



DOI: <https://doi.org/10.17921/1415-6938.2025v29n4p832-842>

Biochemical Profile of Goats Infected with Gastrointestinal Nematodes and Fed Diet Containing Different Levels of *Mimosa caesalpiniiifolia* and *Acacia mearnsii*

Perfil Bioquímico de Caprinos Infectados com Nematoides Gastrintestinais e Alimentados com Ração Contendo Diferentes Níveis de *Mimosa caesalpiniiifolia* e *Acacia mearnsii*


Received on: July 3, 2025


Accepted on: September 5, 2025


Marcos Vinícius Leite Bernardino: Instituto Federal do Maranhão, Campus São Luís. MA, Brazil. 

Pedro Celestino Serejo Pires Filho: Instituto Federal do Maranhão, Campus São Luís. MA, Brazil. 

Nayla Helena Silva Buna: Instituto Federal do Maranhão, Campus São Luís. MA, Brazil. 

Jéssica Rodrigues Santos Valois: Instituto Federal do Maranhão, Campus São Luís. MA, Brazil. 

Yasmin Suelen Alves Pinheiro: Instituto Federal do Maranhão – IFMA, Campus São Luís-Maracanã, Maranhão, Brazil. 

Daniel Praseres Chaves: Universidade Estadual do Maranhão – UEMA, Campus Luís, Maranhão, Brazil. 

Danilo Rodrigues Barros Brito: Instituto Federal do Maranhão, Campus São Luís. MA, Brazil. E-mail: danilobrito@ifma.edu.br 

Abstract

Possible serum alterations should be verified, which reflect the health conditions of animals subjected to different types of feed, when considering the inclusion of legumes in the diet of goats. Therefore, this study aimed to establish the biochemical profiles of goats infected with gastrointestinal nematodes and fed different levels of *Mimosa caesalpiniiifolia* (thrush) and *Acacia mearnsii* (acacia). The animals were divided into three groups (10 animals per group) that received different amounts of each plant. Group I (control) received feed without any of the plants. Group II received 50% acacia and 50% sabiá (50/50). Group III received 70% acacia and 30% sabiá (70/30). The results showed that aspartate aminotransferase (112.7 UI·L), creatinine (0.61 mg·dL), and albumin (1.91 g·dL) were higher in the 70/30 treatment in the first fifteen days, as well as total proteins (5.90 g·dL) and cholesterol (49.1 mg·dL). The glucose contents change slightly, with the 70/30, 50/50, and control groups presenting values of 35, 42.8, and 32.8 mg·dL, respectively. The average urea levels found at the first collection in the 50/50, 70/30, and control groups were 38.1, 40.1, and 32.7 mg·dL, respectively. These urea values were higher than the reference values (8–20 mg·dL). Even though serum levels changed when compared with reference values, there were no differences between the experimental groups; therefore,

it is safe to include these legumes in the diets of goats.

Keywords: Taniferous Plants. Serology. Goat Farming.

Resumo

A inserção de leguminosas na dieta de caprinos deve ser acompanhada com a verificação de possíveis alterações séricas, que refletem as condições de saúde dos animais submetidos a diferentes níveis de ração. Com isso, este trabalho teve como objetivo estabelecer o perfil bioquímico de caprinos infectados com nematoides gastrintestinais e alimentados com diferentes níveis de *Mimosa caesalpiniiifolia* (sabiá) e *Acacia mearnsii* (acácia). Os animais foram distribuídos em três grupos (10 em cada grupo), os quais receberam quantidades distintas de cada planta. Grupo I (controle), recebeu ração sem adição de nenhuma das plantas. Grupo II, recebeu a proporção de 50% de acácia e 50% de sabiá (50/50). E Grupo III, recebeu 70% de acácia e 30% de sabiá (70/30). Nos resultados obtidos verificou-se que os valores de Aspartato Aminotransferase (AST) (112,7 UI.L), creatinina (0,61 mg.dL) e albumina (1,91 g.dL) foram maiores no tratamento 70/30 nos primeiros quinze dias, assim como proteínas totais (5,90 g.dL) e colesterol (49,1 mg.dL). As taxas de glicose sofreram uma pequena alteração, onde o tratamento 70/30 apresentou 35 mg.dL, 50/50 (42,8 mg.dL) e grupo controle (32,8 mg.dL). A média dos níveis de ureia encontrados na primeira coleta, em cada grupo foram: 50/50 (38,1 mg.dL), 70/30 (40,1 mg.dL) e controle (32,7 mg.dL). Esses valores encontrados para ureia foram altos se comparado com os valores de referência (8-20 mg.dL). Conclui-se que mesmo havendo alterações nos níveis séricos quando comparados aos valores de referência, não houve diferenças entre os grupos experimentais, sendo, portanto, seguro o fornecimento dessas leguminosas na dieta de caprinos.

