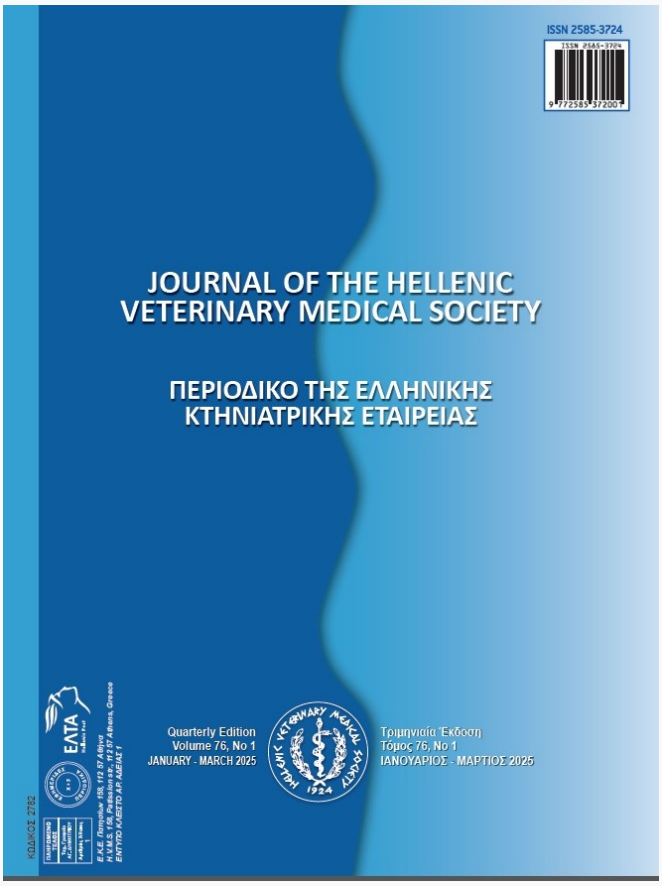
Journal of the Hellenic Veterinary Medical Society

Vol 76, No 1 (2025)



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doi: 10.12681/jhvms.37150

To cite this article:

Chávez, V., Vargas Rocha, L., Rojas-Moncada, J., & Torrel, T. (2025). Fasciolicidal efficacy comparison between Amaro (Chuquiraga weberbaueri) and triclabendazole in calves experimentally infected with Fasciola hepatica metacercaria. *Journal of the Hellenic Veterinary Medical Society*, *76*(1), 8697–8704. https://doi.org/10.12681/jhvms.37150

J HELLENIC VET MED SOC 2025, 76 (1): 8697-8704
ΠΕΚΕ 2025, 76 (1): 8697-8704

Research article
Ερευνητικό άρθρο

Fasciolicidal efficacy comparison between Amaro (*Chuquiraga weberbaueri*) and triclabendazole in calves experimentally infected with *Fasciola hepatica* metacercaria

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ABSTRACT: The Cajamarca valley is an endemic area for cattle affected by *Fasciola hepatica*. Despite demonstrated resistance to triclabendazole, the use of this anthelmintic remains prevalent. Therefore, constant efficacy evaluations of this active ingredient and exploring alternatives for parasite control are necessary. This study aimed to determine the effectiveness of Amaro (*Chuquiraga weberbaueri*) and triclabendazole in controlling *F. hepatica* in experimentally infected calves. Three groups (T0, T1, and T2) of four weaned Holstein calves each were formed and infected with 200 metacercaria. The control group (T0) received no antiparasitic treatment, group T1 was dosed with lyophilized aqueous extract of *C. weberbaueri* (200 mg.kg^{-1}, orally, for four consecutive days), and group T2 received a single dose of triclabendazole (12 mg.kg^{-1}, orally). Clinical efficacy was assessed using the Egg Count Reduction Test, and absolute efficacy was determined by adult parasite counts at necropsy. The mean clinical efficacy of *C. weberbaueri* was 46.70% (95% CI: 33.27 - 60.13) and of triclabendazole 25.00 (95% CI: 12.62 - 37.38) (p=0.029). The efficacies increased in the count of adult parasites at necropsy but were not statistically different (p=0.686), *C. weberbaueri* showed an efficacy of 58.63% (95% CI: 45.24 - 72.02), and triclabendazole 66.22% (95% CI: 53.36 - 79.08). Both treatments proved insufficiently active against *F. hepatica* in calves, falling short of the category of effective fasciolicides. Nevertheless, using *C. weberbaueri* could be considered an environmentally friendly option to reduce the parasite burden in cattle.

