EFFICACY OF GARLIC AS AN ANTHELMINTIC IN ADULT BOER GOATS

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Abstract — The goal of this study was to evaluate the effectiveness of garlic (*Allium sativum* L.) for controlling gastrointestinal parasites in adult female Boer goats. The impact of garlic treatment in goats naturally infected with *Haemonchus contortus* and Coccidia was evaluated by measuring fecal egg counts, packed cell volume, FAMACHA scores, and body weight. Goats were exposed to four dosage levels of concentrated (99.3%) garlic juice (2.5 ml, 5 ml, and 10 ml) during four weeks. There was a significant decrease in fecal counts of Coccidia eggs in goats treated with 10 ml of garlic juice (group 4; $p<0.05$). Garlic extract did not reduce fecal egg counts or alleviate anemia associated with *H. contortus* infection at the concentrations tested ($p>0.05$). However, at the intermediate dose of garlic (5 ml), goat body weight was significantly increased (group 3; $p<0.05$). Packed cell volume and FAMACHA scores did not show significant changes. These studies have implications for the control of Coccidia in goats. Garlic extract contributes to the alleviation of gastrointestinal infections in goats by reducing the Coccidia burden and may enhance animal performance in adult goats.

Key words: Boer goats, garlic extract, Coccidia, *Haemonchus contortus*

INTRODUCTION

Infection by gastrointestinal parasites in sheep and goats can result in severe losses. Production losses result from decreased utilization of feeds and in severe cases from death. Goats have numerous internal parasites; two of the most important are the protozoan Coccidia (Dai et al., 2006) and the nematode *Haemonchus contortus* (Waller, 2004). *Haemonchus contortus* is a blood-sucking nematode of the abomasum in small ruminants. It is responsible for extensive losses and huge animal welfare problems globally. Haemonchiasis is associated with clinical and pathological manifestations that include hemorrhagic anemia, hypoprotein anemia, and parasitic gastroenteritis (Ahmed and Ansari, 1989; Albers et al., 1990). The continuous indiscriminate use of anthelmintic drugs has caused a growing problem of parasite resistance to conventional treatments (Jackson and Coop, 2000; Mortensen et al., 2003). Plant essential oils (and/or active components) can

be used as alternatives or adjuncts to current anthelmintics (Anthony et al., 2005).

At least nine different species of *Eimeria* can cause coccidiosis in goats, but some cause much more damage than others (Dai et al., 2006). Although a high percentage of adult animals may be infected, only a small percentage of them become sick. However, coccidiosis is one of the most important diseases of kids and can be responsible for reduced animal performance and death (Dai et al., 2006). Coccidia only cause disease when their numbers become so great that pathological damage is done to the host. The inclusion of essential oil blends has been reported to reduce levels of Coccidia in broilers (Oviedo-Rondón et al., 2006).

Garlic (*Allium sativum*) has been reported to be a parasiticide, amebicide, acarifuge, vermifuge, larvicide, fungicide, and immuno-stimulant besides other properties (Duke, 2002). In Chinese herbal medicine, garlic is used to prevent influenza, relieve

toxicities, and kill parasites such as roundworms and tapeworms (Bensky and Gamble, 1993). Garlic oil has a broad-antimicrobial spectrum; as it has antibacterial, antifungal, antiviral, and antiparasitic effects. Further, it influences the growth of at least 12 different human and nonhuman parasites and has immunomodulatory activity (Anthony et al., 2005).

Garlic has been used to treat animals that suffer from gastrointestinal parasitism (Guarrera, 1999). Studies from organic sheep producers in the US reported the use of garlic as a viable alternative to commercial anthelmintics (Noon, 2003). Availability, improved animal health, and comparable cost to commercial preparations are cited as attributes that make garlic attractive to producers. An anthelmintic effect of garlic in mice has been patented (Erol et al., 2008). Other studies did not report any effect of garlic for the control of nematodes in donkeys (Sutton and Haik, 1999). The efficacy of garlic on Coccidia infections has been reported in rabbits (Toulah and Al-Rawi, 2007). However, studies also indicate that chronic and excessive intake of garlic may cause less desirable effects, such as anemia (Umar et al., 1998).