Palavras-chave: Plantas Taníferas. Sorologia. Caprinocultura.

1 Introduction

Brazil has a goat herd of 12.8 million heads, of which more than 90% are located in the northeastern region (IBGE, 2023), making goat herding a vital agricultural activity for the region's economic structure and generating income for the vast majority of small- and medium-sized producers. However, Brazilian goat farming, especially in the northeastern region, has suffered problems related to increased gastrointestinal nematode infections because of the lack of access to adequate technologies and management techniques for animal feed, health, and welfare (Assis *et al.*, 2003; Brito *et al.*, 2009).

These parasites spend a large portion of their biological cycle outside the host, mainly in pasture areas. Infection thus occurs naturally when animals ingest forage containing infective larvae. This can cause an acute form of infection, leading to rapid death, or a chronic form, resulting in significant production and economic losses (Soares *et al.*, 2023).

The primary form of control for these parasites is antiparasitic medication (Aducci *et al.*, 2021). However, some deworming medications on the market are no longer effective in combating them because inappropriate administration has caused these parasites to acquire resistance to the various active ingredients available. Another factor associated with the overuse of antiparasitics is the residual accumulation of these chemicals in the bodies of animals (Aguilar, 2023).

With the desire for animal products containing fewer chemical residues and a new focus on utilizing sustainable and alternative products to prevent anthelmintic resistance in these worms,

condensed tannins from forage plants have become a potential option for controlling endoparasites (Mottin, 2020). The use of plants for therapeutic purposes in veterinary medicine has proven to be an excellent way to control worm infestations (Bakare *et al.*, 2020).

Mimosa caesalpiniiifolia, popularly known as sabiá, belongs to the Fabaceae family and Mimosaceae subfamily. It is most prevalent in Northeast Brazil, where it is used for charcoal production, cuttings, and the recovery of degraded areas through biological nitrogen fixation (Brito *et al.*, 2018). Furthermore, its leaves have high protein contents (18.8 and 28.6%), allowing for its inclusion in the diets of small and large ruminants (Pires Filho, 2023).

Predominantly found in southeastern Australia, *Acacia mearnsii*, commonly known as black wattle, is a legume that can reach adult heights of 5–15 m (Quoirin *et al.*, 2001; Giesbrecht *et al.*, 2022). In Brazil, this species is most prevalent in the southern region, and is widely used for the extraction of tannins from its bark and in the production of charcoal for energy generation (Poletti, 2022).

Other factors that explain the increased use of medicinal plants in goat feed include their low toxicity and, consequently, reduced health risk to these animals (Ávila *et al.*, 2020). The amount of tannin present in a plant is influenced by several factors, such as age, size, harvested part, and time of year (Euko *et al.*, 2024).

Therefore, combined with the new consumption pattern, the use of serum assessment techniques that accurately represent an animal's metabolic state is important for measuring the suitability of a herd for the use of alternative feeds in a monitoring program (González; Scheffer, 2003).

Biochemical tests are important for measuring the physiological suitability of herbal medicines in a health control approach for goats, as they facilitate an understanding of both the animal's health status and degree of stress, which are interpreted through hematological and biochemical parameters (Roberto *et al.*, 2010).

In a study conducted by Faccin *et al.* (2014), sheep grazing in an area with *Brachiaria brizantha* resulted in alterations in the serum activities and elevations in the levels of gamma-glutamyl transferase (GGT) and aspartate aminotransferase (AST). This demonstrates that certain types of feed can negatively affect biochemical parameters.