Keywords: efficacy; ethnopharmacology; liver fluke; parasite control; parasite resistance

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Date of initial submission: 06-03-2024
Date of acceptance: 12-11-2024

INTRODUCTION

The helminth *Fasciola hepatica*, a parasite widely distributed worldwide among various animal species, has been associated with considerable diseases and production losses (Beesley et al., 2018). Infection by this trematode leads to significant economic and production losses, primarily due to the condemnation of infected livers and weight loss in dairy cattle (Mpisana et al., 2022). This issue arises because *F. hepatica* has developed advanced mechanisms to deceive, evade, and alter the host's immune response. The infection by *F. hepatica* itself represents a source of oxidative stress affecting slaughtered animals, resulting in biochemical and metabolic alterations in the early postmortem period (Nasreldin and Zaki, 2020).

Parasite control in domestic animals has relied primarily on chemical drugs for many years. However, this practice poses challenges, as residues of these products can accumulate in tissues, milk, meat, and other animal-derived by-products intended for human consumption, posing an imminent risk to public health (Rana et al., 2019). Additionally, the disposal of chemical residues into the environment through feces and urine raises additional concerns. Since the soil serves as the ultimate destination for residues of chemical anthelmintics, these compounds can pose an environmental threat, being toxic to beneficial soil organisms, thereby disrupting local microflora (Goodenough et al., 2019; Villar and Schaeffer, 2022).

On the other hand, the extensive use of anthelmintic medications has led to a concerning and dramatic level of resistance to these drugs in various parts of the world, affecting nearly all animal species and demonstrating resistance to different anthelmintic groups across several continents. Factors such as frequent administration, insufficient doses, parasite genetics, and the selection and timing of mass treatment have contributed to the emergence of anthelmintic resistance (Fissiha and Kinde, 2021).

Given the harmful effects of chemical antiparasitic, there has been a shift towards more environmentally friendly alternatives, such as natural products, including bioactive plants. Ethnoveterinary medicine, practiced since historical times worldwide, has recently resurged as an alternative for controlling parasites or countering anthelmintic resistance (Githiori et al., 2005; Nyahangare et al., 2015; Benlarbi et al., 2023). In Peru, it has been identified that the Amaro plant (*Chuquiraga weberbaueri*) is used for the treatment of animal fasciolosis, with ovicidal activity attributed to phenolic components such as chlorogenic acid and ethyl caffeate, as well as the presence of flavonoids, saponins, and lactones (Ortiz et al., 2023).

Given the global significance of the challenge posed by anthelmintic resistance, it is crucial to implement proper use of existing anthelmintics and reduce dependence on these drugs to mitigate the risk of resistance (Fissiha and Kinde, 2021). Cajamarca is an endemic region for *F. hepatica*, a parasite that has been reported in various domestic animals, including guinea pigs, cattle, and horses, among others (Torrel et al., 2022; Torrel et al., 2023; Rázuri et al., 2023). Furthermore, resistance of *F. hepatica* to triclabendazole has been confirmed in this area (Ortiz et al., 2013).

The present study determined the efficacy of a native Andean plant, Amaro (*C. weberbaueri*), and triclabendazole in controlling *F. hepatica* in experimentally infected calves. Despite the well-documented resistance of *F. hepatica* to triclabendazole, this anthelmintic was selected due to its widespread use in local livestock practices. The study aims to raise awareness, discourage its continued use, and explore alternative methods for controlling fasciolosis in cattle from the Cajamarca region by highlighting the need for further research on this anthelmintic.

