IOSR Journal Of Pharmacy and Biological Sciences (IOSR-JPBS)
e-ISSN:2278-3008, p-ISSN:2319-7676. Volume 20, Issue 5 Ser. 2 (Sept. – Oct. 2025), PP 35-41
www.Iosrjournals.Org

Anthelmintic Efficacy And Zootechnical Effects Of Albizia Adianthifolia In Sheep Infected With Haemonchus Contortus

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Abstract
Background : *Gastrointestinal nematode infestations represent a major constraint in small ruminant production, leading to significant economic losses and reduced productivity. The repeated use of synthetic anthelmintics fosters the emergence of drug resistance and raises environmental and health concerns. In this context, bioactive local plants such as Albizia adianthifolia are being explored as sustainable alternatives for parasite control.*
Methods : *Leaves of Albizia adianthifolia were harvested, dried, and used to prepare a hydro-methanolic extract. The biological trial was conducted on 11 lambs (Ovis ovis), aged 8–10 months, naturally infected with Haemonchus contortus. The efficacy of the extract was assessed by monitoring fecal egg counts (FEC) before and after treatment.*
Results : *The hydro-methanolic extract of Albizia adianthifolia induced a significant reduction in FEC after 28 days (approximately 76.61%), although its efficacy remained lower than that of albendazole (100%). Treated animals also showed a positive body weight gain, which was higher than that obtained with albendazole, whereas untreated controls exhibited marked weight loss. Hematocrit levels increased under the effect of the extract (+11.11%), indicating an improvement in the physiological status of the animals. A strong positive correlation was observed between FEC reduction, weight gain, and hematocrit increase, confirming the beneficial impact of the extract on both health and zootechnical performance of infected lambs.*
Conclusion : *The hydro-methanolic extract of Albizia adianthifolia combines moderate anthelmintic efficacy with significant improvements in zootechnical performance, although it is less effective than the synthetic drug in reducing FEC. These findings suggest that this plant represents a promising natural alternative for sustainable ecological control of gastrointestinal strongylosis in small ruminant farming.*
Keywords : *Albizia adianthifolia, forage plant, small ruminants, sustainable parasite control*

Date of Submission: 25-09-2025 Date of Acceptance: 05-10-2025

I. Introduction

Infections caused by gastrointestinal nematodes in domestic ruminants, commonly referred to as gastrointestinal strongyles, represent major pathologies in livestock production[1]. These parasitic diseases lead to reduced zootechnical performance and substantial economic losses for farmers[2]. The epidemiological complexity of such infections-driven by climatic conditions, pasture management, and parasite species diversity-highlights the need for alternative and sustainable control strategies[3]. Traditionally, control has relied heavily on the use of synthetic anthelmintics. While these drugs have long been effective in reducing parasite burdens, their intensive and repeated use has resulted in the emergence of resistance in many nematode populations. In addition, the rising costs of synthetic molecules, coupled with increasing environmental and public health concerns, have prompted a rethinking of preventive and therapeutic approaches to gastrointestinal parasitoses[4].

Against this backdrop, the concept of "nutraceuticals" has gained importance in animal nutrition. A nutraceutical refers to a feed resource whose use prioritizes its health benefits over its strictly nutritional value. Such feeds represent an integrative alternative, aiming to reconcile animal health and productivity without relying exclusively on synthetic products[5,4]. In this context, bioactive forages are attracting growing attention in sheep and goat production systems. These plants, which are not only nutrient- and energy-rich, are also valuable sources of secondary metabolites with antiparasitic properties[6]. Their incorporation into animal diets is being investigated as a means of reducing drug dependency while improving animal welfare. The use of such forages fits into a broader ecological management strategy that enhances the resilience of flocks against parasitic diseases[7]. Several studies conducted in temperate regions have highlighted the promising role of bioactive forage legumes in controlling gastrointestinal nematodes[8]. Species such as red clover, birdsfoot trefoil, sainfoin, and alfalfa have been evaluated in vitro and *in vivo*, demonstrating their ability to decrease parasite egg viability and fecundity[9]. Beyond their favorable nutritional profile, these legumes contain bioactive compounds such as condensed tannins and flavonoids, which are recognized for their anthelmintic and antioxidant effects[10,11]. Condensed tannins act directly on both larval and adult stages of nematodes, while flavonoids enhance the host's immune response[11]. This synergy between bioactive compounds and essential nutrients makes leguminous forages particularly attractive for sustainable gastrointestinal parasite control.