The goal of this study was to evaluate the effectiveness of garlic for controlling gastrointestinal parasites in adult female Boer goats. The specific objectives were to assess the effect of an organically approved garlic extract on fecal egg count, body weight, FAMACHA scores, and packed cell volume in goats that were naturally infected with *Haemonchus contortus* and Coccidia.

MATERIALS AND METHODS

Boer goats were housed at the North Carolina Agricultural and Technical State University farm in Greensboro, NC. The goats were placed in pens in a barn with a sand rock floor. Wood shavings were applied over the ground as an isolation material. Each pen had its own feeder and watering system. The goats were fed a basal diet from Southern States (SSC – 31-911800 Goat Feed, 17% crude protein). Clean water was available ad libitum to the animals at all times. The animals were sheltered in a barn during the evening hours and let out to pasture during the day. Twenty adult female Boer goats weigh-

ing ~40 kg were randomly assigned to four homogenous treatment groups of five animals.

Treatment of animals with garlic juice

An organically approved garlic barrier (Organic Materials Review Institute) in the form of concentrated garlic juice (99.3% pure) was obtained from Garlic Research Labs Inc. (Glendale, CA). Treatments and drench were prepared in the following manner: group 1, untreated goats, which were drenched with 1 oz of sterile distilled water; group 2 received garlic juice concentrate at a rate of 2.5 ml diluted in sterile distilled water to make a 1-oz solution; group 3 received garlic juice concentrate at a rate of 5 ml diluted in sterile distilled water to make a 1-oz dose; and group 4 received garlic juice concentrate at a rate of 10 ml diluted in sterile distilled water to make a 1-oz dose. After taking fecal and blood samples, and weighing the goats, treatments were administered as a drench.

Sample collection

Following drenching, body weight was measured and fecal and blood samples were collected once a week over a four-week period. Fecal samples were collected from the rectum of the animals. Aliquots of two grams of the fecal sample from each goat were used for laboratory analysis. Blood samples were collected once a week by drawing 10 ml of blood per goat from the jugular vein. Blood samples per goat were collected in test tubes containing 0.1 ml of acid citrate dextrose to prevent blood coagulation.

FAMACHA® scores, body weight and packed cell volume

Color of the ocular mucous membranes was scored using FAMACHA® cards (SSCRP.org) weekly. Scores of 1=optimal, 2=acceptable, 3=borderline, 4=dangerous, and 5=fatal were used to evaluate color. Body weights of animals were taken using a standard chute scale.

To determine the packed cell volume, an aliquot of blood with anticoagulant from each goat was collected in micro-capillary tubes and then centrifuged for 10 min at 14,000 rpm in an IEC MB Micro

Hematocrit centrifuge (Damon/IEC Division). After centrifugation, samples were analyzed for packed cell volume (%) using a micro-capillary reader (Damon/IEC Division).

Fecal egg count

Fecal samples were analyzed on the day of collection for eggs per gram of feces. Fecal aliquots were weighed to two grams. The fecal samples were analyzed using a modified McMaster technique (Paracount-EPG™, 1984). Slides were read using an Olympus B 201 microscope (Optical Elements Corporation) at 10x magnification. The egg count was focused to determine the presence of *Haemonchus contortus* and Coccidia. The number of eggs counted on the McMaster slide was multiplied by 50 to get the parasite eggs per gram of feces for each animal.

Statistical analysis

Two-way (treatment and date) analysis of variance using SAS (SAS Institute Inc., 1985) was used to analyze body weight, fecal egg count, and packed cell volume. Statistical significance was determined using $p < 0.05$. Dunnett's method was used with the GLM procedure to compare between the control effect (group 1) and the effect of each treatment (groups 2, 3, and 4) to determine the response to garlic extract. Correlations between body weight, fecal egg count, and packed cell volume were also checked.