MATERIALS AND METHODS

Place and experimental design

The research was conducted in the Cajamarca valley at the facilities of the Facultad de Ciencias Veterinarias (FCV), National University of Cajamarca (UNC), Peru. In the cattle pens of the FCV livestock farm, 12 Holstein calves were selected and individually identified with ear tags after being weaned at three months of age.

Despite being exclusively fed with milk for the first three months, fecal samples were collected in the mornings by anal sphincter stimulation (approximately 100 g) and processed using the Natural Sedimentation Technique (Dennis et al., 1954) at the Laboratorio de Parasitología Veterinaria y Enfermedades Parasitarias of the UNC. This was done to ensure the absence of *F. hepatica* eggs in the fecal samples.

After confirming the absence of infection, the calves were infected with 200 metacercaria per animal on day 100 of life. The metacercaria, produced at the Laboratorio de Inmunología of the UNC, were administered orally in gelatin capsules using anatom-

ical forceps. A period of 77 days was allowed after infection to permit the development of larval forms to the adult stage in the bile ducts and the production and excretion of eggs.

After the completion of 77 days post-infection, new fecal samples were collected in the morning and processed similarly to the initial sampling. The egg count per gram of feces facilitated the formation of three homogeneous groups based on parasitic load and the number of animals: the control group (T0), the Amaro group (T1), and the triclabendazole group (T2).

On day 78 post-infection, group T1 received a lyophilized aqueous extract of *Chuquiraga weberbaueri* in capsules at 200 $mg.kg^{-1}$ of body weight, for four consecutive days. Since 200 mg of plant capsules were formulated, one capsule was administered for each kg of body weight. These were placed with the hand behind the tongue roll and the mandible was slightly raised to ensure swallowing. Group T2 received a single dose of triclabendazole at a rate of 12 $mg.kg^{-1}$ of body weight, orally. The body weight of each calf was calculated using a bovine measuring tape, and the dosage per animal was determined by multiplying the therapeutic dose of the anthelmintic by the weight in kg, divided by the product concentration.

The metacercaria were produced through the breeding and infection of *Lymnaea* snails. Initially, eggs of *F. hepatica* were obtained from the bile ducts of cattle processed in the slaughterhouse. These eggs were incubated for two weeks at 28°C, after which hatching was stimulated using light at 2000 lumens. Each snail, aged 2 to 3 months, was infected with 2 to 3 miracidia in wells of recycled ELISA plates and maintained under controlled breeding conditions for 1.5 to 2 months. Subsequently, the snails were placed in polyethylene bags with water and exposed to sunlight and thermal shocks (refrigeration and incandescent light) 2 to 4 times per day. Following this process, the metacercaria encysted on the walls of the bags were counted under a stereoscope and finally placed into empty gelatin capsules.

Amaro tablets production

Fresh Amaro plants were dried for 24 hours at 45°C in an oven, then de-leaved and crushed. One hundred grams of the resulting powder were weighed, placed in a 4 L flask with 2 L of distilled water, and brought to a boil for 10 minutes. Subsequently, it was allowed to cool and filtered through gauze and filter paper in a Büchner funnel under vacuum to remove solids. The filtrate was vacuum-concentrated in a rotary evaporator until it reached one-fourth of its initial volume. The concentrated extract was transferred to a lyophilization flask, where it underwent a cooling bath at 42°C for 15-20 minutes to impregnate and solidify the extract. Finally, it was placed in an ultra-freezer at -80°C for 72 hours and then lyophilized at 66 mTorr at -80°C for 48 hours.

Amaro (200 mg) capsules were produced in a controlled environment at 24°C and 50% humidity. Gelatin capsules (00) were used, and their average empty weight was determined from 20 capsules. Encapsulation was performed using a semi-automatic double-zero capsule filler, incorporating 50 empty capsules with the larger part facing downward. The weighed sample was added and uniformly distributed into the capsules with a spatula. The upper part of the capsule filler was attached, joining both parts of the capsules. Twenty filled capsules were weighed to obtain the average weight, which was compared with the average weight of the empty capsules. The capsules were stored in a plastic bag to prevent degradation and kept in a tightly sealed high-density polypropylene container.