In Africa, and more specifically in Côte d'Ivoire, *Albizia adianthifolia* is one such forage species with significant potential in ethnoveterinary medicine. This tree forage, native to the Ivorian flora and belonging to the Leguminosae family (Fabaceae), has been reported to possess high nutritive value, particularly crude protein levels exceeding 30% of dry matter, along with major minerals and trace elements essential for livestock maintenance[12]. Previous in vitro studies demonstrated its anthelmintic activity against *Haemonchus contortus*, a major gastrointestinal nematode of sheep and goats in Côte d'Ivoire[13]. The same study also revealed the presence of condensed tannins and flavonoids in the hydro-methanolic extract of *Albizia adianthifolia*, compounds commonly associated with antiparasitic activity. Therefore, the present study aimed to evaluate *in vivo* the anthelmintic efficacy of the hydro-methanolic extract of *Albizia adianthifolia* and its beneficial effects on the health status of sheep naturally infected with *Haemonchus contortus*.

II. Material And Methods

Experimental site

The experimental study was conducted at Nangui Abrogoua University, within a small experimental sheepfold (Figure 1) located approximately 20 m from the Research Unit in Applied Sciences for Animal and Human Production and Health (URSASAH/Zoonosis). The sheepfold is a roofed shelter with a surface area of 25 m² and a height of 3 m. It is divided into two wooden pens where the animals were housed. Each pen measures 3 m in length, 2.3 m in width, and 1.7 m in height. The animals stood on a raised slatted floor positioned about 45 cm above ground level to facilitate weekly cleaning. The slats were made of 3 cm-thick wooden strips spaced approximately 2 cm apart, allowing feces to pass through.

Figure 1. Experimental sheepfold at Nangui Abrogoua University

Plant material

The plant material consisted exclusively of leaves from the forage species *Albizia adianthifolia*, collected in Agboville. The collected leaves were dried and used to prepare a hydro-methanolic extract.

Animal material

A total of 11 lambs (*Ovis ovis*), aged 8 to 10 months, of the Djallonké breed (West African Dwarf sheep) (Figure 2), weighing between 15.5 and 21.2 kg and showing clinical signs of gastrointestinal nematode infection (soiling of the hindquarters), were purchased from the "Coco Service" livestock market near Nangui Abrogoua University (Abidjan). Upon arrival, all animals were fed and managed under the same conditions, in accordance with the recommendations of the World Association for the Advancement of Veterinary Parasitology (WAAVP)[14,15].

Figure 2. Djallonké sheep in the experimental sheepfold

In vivo evaluation of the anthelmintic efficacy of *Albizia adianthifolia*

Preliminary parasitological analysis

Upon arrival, each lamb was weighed and subjected to coproscopic analysis to determine fecal egg counts (FEC, eggs per gram of feces). The animals were then treated orally with 20% amprolium at a dose of 2.5 mg/kg body weight to eliminate coccidia. Based on FEC, the lambs were divided into three groups (Group 1, Group 2, and Group 3). Groups 1 and 2 each included three female lambs, while Group 3 included five. Among the remaining parasites, *Haemonchus contortus* eggs predominated, representing more than 88% of the total eggs in all animals.

Preparation of oral suspensions

Oral suspensions were prepared from the plant extract and albendazole (synthetic anthelmintic). Based on body weight, lambs received 80 mg/kg of the plant extract and 7.5 mg/kg of albendazole. Each animal received a total volume of 40 mL of suspension. The plant extract was dissolved in 5% Tween 80[15]. Suspensions were administered orally as a single dose using a syringe.

