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Anthelmintic Efficacy of Complex Herbal Preparations and their Effect on Hematological Parameters in Sheep

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ABSTRACT

Gastrointestinal helminthiases are among most widespread and economically important diseases of small ruminants. It can lead to retardation in growth, reduced productivity, and significant financial losses. In Kazakhstan, infestation rates in sheep often exceed 79%. The complete reliance on chemical anthelmintics have created concerns of drug resistance, residues, and environmental impacts. These challenges highlight urgent need for effective, safe, and eco-friendly alternatives. Medicinal plants represent a promising solution but comprehensive in vivo studies under natural infection conditions remain limited. Our study investigates the in-vivo anthelmintic efficacy of a complex of medicinal plants *Artemisia absinthium, Artemisia lerchiana, Hypericum perforatum, Bidens tripartita*, and *Chelidonium majus*. The clinical and parasitological tests were conducted on 40 sheep having the age between 1–2 years, spontaneously infected with *Moniezia* and *Strongylata*. The infestation was assessed by helminth egg counts in VIGIS chamber. The effectiveness of preparations was evaluated 14 days after the administration in terms of the prevalence efficacy and intensity efficacy. The results of control and critical tests showed high anthelmintic efficacy against gastrointestinal helminthic diseases in sheep. Complex herbal preparation 1 achieved 90% IE and 90% PE against *Moniezia*, and 95% IE and 90% PE against strongylata. These results were found comparable to standard albendazole-based drug Alvet. The second complex herbal preparation 2 showed 80.5% IE and 80% PE against *Moniezia*, and 90.2% IE with 80% PE against strongylata. The other hematological and biochemical parameters were found with in normal values and bactericidal activity of serum was found increased in treated groups. The findings highlight potential of plant-based formulations as effective and eco-friendly alternatives to synthetic anthelmintics.

Keywords: Anthelmintic efficacy, Common wormwood, Lerche's wormwood, Perforate St. John's wort, Three-part beggar ticks, Greater celandine, In-vivo method.

INTRODUCTION

Sheep farming is an important component of the livestock sector in Kazakhstan. It contributes to the production of high-quality meat, milk, and wool. Sheep farming is also supporting the country's export potential. The animal husbandry has been intensified now to meet growing domestic and international demand (Abutalip et al. 2024). However, certain health challenges such as parasitic diseases have become increasingly significant. Among these, gastrointestinal helminthiases remain one of most serious threats to productivity (Karmaliev et al. 2020). It can cause growth retardation in young animals, reduced reproductive efficiency, deterioration of general health and economic losses (Mavrot et al. 2015). The prevalence of helminth infections in sheep in Kazakhstan is reported to be as high as 79–89% depending on farm type and climatic zone (Kositsa 2020).

Conventional control of gastrointestinal helminths largely relies on chemical anthelmintics (Karmaliev 2021). These anthelmintics form basis of deworming strategies worldwide (Iatusevich 2017). However, their long-term and indiscriminate use has resulted in serious drawbacks. These drawbacks include the development of drug resistance, residue accumulation in meat and milk, environmental contamination, and consumer health concerns. In addition, the economic burden associated with repeated chemical treatments further challenges

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resource-limited farmers. These limitations highlight urgent need for alternative, environmentally safe, and cost-effective anthelmintic strategies (Sargison 2012).

Phytotherapy represents hopeful approach for sustainable parasite control. Medicinal plants have long been used in ethnoveterinary practice. It offers broad pharmacological actions, lower toxicity and reduced risk of resistance development when compared to synthetic drugs (Novruzova 2023). In recent years, more attention has been given to antiparasitic potential of local flora, particularly in regions such as Kazakhstan (Nametov et al. 2023).

Among these plants, wormwood species (*Artemisia absinthium*, *Artemisia lerchiana*) are well documented for their strong anthelmintic, bactericidal, and antiparasitic properties (Magerramov 2013). Their essential oils and tannins have been shown to disrupt parasite metabolism and cuticular integrity. Similarly, perforate St. John's wort (*Hypericum perforatum*) contains bioactive compounds such as hypericin, flavonoids, and essential oils. They exert antimicrobial, anti-inflammatory, and antiparasitic effects (Avdachenok 2017; Eliseeva and Tkacheva 2018; (Karmaliev et al. 2024). Greater celandine (*Chelidonium majus*) is rich in isoquinoline alkaloids (e.g., chelidonine). It impairs mitochondrial functions of parasites and contributes to reduced viability (Li et al. 2024). Three-part beggarticks (*Bidens tripartita*) show pronounced anti-inflammatory, immunomodulatory, and antiparasitic activities. This is due to their tannins, essential oils, and polyphenols (Karomatov & Abduvokhidov 2017; Rodin et al. 2022).