Dosage controls

Fecal samples were collected directly from the rectum, approximately 100 g each, by stimulating the anal sphincter on four occasions with eight-day intervals until day 32. These collections aimed to conduct egg count per gram of feces.

The decision was made to end the egg per gram of feces (EPG) count on day 32 because during this period *F. hepatica* is in the early immature stage (1 to 4 weeks). It does not mature or produce eggs within the first 30 days (Wood et al., 1995).

Clinical efficacy estimate

Clinical efficacy (% C.E.) was determined by calculating the percentage reduction in *F. hepatica* EPG counts using the following formula (Young et al., 1999).

$$\%C.E.=\frac{Average\ EPG\ Day\ 0-Average\ EPG\ Day\ 8-32}{Average-EPG\ Day\ 0}\times 100$$

Following the guidelines of the World Association for the Advancement of Veterinary Parasitology (WAAVP), the efficacy percentage in each group was

classified according to the following ranges: highly effective (>98%), effective (90 - 98%), moderately effective (80 - 89%), and insufficiently active (<80%) (Wood et al., 1995).

Absolute efficacy estimate

To calculate absolute efficacy through observation of adult *F. hepatica* in the liver, the 12 calves were transported to the municipal abattoir in Cajamarca for slaughter on day 34 post-treatment. During postmortem examination, livers were selected, and longitudinal cuts were made through the bile ducts for identification, recovery, and counting of adult *F. hepatica*. The percentage of absolute efficacy (E) was calculated using the geometric means (GM) of the count of adult flukes in the bile ducts, comparing the control group and the treatment group, following the guidelines of WAAVP (Wood et al., 1995).

$$\%E = \frac{GM\ F.\ hepatica\ control\ group - GM\ F.\ hepatica\ treated\ group}{GM\ F.\ hepatica\ control\ group} \times 100$$

Statistical analysis

The collected data were organized using Microsoft Excel. Averages of EPG and corresponding standard deviations were calculated. Additionally, efficacies along with their 95% confidence intervals were determined.

The EPG values and the number of adult *F. hepatica* (NAP) were subjected to the Shapiro-Wilk normality test. Since not all values conformed to the assumptions of normality or variance were high, these were analyzed using the Kruskal-Wallis test to identify potential statistical differences in mean EPG or NAP among the three groups and across different days. The comparison of clinical and absolute efficacies between treatment groups was performed using the Mann-Whitney U test, a non-parametric method suitable for data that do not follow a normal distribution. All analyses were conducted using IBM SPSS Statistics version 27.0.1 and a significance level of $p<0.05$ was considered.

RESULTS

The EPG decreased in both groups, T1 (*C. weberbaueri*) and T2 (triclabendazole), compared to T0 (Control Group). However, no statistical differences were observed between groups or days (Table 1). Similarly, efficacies between both treatment groups did not show statistical differences in days, except for

Table 1. Fecal count egg per gram of feces (EPG) in groups of calves experimentally infected with *Fasciola hepatica*

Day	Count	T0: Control	T1: 200 mg.kg^{-1} ×4 d *C. weberbaueri*	T2: 12 mg.kg^{-1} Triclabendazole	*p-value* [a]
Day 0	EPG x̄ ± SD	9.00 ± 2.94	13.25 ± 0.96	11.75 ± 2.87	*0.094*
Day 8		9.25 ± 2.75	7.75 ± 2.87	8.75 ± 4.79	*0.734*
Day 16	EPG x̄ ± SD	8.25 ± 0.96	6.75 ± 2.06	9.25 ± 2.06	*0.258*
Day 24		6.25 ± 0.96	7.00 ± 1.15	8.25 ± 0.96	*0.082*
Day 32		8.5 ± 0.58	6.75 ± 2.06	9.00 ± 1.41	*0.300*
p-value [a]		*0.379*	0.070	0.057	

SD: Standard deviation
[a]No statistical difference between rows and or columns ($p>0.05$, Kruskal-Wallis test)

Table 2. Clinical efficacy compared between *Chuquiraga weberbaueri* extract and triclabendazole in experimentally infected calves with *Fasciola hepatica*