Animal treatment

Animals were allocated into groups homogeneously based on FEC. Groups 1 and 2, treated with the plant extract and albendazole respectively, each contained three lambs. In these groups, one lamb had FEC < 3,000 eggs, one had FEC between 3,000 and 10,000 eggs, and one had FEC > 10,000 eggs. Group 3, untreated, included five lambs: two with FEC < 3,000 eggs, one with FEC between 3,000 and 10,000 eggs, and two with FEC > 10,000 eggs. Group 2 (albendazole-treated) served as the positive control, while Group 3 (untreated) served as the negative control.

Measured parameters

The parameters monitored were body weight gain, hematocrit, and FEC. At the start of the experiment and on day 7, a single measurement was taken for all parameters. From week 2 onwards, two measurements per week were conducted, except for hematocrit, which was measured once weekly throughout the study. Body weight and hematocrit were monitored until the end of the experiment (56 days), while FEC was assessed over 28 days.

Body weight gain determination

Body weight was measured twice weekly throughout the experimental period using a weighing scale. First, the person conducting the weighing was measured alone (W_0), and then holding the lamb (W_x). The lamb's weight (W) was calculated as the difference between W_x and W_0. The body weight gain (BWG, %) during the experiment was calculated using the following formula:

$$\text{BWG}\ (\%) = \frac{W_x - W_0}{W_0} \times 100$$

W_0 = mean body weight of lambs before treatment
W_x = mean body weight of lambs per week after treatment

Hematocrit measurement

Hematocrit was used to assess anemia caused by blood-feeding parasites. In tropical regions, approximately 45% of lamb mortality due to anemia is attributable to *Haemonchus contortus*[16].

Blood samples were collected from the jugular vein into EDTA-heparinized tubes using a needle. For each lamb, capillary tubes were filled by capillarity with approximately three-quarters of blood from the EDTA tube. The capillaries were sealed at one end and centrifuged at 4,000 rpm for five minutes. Following separation of red blood cells, white blood cells, and plasma, hematocrit readings were immediately taken using a hematocrit reader.

Hematocrit (%) was calculated as the proportion of red blood cells in the total volume of centrifuged blood, according to[17]:

$$\text{Hematocrit (\%)} = \frac{\text{Volume of red blood cells}}{\text{Total volume of centrifuged blood}} \times 100$$

The hematocrit increase rate (HI) during the experiment was also determined using the following formula:

$$\text{HI (\%)} = \frac{H_x - H_0}{H_0} \times 100$$

H_0 = Mean hematocrit before treatment
H_x = Mean hematocrit per week after treatment

Parasitological parameter: fecal egg count (FEC)

Fecal egg counts (eggs per gram, EPG) were the only parasitological parameter measured during the *in vivo* study. FEC was determined using the McMaster flotation technique with a saturated NaCl solution (density 1.19). Three grams of feces, collected directly from the rectum, were homogenized in 42 mL of the saturated NaCl solution. The fecal slurry was filtered through a tea strainer, and the filtrate was used to fill both chambers of a McMaster counting slide with a Pasteur pipette. Eggs were counted under a microscope (100×) along the grid lines. The number of eggs per gram of feces was calculated by multiplying the total eggs counted in both chambers by 50[18]:

FEC=Number of eggs counted in both chambers×50

The anthelmintic efficacy of the plant extract was expressed using the fecal egg count reduction (FECR) formula proposed by[19] and recommended by the World Association for the Advancement of Veterinary Parasitology (WAAVP):

$$\text{FECR (\%)} = \left(1 - \frac{M_x}{M_0}\right) \times 100$$

M_x = arithmetic mean of eggs per gram per week after treatment
M_0 = arithmetic mean of eggs per gram before treatment

Statistical analyses

Body weight gain, hematocrit increase, and reduction in fecal egg excretion were expressed as means. One-way ANOVA was used to compare means among different animal groups to evaluate the effect of the plant extract on these parameters. In addition, analysis of covariance (ANCOVA) was performed to assess the influence of parasitological parameters on biological parameters. When ANOVA indicated a significant difference between means at the 5% threshold ($\alpha < 0.05$), Tukey's post hoc test was applied to determine the level of difference. All statistical analyses were conducted using XLSTAT 2025.1 integrated into Excel 2024.