Therefore, the objective of this study was to determine the biochemical profiles of goats infected with gastrointestinal nematodes and fed diets containing different concentrations of *Mimosa caesalpiniiifolia* and *Acacia mearnsii*.

2 Material and Methods

The experiment was conducted in the Sheep and Goat Farming Department and Animal Health Laboratory, both located at the Federal Institute of Maranhão (IFMA), São Luís, Maracanã Campus, Ensaio e Ciências, v.29. n.4, p.832-842, 2025.

and at the Cernitas Laboratory. The campus is located at an altitude of 35 m, latitude of 2°37'01"S and longitude of 44°16'19"W. The Cernitas Laboratory is located in São Luís, Maranhão, at an altitude of 39 m, latitude of 2°32'50.846"S and longitude of 44°12'58.964"W. According to the Köppen and Geiger (1928) classification, the city has a hot and semi-humid tropical climate of the Aw type, with a rainy season from January to June and an average annual rainfall of 1800 mm.

Thirty Anglo–Nubian crossbred goats, approximately 10 months old and weighing 20 kg, were used. The study was conducted over a 60-d period, of which the first 15 d were dedicated to the animals' adaptation to the facilities, diet, and routines. The animals were divided into three randomly distributed groups containing 10 animals each and received diets with different proportions of *A. mearnsii* and *M. caesalpinifolia*. The diet of Group I (control) was formulated as a base diet composed of corn (41.1%), soybean (12.9%), wheat (5.3%), masai grass (40.0%), and limestone (0.7%), without Acacia and Sabiá. For Group II (50% Black Acacia and 50% Sabiá), the base diet was used, with the addition of 2.93% (2.5 g of tannin) of Acacia and 6.16% (2.5 g of tannin) of Sabiá. The diet for Group III (70% Black Acacia and 30% Sabiá) consisted of a base diet with the addition of 4.16% (1.68 g of tannin) of Acacia and 3.71% (3.32 g) of Sabiá. The experimental procedures were approved by the Ethics Committee on Animal Experimentation (CEUA) of the Federal Institute of Maranhão (IFMA) under opinion number 01/2022.

The animals were kept in a semi-extensive system and fed roughage and concentrate. The diets were isoproteinic and isoenergetic, balanced according to the requirements prescribed by the NRC (2007), and had the potential for an average weight gain of approximately 100 g/day for animals with an average live weight of 20 kg and receiving 310 g of base feed.

Fecal samples were collected biweekly from the rectum of animals and processed immediately to measure the elimination of nematode eggs. The eggs per gram of feces (EPG) count was performed according to the modified Gordon and Whitlock technique (Ueno; Gonçalves, 1994).

For biochemical tests, blood was drawn by puncturing the jugular vein with a 25 × 7-mm disposable needle after first disinfecting the area with iodinated alcohol. The blood was deposited directly into a properly labeled 5-mL vacutainer glass vial and sent to the Animal Health Laboratory, where it was refrigerated and stored at 4 °C for clot retraction. After clot retraction, the sample was centrifuged at 3000 rpm for 5 min to separate the serum, which was stored at –20 °C until laboratory tests.

In the laboratory, samples were processed and evaluated for albumin (bromocresol blue method), plasma glucose (orthotoluidine method), total protein (biuret method), urea (urease method), creatinine (kinetic method), cholesterol, serum AST, gamma glutamyltransferase (GGT), and alkaline phosphatase (ALP) levels. The samples were treated with commercial reagents for biochemical