RESULTS

Variation was observed in fecal counts of *H. contortus* and Coccidia eggs by weeks and groups (Tables 1 and 2). Eggs per gram of feces for *H. contortus* decreased in the first three weeks in all treated groups; the greatest reduction was observed in week II. However, statistical analysis showed no significant difference between treated and untreated goats ($p > 0.05$; Table 1). Goats are infected with mixed species of nematodes, and it is important to study possible other targets of garlic in light of its reported anti-nematode activities in mice (Erol et al., 2008).

A significant decrease in the numbers of Coccidia was observed in goats from group 4, which received the highest dose (10 ml) of garlic extract, compared to the control group ($p < 0.05$; Table 2). No significant effect of garlic on fecal egg count was observed among the groups; eggs per gram of feces decreased in all weeks during the first three weeks

Table 1. *Haemonchus contortus* fecal egg counts in goats treated with different concentrations of garlic extract. The results are expressed as means ± S.E. of n = 5; Results presented in eggs per gram of feces; p>0.05.

Animal groups	Treated doses (ml)	Before treatment	After treatment (weeks)			
		Control	I	II	III	IV
Group 1	0	1818.8±935.7	1075.0±686.3	1625.0±923.2	1237.5±494.2	1612.5±811.2
Group 2	2.5	2946.7±873.1	2575.0±1406.9	837.5±300.2	987.5±197.2	587.5±229.4
Group 3	5.0	2109.8±601.1	1237.5±379.9	687.5±201.4	650.0±196.8	1962.5±837.2
Group 4	10.0	1226.8±511.8	962.5±534.7	550.0±252.4	1162.5±517.3	950.0±173.2

Table 2. Coccidia fecal egg counts in goats treated with different concentrations of garlic extract. The results are expressed as means ± S.E. of n = 5; Results presented in eggs per gram of feces; *p<0.05, compared with the control group.

Animal groups	Treated doses (ml)	Before treatment	After treatment (weeks)			
		Control	I	II	III	IV
Group 1	0	121.3±61.0	525.0±245.4	287.5±162.5	162.5±82.6	425.0±171.4
Group 2	2.5	387.0±175.1	350.0±125.8	300.0±73.6	466.6±128.3	266.7±118.1
Group 3	5.0	217.5±72.5	312.5±89.8	325.0±131.5	175.0±59.5	766.7±218.4
Group 4	10.0	727.5±270.0[*]	1025.0±480.6[*]	775.0±385.4[*]	112.5±23.9[*]	250.0±90.1[*]

Table 3. Changes of animal body weight in goats treated with different concentrations of garlic extract. The results are expressed as means ± S.E. of n = 5; Results presented in kg; *p<0.05, compared with the control group.

Animal groups	Treated doses (ml)	Before treatment	After treatment (weeks)		
		Control	I		IV
Group 1	0	48.9±5.5	45.9±9.7		50.8±8.3
Group 2	2.5	45.0±6.4	44.7±9.8		48.6±4.9
Group 3	5.0	52.8±9.3*	53.4±3.5*		55.5±4.8*
Group 4	10.0	44.4±3.2	48.0±6.0		47.7±5.5

Table 4. Changes of FAMACHA scores in goats treated with different concentrations of garlic extract during the experiment. The results are expressed as means ± S.E. of n = 5; Results presented as scores; p>0.05.

Animal groups	Treated doses (ml)	Before treatment	After treatment (weeks)			
		Control	I	II	III	IV
Group 1	0	2.5±0.58	2.3±0.50	2.25±0.96	2.25±0.50	2.3±0.96
Group 2	2.5	2.8±0.50	3.3±0.50	2.5±0.58	2.5±0.58	2.8±0.50
Group 3	5.0	1.5±0.58	2.5±0.58	2.25±0.96	2.0±0.82	2.3±0.96
Group 4	10.0	2.35±0.50	2.3±0.50	3.0±0.82	2.8±1.26	2.8±0.50

Table 5. Changes of packed cell volume in goats treated with different concentrations of garlic extract during the experiment. The results are expressed as means ± S.E. of n = 5; Results presented in %; p>0.05.