Days	% Efficacy (95% CI)		*p-value*	Status
	T1: 200 mg.kg^{-1} ×4 d *C. weberbaueri*	T2: 12 mg.kg^{-1} Triclabendazole		
Day 8	41.51 (28.24 - 54.78)	25.53 (13.06 - 38.00)	*0.886*	IA
Day 16	49.06 (35.60 - 62.52)	21.28 (9.58 - 32.98)	*0.200*	IA
Day 24	47.17 (33.73 - 60.61)	29.79 (16.71 - 42.87)	*0.200*	IA
Day 32	49.06 (35.60 - 62.52)	23.40 (11.30 - 35.50)	*0.200*	IA
Average	46.70 (33.27 - 60.13)	25.00 (12.62 - 37.38)	*0.029**	IA

CI: Confidence interval
*Statistical difference between both treatment groups ($p<0.05$, Mann-Whitney U test)
IA: Insufficiently active

the general efficacy (p<0.05) (Table 2).

During the necropsy, the fecal egg count and the number of adult *F. hepatica* parasites in the bile ducts of the calves were recorded (Figure 1). The highest number of adult parasites (NAP) was observed in the Control Group, followed by T1, and finally T2, although these differences were not statistically significant (p>0.05) (Table 3). Furthermore, the percentage reduction of NAP (efficacy) between T1 and T2 also did not show a significant difference (p>0.05) (Table 4).