III. Result

Effect of *Albizia adianthifolia* extract on body weight

The body weight of the animals was monitored after treatment. As shown in Table 1, lambs treated with the plant extract had weights ranging from 17.03 ± 1.46 kg to 20.00 ± 1.40 kg between week 0 and week 8. The body weight gain (BWG) in this interval was 3.74% at week 2 post-treatment, increasing to 17.44% by the final week of the experiment. For animals treated with albendazole, body weights ranged from 19.2 ± 2.23 kg to 20.83 ± 1.16 kg over the same period. BWG during the first two weeks was 0.69%, reaching 8.51% by week 8. In contrast, the untreated control group exhibited a gradual decline in body weight, from 17.8 ± 2.15 kg before treatment to 14.47 ± 1.17 kg at the end of the experiment. The BWG in this group was consistently negative from week to week: -3.59% at week 2 and -18.73% at the end of the experiment. Statistical analyses revealed significant differences in BWG between groups over time. BWG in Group 1 (treated with *Albizia adianthifolia* extract) was higher than in Group 2 (treated with albendazole), while animals in Group 3 (untreated control) consistently exhibited weight loss, reflected by negative BWG values.

Table 1 : Effect of *Albizia adianthifolia* extract on the body weight of lambs

Treatment groups	Parameter measured	Week 0 Day 0	Week 2 Day 14	Week 4 Day 28	Week 6 Day 42	Week 8 Day 56
Group 1: Treated with *Albizia adianthifolia* extract	Mean body weight (kg)	17.03±1.46	17.67±1.52	18.20±0.95	19.70±1.41	20.00±1.40
		N = 3	N = 3	N = 3	N = 3	N = 3
	BWG (%)	0	3.74^{a}	6.87^{a}	15.68^{a}	17.44^{a}
Group 2: Treated with albendazole	Mean body weight (kg)	19.2±2.23	19.33±2.08	19.87±1.89	20.07±1.83	20.83±1.16
		N = 3	N = 3	N = 3	N = 3	N = 3
	BWG (%)	0	0.69^{b}	3.47^{b}	4.51^{b}	8.51^{b}
Group 3: Untreated control	Mean body weight (kg)	17.8±2.15	17.16±1.59	16.14±1.71	15.03±1.19	14.47±1.17
		N = 5	N = 5	N = 5	N = 4	N = 3
	BWG (%)	0	-3.59^{c}	-9.33^{c}	-15.54^{c}	-18.73^{c}

N = Number of sheep per group; BWG (%) = Body weight gain rate.
Different letters within the same column indicate a significant difference between body weight gain rates ($P < 0.05$).

Effect of *Albizia adianthifolia* extract on hematocrit

Hematocrit was measured to assess the effect of the different treatments on the physiological status of the animals (Table 2). After eight weeks of experimentation, the group treated with *Albizia adianthifolia* extract (Group 1) showed a significant increase in hematocrit, rising from 28.50 ± 0.44% at Day 0 to 31.10 ± 0.49% at Day 56. The rate of increase was estimated at 2.92% in the second week and progressively reached 11.11% by the end of the experiment. In animals treated with albendazole (Group 2, positive control), mean hematocrit increased from 26.5 ± 1.59% to 28.5 ± 1.32% between Day 0 and Day 56, corresponding to a progressive rise from 0.63% at the second week to 7.55% at the eighth week. In contrast, untreated animals (Group 3, negative control) showed a decrease in hematocrit between Day 0 and Day 28 (from 27 ± 1.92% to 23.70 ± 4.15%), followed by a slight increase to 24.67 ± 0.58% at Day 42, before stabilizing at 25.00 ± 1.32% at Day 56.