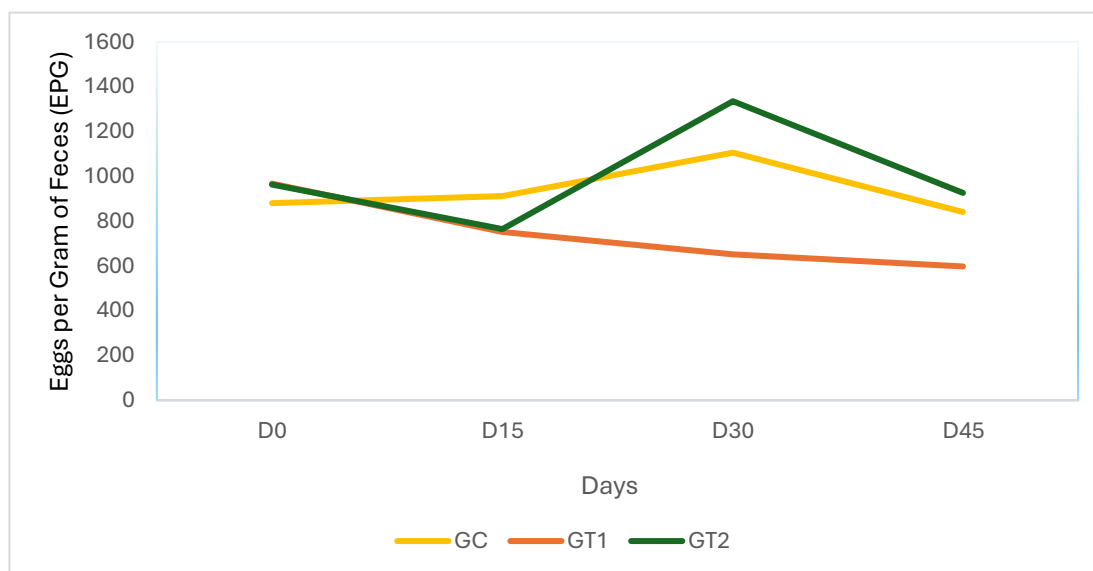
profiling using a semi-automatic spectrometer at specific wavelengths for each constituent and an ion-selective assay.

The results were verified by analysis of variance and comparing the means, which were compared using Tukey's test at a 5% probability level. Statistical analyses were performed using the statistical program GraphPad Prism 8 (GraphPad Software, Oberlin, San Diego, CA, USA).

3 Results and Discussion

The OPG conducted at the beginning of this study demonstrated a similar degree of parasitism between the groups studied (Figure 1), with a decrease throughout the experiment in the group that received base feed with the addition of 50% sabiá and 50% acacia.

Figure 1 – Average number of eggs per gram of feces (EPG) for the goat experimental groups on the days of collection



GC, Control Group; GT1, 50% Acacia and 50% Sabiá; GT2 –70% Acacia and 30% Sabiá.

Source: research data.

When establishing the protein fractions present in the blood sera of goats subjected to treatments containing different levels of *M. caesalpinifolia* and *A. mearnsii*, it was observed that the creatinine levels under the three treatments until day 30 remained below the reference values for the species (1.2–1.9 mg·dL) (Kaneko *et al.*, 2008), with a small increase from day 45 of the experiment (Table 1). According to González and Silva (2017), the blood creatinine concentration is closely related to muscle mass in animals. This metabolite is not influenced by nutrition and its quantitative parameters tend to remain constant in these animals (González *et al.*, 2000).

Blood urea levels were analyzed considering the amount of protein present in the diet and kidney functioning (Kaneko, 1997). The urea dosage remained above the reference averages (8–20 mg/dL),

and the group that received 50% of both plants in their diet had the highest values throughout the experiment (Table 1). According to Gressler *et al.* (2015), high urea levels from day 0 onward may have been associated with a similar difference between crude protein degradation and the availability of metabolizable energy in the ruminal system. Albumin levels were not significantly different between the experimental groups ($p < 0.05$) (Table 1), and were lower than those reported by Mundim *et al.* (2007). According to Pinto *et al.* (2019), urea and albumin are strictly correlated with protein metabolism in ruminants, which may vary depending on dietary protein availability.

The total protein levels showed similar trends on day 0, remaining below the reference values established in the literature (60–79 g/L) (Table 1). It should be noted that, from days 15 and 30 onward, the values remained within the parameters considered normal according to González (2006) in all groups.

On day 45, there was a significant increase in the values referring to the total protein contents. This increase may be associated with the use of the external digestibility indicator (LIPE®). When used in ruminants, LIPE can increase the digestibility rate of crude protein by hindering the access of proteolytic bacteria to protein molecules (Souza, 2016).

