak-furtado, 2006).

Krychak-Furtado (2006), studied 35 plant extracts that were evaluated in vitro against gastrointestinal nematodes of sheep. Of these, 13 extracts showed efficacy higher than 80%: melochia villosa (Melochia villosa), aster (Aster lanceolatus), rice grass (Oryza latifolia), rose hips (Pavonia angustifolia), pitomba (Trichilia pallida), guinea (Petiveria alliacea), jenipap (Genipa americana), tree fern (Dicksonia sellowiana) (dry powder 1 g), D. sellowiana (dry powder 2 g), D. sellowiana (crude extract), D. sellowiana (filtered extract), Pterocaulon interruptum (acetyl fraction) and P. interruptum (crude extract).

In scientific proof of anthelmintic activity of medicinal plants through in vitro and in vivo experimental models, in vitro experiment protocols preferably use egg hatching test and larval development and motility test to analyze the effect of plant extracts or constituents on free-living nematodes or animal parasites (Githiori et al., 2006).

The benefits of phytotherapy in the treatment of diseases of production animals according to Padilha et al. (2000) are, to reduce the cost of treatment and avoid the existence of chemical residues. However, in veterinary medicine, differently from what happens in human medicine, the researches covering phytotherapic products for the control of diseases are little fomented so far.

3.5 Biological Control

Biological control is a term employed to the use of natural antagonists available in the environment, to decrease to a sub-clinical and economically acceptable threshold the population of an agent that causes productive losses to livestock or agricultural activity, besides the purpose in less negative effects on the environment than chemical methods (Graminha et al., 2001; Mota et al., 2003). Biological control provides a viable alternative for the mitigation of strongyloides infective larvae in the environment (Healey et al., 2018; Hernández et al., 2018; Vilela et al., 2018).

Profuse biological agents, nematode antagonists are headed for new studies, such as protozoa, bacteria, viruses, and nematophagous fungi. (Grønvold et al., 1996; Maciel et al., 2006). Among the advantages in the use of nematophagous fungi in biological control, is the synergism in chemical control, which obtains a greater action on the infective forms present in the feces, as well as on the adult helminths that are parasitizing the animal (Ribeiro, 2003; Braga et al., 2008). The introduction of fungi does not seek to annul the use of anthelmintics, but to perform the control in a synergistic way, thus reducing the amount used (Larsen, 1999).

Fungal nematophages as a form of biological control is an alternative to complement the control strategies of gastrointestinal helminths. The dissemination of fungal structures directly in the feces, where egg hatching occurs and larvae become infective (L3), which is one of the ways used for the establishment of biological control of bovine gastrointestinal parasitic nematodes (Paz-Silva et al., 2011). The introduction of these fungi as predatory agents of helminths, and the need for their presence in the fecal bolus of the hosts for the possible reduction of infective forms in this micro-ecosystem and consequently in the pasture. (Braga; Araújo, 2014). Therefore, it must resist passage through the gastrointestinal tract, not harming the environment and in turn a viable production (Gomes,1998). This form of biological control is able to predate the free-living stages of nematodes, resulting in a smaller amount of larvae available in the environment and pastures in which the animals feed and consequently their reinfection (Araújo et al., 2004; Braga et al., 2011).

Nematophagous fungi inhabit the soil, where they closely coexist with a wide variety of individuals of many populations. Such a relationship has triggered an extraordinary adaptation process, and different eco-biological associations with other microorganisms have been established (Mendoza-de Gives et al., 2022). The main studies with fungi have focused on predatory species belonging to the genera Dunddingtonia, Arthrobotrys and Monacrosporium (Larsen 2000).

By effect on the larvae, these fungi are distributed into three groups: the endoparasitic fungi that have a penetrating action on the cuticle or being ingested by the hosts, and in their interior develop vegetative hyphae that drain the internal constituents (Nordbring-Hertz et al., 2006). Opportunistic fungi or ovicides that colonize eggs and their developing larvae, penetrate through the shell through tiny pores. Consequently, the development of hyphae takes place internally, making the shell impermeable (Braga; Araújo, 2014). Predatory fungi are the most tested for nematodes that parasitize farm animals. They produce a series of traps such as three-dimensional adhesive nets, buttons, hyphae, constrictor and non-constrictor rings along the mycelium to seize the nematodes. If under circumstance it captures a nematode, it will have its cuticle penetrated and its internal contents digested by the hyphae developed inside (Braga; Araújo, 2014).

Among the fungi studied, the predator Dunddingtonia flagrans stands out, by virtue of its conidia and mycelial masses are able to cross the gastrointestinal tract of animals, there is a supremacy of chlamydospores in maintaining nematophagous activity (Larsen et al., 1992; Waghorn et al., 2003). The effectiveness of the fungus has been substantially by oral administration of pellets. This formulation has proven effective, both economically and biologically, by providing protection and preventing these organisms from spreading in the environment (Braga; Araújo, 2014).