Table 2: Effect of *Albizia adianthifolia* extract on hematocrit

Treatment groups	Parameter measured	Week 0 Day 0	Week 2 Day 14	Week 4 Day 28	Week 6 Day 42	Week 8 Day 56
Group 1: Treated with *Albizia adianthifolia* extract	Mean hematocrit (%)	28.50±0.44	29.33±2.08	29.57±1.83	30.03±1.00	31.10±0.49
		N = 3	N = 3	N = 3	N = 3	N = 3
	HI (%)	0	2.92^{a}	3.74^{a}	5.38^{a}	11.11^{a}
Group 2: Treated with albendazole	Mean hematocrit (%)	26.5±1.59	26.67±1.15	26.83±1.61	27.67±1.15	28.5±1.32
		N = 3	N = 3	N = 3	N = 3	N = 3
	HI (%)	0	0.63^{b}	1.26^{b}	4.4^{a}	7.55^{b}
Group 3: Untreated control	Mean hematocrit (%)	27±1.92	25.20±1.92	23.70±4.15	24.67±0.58	25.00±1.32
		N = 5	N = 5	N = 5	N = 4	N = 3
	HI (%)	0	-6.67^{c}	-12.22^{c}	-8.64^{b}	-7.41^{c}

N = Number of sheep per group; HI (%) = Hematocrit increase rate.
Different letters within the same column indicate a significant difference between hematocrit increase rates ($P < 0.05$).

Effect of *Albizia adianthifolia* extract on *Haemonchus contortus* egg excretion

The evaluation of the effect of *Albizia adianthifolia* extract on fecal egg excretion (Table 3) revealed a progressive reduction in EPG among treated animals. Two weeks post-treatment, mean EPG decreased from 5700±3894 at baseline to 1933±1401, corresponding to a 66.08% reduction. By the fourth week, mean EPG had further declined to 1333±1106, representing a 76.61% reduction. In animals treated with albendazole (positive control), the decline was even more pronounced, with mean EPG dropping from 6800±5151 to 33±58 after two weeks, followed by a complete elimination of eggs between the second and fourth weeks (99.51% and 100% reduction, respectively). In contrast, untreated animals (negative control) showed worsening parasitism, with mean EPG increasing from 7400±6239 to 11280±9202, and "reduction rates" becoming negative (-28.92% at two weeks and -52.44% at four weeks).

These findings confirm that the hydro-methanolic extract of *A. adianthifolia* exerts genuine anthelmintic activity, though less effective than albendazole. Statistical analysis indicated a significant difference ($P < 0.05$) among groups during the trial. Moreover, a strong positive correlation was observed between the three measured parameters: hematocrit increase and body weight gain ($r = 0.907$), hematocrit increase and EPG reduction ($r = 0.902$), and EPG reduction and body weight gain ($r = 0.822$). This correlation demonstrates that improvement in one parameter (EPG reduction) is consistently associated with improvement in the others (hematocrit and body weight gain). Conversely, an increase in parasite egg excretion was accompanied by a simultaneous deterioration of physiological and zootechnical performance (Table 4).

Table 3: Effect of *Albizia adianthifolia* extract on fecal egg excretion

Treatment groups	Parameter measured	Week 0 Day 0	Week 2 Day 14	Week 4 Day 28
Group 1: Treated with *Albizia adianthifolia* extract	Mean EPGx10^{-2}	57.00±38.94	19.33±14.01	13.33±11.06
		N = 3	N = 3	N = 3
	FECR (%)	0	66.08[b]	76.61[b]
Group 2: Treated with albendazole	Mean EPGx10^{-2}	68.00±51.51	0.33±0.58	0±0
		N = 3	N = 3	N = 3
	FECR (%)	0	99.51[a]	100[a]
Group 3: Untreated control	Mean EPGx10^{-2}	74.00±62.39	95.40±80.49	112.8±92.02
		N = 5	N = 5	N = 5
	FECR (%)	0	-28.92[c]	-52.43[c]

N = Number of sheep per group; FECR (%) = Fecal egg count reduction rate.
Different letters within the same column indicate a significant difference in fecal egg count reduction rates ($P < 0.05$).