Table 1 – Means and standard deviations of the protein profile of goats fed different levels of acacia and sabiá

Variable	Treatment	Days			
		0	15	30	45
Urea mg·dL	50/50	38.1±7.29a	32.1±4.79a	34.3±4.69a	32.9±3.78a
	70/30	40.1±10.14a	26.7±4.13a	33.33±6.54a	29.7±5.16a
	Control	32.7±5.16a	31.3±7.18a	38.3±8.21a	30.6±7.10a
Creatinine mg·dL	50/50	0.57±0.10a	0.50±0.11a	0.71±0.14a	1.17±0.18ab
	70/30	0.61±0.11a	0.44±0.08a	0.65±0.07a	1.05±0.17a
	Control	0.55±0.06a	0.51±0.05a	0.73±0.08a	1.27±0.12b
Albumin g·dL	50/50	1.63±0.33a	1.51±0.27a	1.66±0.22a	1.67±0.25a
	70/30	1.91±0.41a	1.52±0.19a	1.67±0.27a	1.64±0.27a
	Control	1.73±0.36a	1.57±0.22a	1.78±0.29a	1.80±0.37a
PT-Serum g·dL	50/50	5.09±0.44a	6.12±0.29a	6.34±0.82a	21.14±1.30a
	70/30	5.90±1.03a	6.10±0.58a	6.31±0.69a	20.77±2.21a
	Control	5.56±0.89a	6.40±0.79a	6.70±0.79a	21.40±1.44a

For each variable, values followed by lowercase letters in the same column did not differ from each other according to Tukey's test ($p > 0.05$).

Source: research data.

Considering the other variables related to hepatic metabolism of the animals, some enzymes did not present significant differences between them (Table 2). Serum AST activity was observed, which remained well below the reference values cited by Kaneko *et al.* (2008) in all groups and on all experimental days (167.0–523.0 U/L). The results obtained were lower than those found by Soares *et al.* (2022) in Lacaune sheep raised in Northeastern Zona da Mata and by Souto *et al.* (2023) in dairy

goats with clinical and subclinical forms of pregnancy toxemia. This enzyme is more concentrated in the liver, and when quantified in ruminants, provides a good indication of liver function (Silva *et al.*, 2023).

ALP and GGT levels remained within the averages established in the literature (93–386 U/L and 20–56 U/L, respectively) in the 70/30 and 50/50 treatment groups (Table 2), demonstrating that the inclusion of these plants in goat diets did not compromise liver function.

Silva *et al.* (2004) found that factors related to animal sex, breed, and age significantly influence the behavior of GGT, AL, and AST in the blood fraction.

Table 2 – Means and standard deviations of the enzymatic profiles of goats fed different levels of acacia and sabiá

Variable	Treatment	Days			
		0	15	30	45
AST U/L	50/50	20.0±7.27a	22.0±6.09a	17.2±6.14a	21.2±6.66a
	70/30	12.7±6.11a	20.8±6.08a	20.9±8.21a	24.2±8.16a
	Control	23.2±9.89a	19.3±6.86a	20.2±5.90 ^a	25±6.39a
F.A U/L	50/50	146.6±236.47a	201.2±257.81a	187.7±204.11a	184.3±224.94a
	70/30	112.7±109.39a	221.6±186.39a	182.4±148.98a	169.1±135.81a
	Control	219.5±269.99a	397.7±456.89a	350.6±349.82a	305.6±365.26a
GGT U/L	50/50	29.4±12.81a	28.0±3.88a	27.9±6.0ab	31.2±7.20a
	70/30	33.3±6.92a	27.2±6.12a	26.6±4.50a	28.9±5.97a
	Control	33.0±7.80a	34.3±10.79a	33.2±5.78b	31.5±7.41a

For each variable, values followed by lowercase letters in the same column did not differ from each other according to Tukey's test ($p>0.05$).

Source: research data.

Cholesterol can be of either endogenous or exogenous origin (González; Silva, 2017). When measured, it indicates the total amount of lipids present in blood plasma, corresponding to approximately 30% of the total amount (Villa *et al.*, 2009).