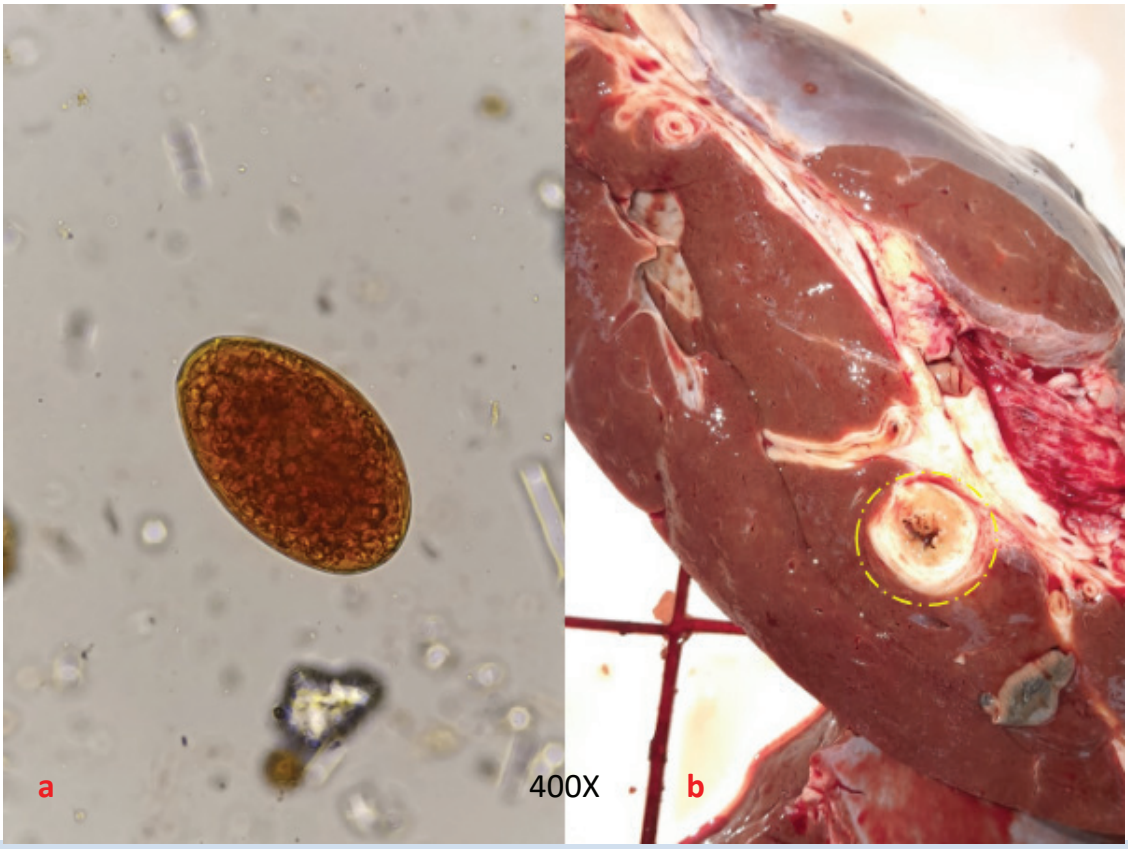

Figure 1. Egg observed in Natural Sedimentation (a) and adult *Fasciola hepatica* parasite in the bile ducts of the calves (b). Calcification of the bile ducts is observed (yellow circle)

Table 3. Count of the number of adult parasites (NAP) in groups of calves experimentally infected with *Fasciola hepatica* at postmortem

Group	Calve	NAP Count	Mean$^{(G)}$ NAP ± SD	*p-value**
T0: Control	**I**	4	8.85 ± 13.22	
	II	12		
	III	4		
	IV	32		
T1: 200 mg.kg^{-1} ×4 d *C. weberbaueri*	**I**	3	3.66 ± 0.96	*0.204*
	II	4		
	III	5		
	IV	3		
T2: 12 mg.kg^{-1} Triclabendazole	**I**	2	2.99 ± 1.50	
	II	2		
	III	5		
	IV	4		

$^{(G)}$ Geometric mean
SD: Standard deviation
*No statistical difference between groups (p>0.05, Kruskal-Wallis test)

Table 4. Comparative absolute efficacy of *Chuquiraga weberbaueri* extract and triclabendazole in calves experimentally infected with *Fasciola hepatica*

Group	% Efficacy (95% CI)	*p-value**	Status
T1: 200 mg.kg^{-1} ×4 d *C. weberbaueri*	58.63 (45.24 - 72.02)	*0.686*	IA
T2: 12 mg.kg^{-1} Triclabendazole	66.22 (53.36 - 79.08)		IA

CI: Confidential interval
*No statistical difference between groups (p>0.05, Mann-Whitney U test)
IA: Insufficiently active

DISCUSSION

The egg count in the control and treated group with *C. weberbaueri* and triclabendazole did not reveal any statistical differences (p>0.05). Similarly, the count of adult *F. hepatica* during necropsy was comparable across the three groups (p=0.204).

The plant *C. weberbaueri* has been evaluated in sheep infected with *F. hepatica* at a dose of 100 mg.kg^{-1} over five consecutive days using an aqueous extract, achieving an absolute efficacy of 51.79% (Ortiz et al., 2023). In this study, the absolute efficacy at a double dose (200 mg.kg^{-1}) was slightly higher (58.63%), indicating that the plant is more effective at higher doses, as the NAP was lower (min. 3 and max. 5) compared to the findings of Ortiz et al. (2023), who reported NAPs ranging from 20 to 80. The same authors suggest that the fasciolicidal activity of the plant is due to its phenolic compounds, such as chlorogenic acid, ethyl caffeate, flavonoids, saponins, and lactones.

It is important to note that no clinical signs or symptoms of toxicity were observed at the administered dose. However, further toxicity studies at different concentrations of the plant are necessary to confirm these findings and determine a safe dosage range for cattle. At a dose of 100 mg.kg^{-1}, liver enzymes and hepatic markers in sheep did not indicate any significant toxicity of the aqueous extract after the third week of treatment (Ortiz et al., 2023).

On the other hand, in local cattle farming in Cajamarca, triclabendazole has been reported as ineffective for several years. A study with a clinical trial and an *in vivo* efficacy test in sheep showed an efficacy of 25.2% against *F. hepatica* isolated from dairy cattle in Cajamarca, Peru (Ortiz et al., 2013). In a recent study, efficacy ranging from 13.36 ± 4.30 to 62.24 ± 9.60% was found in fasciolosis control in naturally infected dairy cattle (Rojas-Moncada et al., 2024).