Table 4: Correlation Coefficients Between the Measured Parameters

	HI rate	BWG rate	FECR rate
HI rate	**1**	0.907	0.902
BWG rate	0.907	**1**	0.822
FECR rate	0.902	0.822	**1**

HI = Hematocrit increase rate; BWG = Body weight gain; FECR = Fecal egg count reduction rate

IV. Discussion

The *in vivo* evaluation of the hydro-methanolic extract of *Albizia adianthifolia* confirms its anthelmintic potential, previously demonstrated in vitro. The results show significant effects on both zootechnical parameters (body weight, hematocrit) and parasitological parameters (EPG). Indeed, animals treated with the extract exhibited increases in hematocrit (+11% over eight weeks) and body weight (+17.4%), which were not observed in the untreated control group. These zootechnical improvements were even superior to those recorded in the albendazole-treated group. However, in terms of parasitological efficacy, *A. adianthifolia* was less effective than albendazole, achieving a 76.6% reduction in EPG compared to 100% for the reference drug. This observation is consistent with[20], who reported that herbal remedies often show lower *in vivo* efficacy than synthetic anthelmintics.

The enhanced zootechnical performance of animals treated with the extract can be attributed to the nutritional richness of *A. adianthifolia*. The plant is particularly high in crude protein, essential for growth and resilience to parasitic infestations[12]. It also contains elevated levels of minerals, notably iron, exceeding the minimum requirements for optimal livestock maintenance, which may explain the faster correction of anemia observed through increased hematocrit compared to albendazole. Moreover, several studies have shown that protein-enriched diets enhance the immune response and reduce production losses associated with parasitism[21]. Thus, beyond its anthelmintic effect, *A. adianthifolia* acts as a functional feed, providing beneficial nutritional supplementation to the animals.

The observed activity can also be attributed to the plant's biochemical composition. According to[13], condensed tannins are present in hydro-methanolic extracts of *A. adianthifolia* at moderate levels (28.9 g/kg DM), within the beneficial range reported in the literature (20–40 g/kg DM)[22]. Condensed tannins exert a dual action: they directly interact with parasite membrane proteins and form complexes with dietary proteins, protecting them from ruminal degradation and enhancing absorption in the abomasum[23,24,25]. This mechanism may explain both the reduction in EPG and the improvement in zootechnical performance. Despite these promising results, certain limitations should be noted. The efficacy of *A. adianthifolia* remains lower than that of synthetic anthelmintics, which may limit its exclusive use in controlling severe infestations.

In conclusion, *Albizia adianthifolia* represents a local forage resource with high potential for integrated control of gastrointestinal strongylosis. While its parasitological efficacy is lower than that of albendazole, its nutritional contribution and positive effects on the physiological status of animals make it a promising alternative to reduce reliance on synthetic anthelmintics. Its incorporation into livestock systems could contribute to more sustainable parasite management, balancing animal health, productivity, and the valorization of endogenous resources.

V. Conclusion

This study demonstrated the *in vivo* efficacy of the hydro-methanolic extract of *Albizia adianthifolia* in sheep naturally infected with *Haemonchus contortus*. The extract significantly improved zootechnical and physiological performance, particularly hematocrit and body weight gain, while markedly reducing parasite burden. Although its anthelmintic efficacy was lower than that of albendazole, *A. adianthifolia* offers the advantage of combining antiparasitic properties with high nutritional value in proteins and minerals, enhancing the resilience of small ruminants against parasitic infections. Rational use of *A. adianthifolia* could therefore be integrated into a sustainable strategy for managing gastrointestinal strongylosis, reducing reliance on synthetic anthelmintics and promoting the use of a locally available resource.

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