Regarding the values obtained, there was no statistical difference ($p>0.05$) between the experimental groups, except for the 70/30 treatment, which exhibited a small drop in its quantitative parameter from day 15 (Table 3). The serum concentrations of total cholesterol on days 30 and 45 were similar to those reported by Gressler *et al.* (2015).

Serum glucose activity does not change greatly in ruminants because no glucose from the alimentary tract enters the bloodstream during digestion (Lima *et al.*, 2016). This biochemical indicator is regulated by insulin and glucagon (Argolo, 2019). The levels of this metabolite were higher in the 50/50 group than in the control group (Table 3). The glucose values in the animals at the beginning of the experiment were similar to those obtained by Brito *et al.* (2020) in goats infected with gastrointestinal nematodes and treated with condensed tannins.

Table 3 – Means and standard deviations of the energy profile of goats fed different levels of acacia and sabiá

Variable	Treatment	Days			
		0	15	30	45
Glucose mg· Dl	50/50	37.8±6.89a	42.8±6.37a	39.2±7.48a	40.1±9.07a
	70/30	37.1±10.71a	35.0±6.0b	45.8±6.21a	35.7±7.93ab
	Control	36.6±5.27a	32.8±7.95b	41.1±7.92a	30±5.86b
Cholesterol mg· Dl	50/50	47.5±11.53a	54.4±8.40a	59.7±9.70a	61.3±14.14a
	70/30	49.1±7.26a	44.9±8.06b	53.9±8.53a	52.9±12.30a
	Control	43.6±10.13a	51.5±6.78ab	55.5±15.10a	57.7±11.03a

For each variable, values followed by lowercase letters in the same column did not differ from each other according to Tukey's test ($p>0.05$).

Source: research data.

4 Conclusion

We conclude that the protein, energy, and enzyme profiles of goats fed different concentrations of sabiá and black wattle were not affected by differences in the concentrations of the two plants in the animal diets.

Notably, the increase in total protein content on day 45 of the experiment was possibly influenced by the use of purified eucalyptus lignin (LIPE). Further research involving the use of LIPE with other plants is required to understand the dynamics of this product in animal bodies.

Acknowledgements

The authors would like to thank the Federal Institute of Education, Science, and Technology of Maranhão – IFMA and the Foundation for Research and Scientific and Technological Development Support of Maranhão – FAPEMA.

References

ADDUCI, I. *et al.* Haemonchosis in Sheep and goats, control strategies and development of vaccines against *Haemonchus contortus*. *Animals*, v.12, n.18, p.2339, 2022. doi: <https://doi.org/10.3390/ani12182339>

AGUIAR, H. A. *Avaliação de extrato de própolis verde para inibição da eclodibilidade e migração larval de Trichostrongylidae de caprinos*. Uberlândia: Universidade Federal de Uberlândia, 2023.

ASSIS, L.M. *et al.* Ovicidal and larvicidal activity in vitro of *Spigelia anthelmia* Linn. extracts on *Haemonchus contortus*. *Vet. Parasitol*, v.117, n.1-2, p.43-49, 2003. doi: <https://doi.org/10.1016/j.vetpar.2003.07.021>

ARGOLO, E.P. *Perfil metabólico de caprinos sob restrição alimentar e realimentação*. Mossoró: Universidade Federal Rural do Semiárido, 2019.

ÁVILA, L.M. *et al.* Main herbal medicines used in the control of ectoparasites and endoparasites in horses and cattle – Bibliography Review. *RSD*, v.9, n.11, p.e359119503, 2020. doi: <https://doi.org/10.33448/rsd-v9i11.9503>.

BAKARE, A.G. *et al.* Potential of ethno-veterinary medicine in animal health care practices in the South Pacific Island countries: a review. *Trop. Anim. Health Prod.*, v.52, p.2193-2203, 2020. doi: <https://doi.org/10.1007/s11250-019-02192-7>

BRITO, D.R.B. *et al.* Supplementation with dry *Mimosa caesalpinifolia* leaves can reduce the *Haemonchus contortus* worm burden of goats. *Vet. Parasitol.*, v.252, n.15, p.47-51, 2018. DOI: <https://doi.org/10.1016/j.vetpar.2018.01.014>.