Animal groups	Treated doses (ml)	Before treatment	After treatment (weeks)			
		Control	I	II	III	IV
Group 1	0	25.5±5.6	22.0±2.0	23.3±3.9	22.8±2.9	22.8±3.2
Group 2	2.5	25.7±3.8	22.7±2.1	22.7±2.5	23.3±1.5	24.3±2.9
Group 3	5.0	23.8±2.8	23.3±1.7	23.3±3.9	20.5±5.1	22.3±4.6
Group 4	10.0	21.8±6.9	22.5±4.5	22.3±5.3	20.8±7.1	21.0±5.9

and subsequently increased when compared to the control (p>0.05). All goats probably are infected with Coccidia at some stage of their life, but only a small percentage of them actually become ill. Even so, coccidiosis is one of the most important diseases of kids and can be responsible for diarrhea, weight loss, and even death. The development of clinical coccidiosis in goats is considerably dependent on the species involved (Dai et al., 2006). It is important to define the spectrum of activity of garlic in light of the reported diversity of Coccidia species infecting goats (Norton, 1986).

Table 3 shows the effects of treatment on body weight measurements. Weekly body weight mea-surements were not statistically different over time. In all groups of animals, body weights were increased by the end of the study (IV week). Statistically, there was a significant difference between the body weight of animals in group 3, which received 5 ml of garlic extract, and the control group (55.5 vs. 52.8 kg; p<0.05), but none between other treatments. Animals in group 3 were heavier than all other groups and the weights remained high throughout the study. In human studies, the use of garlic is associated with decreases in body weight (Kim et al., 2007). The effect in goats may be species-specific and needs further study.

Garlic did not have a significant effect on packed

cell volume: all groups varied within the natural range for goats. Packed cell volume values are directly related to anemia, which is an important tool in the diagnosis of parasitic infections (Vatta et al., 2002). Low packed cell volume may be indicative of anemia, which is correlated with high fecal egg count and parasite burdens associated with *Haemonchus contortus* infection (Pandey, 1999).

Statistically, there was no significant difference between the FAMACHA scores of animals in different groups. The FAMACHA system, which is a useful tool for identifying anemic sheep and goats, helps reduce the use of dewormers (Kaplan et al., 2004). In this study, neither packed cell volume nor FAMACHA results indicated anemia. Increased incidence of anemia in response to garlic doses was not observed in goats.

The results of this study showed that concentrated garlic extract at certain doses may be useful for controlling coccidiosis in the animals. The doses of garlic extract used did not cause anemia in goats. An anthelmintic effect of garlic was not observed. Further, the use of garlic extract may be an additional or substitute management approach to control Coccidia numbers in conventional and organic goat production.

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ЕФЕКАТ БЕЛОГ ЛУКА КАО АНТИХЕЛМИНТИКА КОД АДУЛТА БУРСКИХ КОЗА

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Циљ ових истраживања је проучавање ефикасности белог лука (*Allium sativum* L.) у контролисању гастро-интестиналних паразита код адулта женки бурских коза. Антихелминтски утицај белог лука на природно инфициране козе са *Haemonchus contortus* и Coccidia је одређиван на основу броја јаја у екскрементима, хематокрита, резултата FAMAHA теста и тежине тела. Козе су третиране са 2.5, 5.0 и 10.0 ml концентрованог сока белог лука. Резултати су показали да је третманом са 10.0 ml екстракта белог лука смањен број јаја Coccidia, док је третман са 5.0 ml утицао на повећање телесне тежине. Међутим, није забележен ефекат екстракта белог лука на број јаја *Haemonchus contortus* и друге праћене параметре. Ова проучавања су показала да се екстракт белог лука може користити за редукцију броја Coccidia и за побољшање здравственог стања животиња.