Thus, biological control with nematophagous fungi can be employed to decrease populations of nematode helminths, since these are their natural antagonists. And its advantages are due to the synergism in chemical control, which obtains a greater action on the infective forms present in the feces, as well as on the adult helminths that are parasitizing the animal (Ribeiro, 2003; Braga et al., 2008).

3.6 Nutritional Handling

Infections by helminths in the herd can usually be resolved in a brief manner through treatment with anthelmintics (Cesar; et al., 2008). Gomes (2010) states that, due to the fact that anthelmintics alter the mechanisms of natural immunity, in addition to the costs, their use may not always solve the problems caused by helminths. Therefore, it is necessary to use other means to try to recover animals affected by gastrointestinal worms. Through the use of preventive measures to help in the control of helminths, the protein supplementation appeared, which has the function of offering nutritional contribution, obtaining, consequently, a range of improvements in the immunity of animals.

The use of protein supplementation can be effective in reducing the amount of parasites in the animals, however, it has a low effect in establishing parasite reinfection (Barger; et al., 1996). Roberts & Adams (1990) also confirmed that egg counts decreased in the feces of animals treated with a higher amount of protein and animals that had a lower amount increased the parasite load.

According to Knox and Steel (1999) and Veloso et al. (2004), the use of supplements in the diet of animals can ensure improvements in nutritional intake, and thereby increase the ability of animals to resist infection. Another advantage is to help reduce the number of OPG (Kyriazakis; Houdijk, 2006).

Thus, a good nutritional management is essential to achieve the best productivity (Pérez; Gerassev, 2002) and through the use of supplementation associated with anthelmintics, bring benefits to animals, since the reduction in stress, the improvement in immunity and as a consequence, the increase in weight gain of animals.

3.7 Selection of Resistant Animals

The use of conventional methods for the control and prophylaxis of helminths has become a major obstacle in animal production, given the ineffectiveness and resistance of most anthelmintic drugs currently available on the market. According to Li et al. (2012), there is a promising search for alternatives for parasite control and reduction of antiparasitic use, such as the selection of resistant animals and by the diversity of the host genome (Sonstergard; Gasbarre, 2001).

Within a group of animals, regardless of their breed, even if they are not designated for parasite resistance, there are about 10 to 20% of animals that are considered "naturally resistant". That is, these are animals that would not need or would need very little anthelmintics for parasite control.

According to Barger (1989), the selection of resistant animals results in a decrease of about 80 to 90% in the parasite load, when compared to herds that have not been subject to selection. According to the selection of resistant animals, it is known that this selection can significantly decrease the seasonal peaks of the parasite load, as well as the number of larvae in pastures. By using parasitism resistant animals, there is a low amount of eggs, causing a reduction in the contamination of pastures by L3. In addition, an animal with a high parasite load of a particular parasite species tends to host more of the other species of parasites (Stear et al., 1998; Amarante et al., 2004).

The ability of an individual to obtain autoimmunity and express resistance varies greatly between and among species, proving to be a genetic control, proven in a range of studies using OPG as an examiner parameter (Gasbarre et al., 2001).

3.8 Selection Forms

For a long time, genes were known to be solely responsible for passing on characteristics from one generation to the next. It is certainly believed that resistance is related to the inheritance of genes or genomic loci that, through the expression of molecules, regulate host immunity with the main function of limiting and controlling pathology (Li et al., 2012).

Recently, the search for new molecular markers has been studied, such as epigenetics. Its definition is described by Fantappie (2013), in which he defines it as "capable of generating modifications in the genome that besides altering the DNA sequence, and are characteristic inheritable by subsequent generations."

Epigenetics is characterized as the study of the molecules that through modulation, express genes to result in a certain phenotype (Krepischi; et al., 2019). As such, resistance is believed to depend on a range of genes, antibodies, and cytokines (Tizard, 2009) being an heritable attribute (Gasbarre; et al., 2001; Fraga et al., 2003; Gupta; et al., 2015).

Thus, selecting resistant animals can be highly advantageous (Biegelmeyer et al., 2012), since resistance is an inheritable trait (Amarante, 2004) and thus a significant decrease in seasonal peaks in parasite load and reduction of larvae in pastures after selection (Pacheco, 2015).

4. Conclusion

The use of anthelmintics as an exclusive control tool has its future compromised also by the lack of prospects for development of new molecules with antiparasitic properties. Therefore, it is of great importance to adopt measures to extend the useful life of the drugs available on the market, controlling resistance in order to diagnose it, even when present in small proportion in the parasite population.

Strategies to slow the process of resistance selection and control resistant strains, usually aggregating minimal chemical treatments, seeking to maximize the effectiveness of the drug and, if possible, list a slow alternation of drugs seeking to limit the contact of the host with the parasite, manipulating the grazing environment.

Therefore, use integrated forms of helminth control, minimizing the use of drugs, using them as one of the available tools and not the only one.

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