Triclabendazole has been reported as insufficiently active in other regions of Peru, particularly in dairy cattle from the Mantaro valley for example (Chávez et al., 2012; Zárate-Rendón et al., 2023). In various countries around the world, *F. hepatica* has been reported as resistant to triclabendazole due to its prolonged use in combating fasciolosis in both animals and humans (Cabada et al., 2016; McMahon et al., 2016; Ramadan et al., 2019).

In light of the results of the present study, measures recommended by various authors need to be implemented. The proper use of anthelmintic drugs and the exploration of alternative approaches are essential strategies to curb the development of anthelmintic resistance. As anthelmintic resistance poses a serious challenge worldwide, the proper use of existing anthelmintics and reducing dependence on these drugs should be implemented to address this challenge (Fissiha and Kinde, 2021).

Although *C. weberbaueri* was insufficiently active (efficacy <80), its use could be beneficial in reducing the parasitic loads of *F. hepatica* in dairy cows or animals with parasites resistant to multiple drugs. On one hand, it represents a more environmentally friendly alternative because chemical anthelmintics alter soil microorganisms (Goodenough et al., 2019; Villar and Schaeffer, 2022). On the other hand, it would provide greater safety for humans as chemical drugs can accumulate in the animal's body and derive products for consumption (Rana et al., 2019).

CONCLUSION

The clinical efficacy of the *C. weberbaueri* extract was superior to that of triclabendazole; however, in terms of absolute efficacy, triclabendazole exhibited a slightly better performance, although without reach-

ing statistical differences. Both anthelmintics proved insufficiently active as they did not significantly reduce the presence of eggs or adult parasites of *F. hepatica* in the calves, suggesting they cannot be considered effective fasciolicides. Despite these results, *C. weberbaueri* could be useful as an ecological alternative to reduce the parasitic load in dairy cattle and obtain products free from synthetic drugs.

CONFLICT OF INTEREST

None declared.

REFERENCES

Beesley NJ, Caminade C, Charlier J, Flynn RJ, Hodgkinson JE, Martinez-Moreno A, et al (2018) Fasciola and fasciolosis in ruminants in Europe: Identifying research needs. Transbound Emerg Dis 65: 199-216.

Benlarbi F, Mimoune N, Chaachouay N, Souttou K, Saidi R, Mokhtar MR, et al (2023) Ethnobotanical survey of the traditional antiparasitic use of medicinal plants in humans and animals in Laghouat (Southern Algeria). Vet World 16: 357-68.

Cabada MM, López M, Cruz MCP, Delgado JR, Hill V, White AC (2016) Treatment failure after multiple courses of triclabendazole among patients with fascioliasis in Cusco, Peru: a case series. PLOS Negl Trop Dis 10: e0004361.

Chávez A, Sánchez L, Arana C, Suárez F (2012) Resistance to anthelmintics and prevalence of bovine fasciolosis in dairy farms in Jauja, Peru. Rev Inv Vet Perú. 23: 90-7.

Dennis W R, Stone WM, Swanson LE (1954) A new laboratory and field diagnostic test for fluke ova in feces. J Am Vet Med Assoc 124: 47-50.

Fissiha W, Kinde MZ (2021) Anthelmintic Resistance and Its Mechanism: A Review. Infect Drug Resist 2021: 5403-10.

Githiori J, Höglund J, Waller P (2005) Ethnoveterinary plant preparations as livestock dewormers: Practices, popular beliefs, pitfalls and prospects for the future. Anim Health Res Rev 6: 91-103.

Goodenough AE, Webb JC, Yardley J (2019) Environmentally-realistic concentrations of anthelmintic drugs affect survival and motility in the cosmopolitan earthworm *Lumbricus terrestris* (Linnaeus, 1758). Appl Soil Ecol 137: 87-95.

McMahon C, Edgar H, Hanna R, Ellison S, Flanagan AM, McCoy M A, et al (2016) Liver fluke control on sheep farms in Northern Ireland: A survey of changing management practices in relation to disease prevalence and perceived triclabendazole resistance. Vet Parasitol 216: 72-83.