BRITO, D. R. B. *et al.* Parasitos Gastrointestinais em Caprinos e Ovinos da Microrregião do Alto Mearim e Grajaú, No Estado do Maranhão, Brasil. *Ciênc. Anim. Bras.*, v.10, n.3, p.967-974, 2009.

BRITO, D. R. B. *et al.* Clinical parameters of goats infected with gastrointestinal nematodes and treated with condensed tannin. *Semin. Ciênc. Agrár.*, v.41, n.2, p.517-530, 2020. doi: <https://doi:10.5433/1679-0359.2020v41n2p517>

EUKO, D. *et al.* Avaliação da folha de bananeira (*Musa spp.*) como produto anti-helmíntico no controle de verminose associado ao bem-estar animal em ovinos. *CLCS*, v.17, n.5, e6270., 2024. doi: <https://doi.org/10.55905/revconv.17n.5-075>

FACCIN, T.C. *et al.* Poisoning by *Brachiaria brizantha* in flocks of naïve and experienced sheep. *Toxicon*, v.82, p.1-8, 2014. doi: <https://doi.org/10.1016/j.toxicon.2014.02.008>.

GRESSLER, M.A.L. *et al.* Respostas bioquímicas de ovelhas submetidas a flushing de curto prazo em região subtropical. *Rev. Bras. Saúde Prod. Anim.*, v.16, p.210-222, 2015. doi: <https://doi.org/10.1590/S1519-99402015000100022>

GIESBRECHT, B.M. *et al.* The performance of *Acacia mearnsii* De Wild for kraft pulping. *Cienc. Fl.*, v.32, n.1, p.266-286, 2022. doi: <https://doi.org/10.5902/1980509850295>

GONZÁLEZ, F.H.D.; SILVA, S.C. *Introdução à bioquímica clínica veterinária*. Porto Alegre: Universidade Federal do Rio Grande do Sul, 2006.

GONZALEZ, F.H.; SILVA, S.C. *Introdução à bioquímica clínica veterinária*. Porto Alegre: UFRGS, 2017.

GONZÁLEZ, F.H.D.; SCHEFFER, J.F.S. Perfil sanguíneo: ferramenta de análise clínica, metabólica e nutricional. In: SIMPÓSIO DE PATOLOGIA CLÍNICA VETERINÁRIA, 1., 2003, Porto Alegre. Anais [...]. 2003. p. 73-89.

GONZÁLEZ, F.H.D. *et al.* Variações sanguíneas de ureia, creatinina, albumina e fósforo em bovinos de corte no Rio Grande do Sul. *Hora Vet.*, v.20, n.1, p.59-62, 2000.

IBGE – Instituto Brasileiro de Geografia e Estatística. Pesquisa Pecuária Municipal. Rio de Janeiro: IBGE, 2023.

KANEKO, J.J.; HARVEY, J.W.; BRUSS, M.L. *Clinical biochemistry of domestic animals*. San Diego: Academic Press, 2008. 916 p.

KANEKO, J.J. *Clinical biochemistry of domestic animals*. San Diego: Academic, 1997.

KÖPPEN, W.; GEIGER, R. *Klimate der Erde*. Gotha: Verlag Justus Perthes. Wall-map b150cmx200cm. 1928.

Ensaio e Ciências, v.29. n.4, p.832-842, 2025.

LIMA, E.H.F. *et al.* Efeito da monensina sódica sobre o perfil metabólico de ovelhas antes e após o parto. *Ciênc. Anim. Bras*, v.17, n.1, p.105–118, 2016. doi: <https://doi.org/10.1590/1089-6891v17i128370>.

MOTTIN, V. D. *Aplicabilidade do extrato da casca do Barbatimão (Abarema cochliacarpos) no controle de nematoides gastrintestinais em caprinos*. 2020. 84 f. Tese (Doutorado em Zootecnia) – Universidade Estadual do Sudoeste da Bahia, Itapetinga, 2020.