Mpisana Z, Jaja IF, Byaruhanga C, Munyaradzi CM (2022) Body condition scores, fluke intensity, liver pathology, and carcass quality of different dairy cattle genotypes infected with *Fasciola* species at high throughput abattoirs in South Africa. Parasitol Res 121: 1671-82.

Nasreldin N, Zaki RS (2020) Biochemical and immunological investigation of fascioliasis in cattle in Egypt. Vet World 13: 923-30.

Nyahangare ET, Mvumi BM, Mutibvu T (2015) Ethnoveterinary plants and practices used for ecto-parasite control in semi-arid smallholder farming areas of Zimbabwe. J Ethnobiol Ethnomed 11: 30.

Ortiz P, Scarcella S, Cerna C, Rosales C, Cabrera M, Guzmán M, et al (2013) Resistance of *Fasciola hepatica* against Triclabendazole in cattle in Cajamarca (Peru): A clinical trial and an in vivo efficacy test in sheep. Vet Parasitol 195: 118-21.

Ortiz P, Cerna C, García A, Hobán C, Murga-Moreno CA, Cabrera M, et al (2023) Chemical Composition and Anthelmintic Activity of the Peruvian Endemic Species *Chuquiraga weberbaueri* "Amaro" on Sheep Fasciolosis. Rec Nat Prod 17: 1031-45.

Ramadan HK-A, Hassan WA, Elossily NA, Ahmad AA, Mohamed AA., Abd-Elkader AS, (2019) Evaluation of nitazoxanide treatment following triclabendazole failure in an outbreak of human fascioliasis in Upper Egypt. PLOS Negl Trop Dis 14: e0008443.

Rana MS, Lee SY, Kang HJ, Hur SJ (2019) Reducing Veterinary Drug Residues in Animal Products: A Review. Food Sci Anim Resour 39: 687-703.

Rázuri B, Murga-Moreno C, Vargas-Rocha L, Rojas-Moncada J, Torrel-Pajares T (2023) First Report of *Fasciola hepatica* in Creole Horses from the Northern Andes of Peru. Cienc Tecnol Agropecuaria 24: e3190.

Rojas-Moncada J, Saldaña L, Urteaga V, Vergara R, Rojas A, Torrel S, et al (2024) Efficacy of anthelmintic drugs to control *Fasciola hepatica* in dairy cattle in Peru. Rev Colomb Cienc Pecu 37: 101-112.

Torrel S, Rojas-Moncada J, Saldaña K, Silva M, Gallardo I, Cadenillas RP, et al (2023) Trematodes of dairy cattle grazing in Cajamarca: *Fasciola hepatica* and *Calicophoron microbothrioides*. Rev Inv Vet Perú 34: e24296.

Torrel TS, Rojas-Moncada J, Estela JE, Vargas-Rocha LA (2022) *Fasciola hepatica* in *Cavia porcellus* from 10 communities in the district of Chota, Cajamarca, Peru. Rev Inv Vet Perú 33: e20880.

Villar D, Schaeffer DJ (2022) Ivermectin use on pastured livestock in Colombia: parasite resistance and impacts on the dung community. Rev Colomb Cienc Pecu 36: 3-12.

Wood IB, Amaral NK, Bairden K, Duncan JL, Kassal T, Malone Jr JB, et al (1955) World Association for the Advancement of Veterinary Parasitology (W.A.A.V.P.) second edition of guidelines for evaluating the efficacy of anthelmintics in ruminants (bovine, ovine, caprine). Vet Parasitol 58: 181-213.

Young KE, Garza V, Snowden K, Dobson RJ, Powell D, Craig TM (1999) Parasite diversity and anthelmintic resistance in two herds of horses. Vet Parasitol 85: 205-14.

Zárate-Rendón DA, Briones-Montero A, Huaraca-Oré NA, Veirano GS, Levecke B, Geldhof P (2023) Comparison of the therapeutic efficacy of five anthelmintics against natural *Fasciola hepatica* infections in dairy cattle from the Mantaro Valley, Peru. Vet Parasitol Reg Stud Rep 38: 100827.