MUNDIM, A.V. *et al.* Influência da ordem e estádios da lactação no perfil bioquímico sanguíneo de cabras da raça Saanen. *Arq. Bras. Med. Vet. Zootec*, v.59, n.2, p.306-312, 2007. doi: <https://doi.org/10.1590/S0102-09352007000200006>

NRC - National Research Council. *Nutrient requirements of small ruminants: sheep, goats, cervids, and New World camelids*. Washington: National Academic Press, 2007. 292 p.

PIRES FILHO, P.C.S. Utilização do tanino condensado do sabiá (*Mimosa caesalpinifolia*) e da Acácia negra (*Acacia mearnsii*) sobre nematóides gastrintestinais em caprinos. 2023. 44 f. Dissertação (Programa de Pós-Graduação em Ciência Animal) - Universidade Federal do Maranhão, Chapadinha, 2023.

PINTO, M. M. *et al.* Avaliação de desempenho e perfil metabólico em bovinos suplementados com solução de aminoácidos e minerais. *Pubvet*, v.13, n.11, p.1-10, 2019. doi: <https://doi.org/10.31533/pubvet.v13n11a455.1-10>

POLETTI, B. Uso de extrato de *Acacia mearnsii* (Acácia Negra) na alimentação de não-ruminantes. Porto Alegre: Universidade Federal do Rio Grande do Sul, 2022.

QUOIRIN, M. *et al.* Multiplication of Juvenile Black Wattle by Microcuttings. *Plant Cell, Tissue Organ Cul.*, v.66, p.199-205, 2001. doi: <https://doi.org/10.1023/A:1010627227018>

ROBERTO, J.V.B. *et al.* Parâmetros hematológicos de caprinos de corte submetidos a diferentes níveis de suplementação no semiárido paraibano. *Rev. Caatinga*, v.23, n.1, p.127-132, 2010.

SILVA, T.G.P. *et al.* Blood biochemical parameters of lambs fed diets containing cactus cladodes. *Arq. Bras. Med. Vet. Zootec*, v.75, n.1, p.48-60, 2023. doi: <https://doi.org/10.1590/1678-4162-12833>

SILVA, S.L. *et al.* Atividade sérica das enzimas AST, ALP e GGT de caprinos das raças Anglo-nubiana e Saanen criados nos estados de São Paulo e Paraíba. *Ars Veterinaria*, v. 20, n. 1, p. 22, 2004.

SOARES, L.L.S. *et al.* Perfil hematológico e bioquímico de ovinos da raça Lacaune criadas na Zona da Mata Nordeste. *Med. Vet*, v.16, n.3, p.165–170, 2022. doi: <https://doi.org/10.26605/medvet-v16n3-4983>

SOUTO, R. J. C. *et al.* Indicadores proteicos, enzimáticos e minerais da toxemia da prenhez clínica e subclínica durante o período de transição de cabras leiteiras. *Ciênc. Anim. Bras*, v.24, 2023. doi: [10.1590/1809-6891v24e-75182E](https://doi.org/10.1590/1809-6891v24e-75182E).

SOUZA, M.F.S. Digestibilidade aparente de dietas para ovinos por meio do indicador externo LIPE®. 2016. 74 f. Dissertação (Programa de Pós-Graduação em Ciência Animal e Pastagens) - Universidade Federal Rural de Pernambuco, Garanhuns, 2016.

SOARES, S.C.P. *et al.* Resistência de nematoides gastrintestinais de caprinos e ovinos aos anti-helmínticos levamisol, ivermectina e albendazol. *Ciênc. Anim. Bras*, v.24, 2023. doi: <https://doi.org/10.1590/1809-6891v24e-75316E>.

UENO, H; GONÇALVES, P.C. *Manual para diagnóstico das helmintoses de ruminantes*. Tokyo: Japan International Cooperation Agency, 1994.

VILLA, N.A. *et al.* Medidas corporales y concentración sérica y folicular de lípidos y glucosa en vacas Brahman fértil y subfértil. *Pesq. Agropec. Bras*, v.44, n.9, p.1198-1204, 2009. doi: <https://doi.org/10.1590/S0100-204X2009000900019>