Although the antiparasitic properties of individual plants have been investigated in vitro and and in-vivo (Karim et al. 2019; Higuera-Piedrahita et al. 2022). However, limited research has focused on the efficacy of complex polyherbal formulations. Polyherbal combinations are hypothesized to provide synergistic effects. It enhances potency and lowers the risk of development of resistance (Singh et al. 2018). Importantly, studies explore application of such combinations in sheep within the context of Kazakhstan's unique agro-ecological environment are lacking.

Therefore, the present study was designed to evaluate the anthelmintic efficacy of locally available polyherbal formulations composed of *Artemisia absinthium*, *A. lerchiana*, *H. perforatum*, *B. tripartita*, and *C. majus* in naturally infected sheep in Kazakhstan. The study also aimed to assess the impact of those formulations on hematological and biochemical parameters. It helps to explore their potential as sustainable alternatives to synthetic anthelmintics.

MATERIALS AND METHODS

Animals and their clinical examination

The experiments with complex herbal preparations were conducted in the scientific laboratory of West Kazakhstan Agrarian and Technical University named after Zhangir Khan.

The study was conducted on a sample of 40 heads of sheep aged 1–2 years old that were spontaneously infected with gastrointestinal *Moniezia* and *Strongylata*. The sheep were kept at the Nurkhan peasant farm (West Kazakhstan Region, Taskalinsk District) in typical steppe conditions. These conditions are characterized by a semi-arid continental climate (average temperature 20-35°C in summer, -5 to -20°C in winter; low humidity; natural pasture grazing). The animals were examined for signs of helminth infestation, and their clinical parameters were analyzed.

Fecal sample collection

40 fecal samples were collected from the 40 animals under study to detect gastrointestinal helminth infestation. The samples were placed in sterile tubes with labels and screw caps and transported to the scientific laboratory of West Kazakhstan Agrarian and Technical University named after Zhangir Khan in a refrigerator.

Parasitological examination

Each fecal sample was macroscopically examined to determine color, odor, and consistency. In addition, the feces were examined for the presence of parasites, blood, or mucus.

Microscopic study

The infestation of animals was determined following the Fülleborn ovoscopy method by counting the number of helminth eggs in a VIGIS chamber. The infested animals were divided into four groups of 10 animals each according to the principle of analogs and labeled with marking spray and microchips to assign them a unique number for radio frequency identification (Karmaliev et al. 2016). This procedure was used to detect parasite eggs (Fig. 1a, b). After thorough mixing, the suspension was sieved to remove undigested feed particles. The liquid was poured into a test tube, and a saturated salt solution was added to fill the volume. The tubes were centrifuged at 1,500rpm for 5 minutes to improve egg resuspension. A coverslip was placed on the surface of the liquid and left for several minutes, after which the tubes were carefully removed in an upright position. The coverslip was transferred to a slide and viewed under a microscope with an 8 MP digital camera and a 10.5-inch LCD touch screen (OPTO-EDU (BEIJING) CO., LTD, model A59.3521).

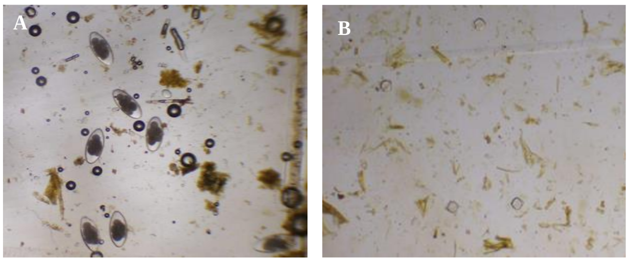

Fig. 1: Helminth eggs in sheep feces; *a — gastrointestinal Strongylata, b — Moniezia.*

Egg counting method

From the total mass of the mixed fecal sample, 1g was taken and placed in a porcelain mortar, adding a small amount of flotation solution and mixing thoroughly with a pestle. The volume was then brought to 30mL. The resulting suspension was filtered through a metal sieve into a plastic beaker with a volume of 30mL and left to settle for 15 minutes. The surface layer was then transferred with a wire loop of 8mm in diameter into one of the chamber cells. The next sample was transferred to the next cell in the same way.

After all cells were filled, the chamber was covered with a plate with a grid, and the cells were filled with flotation solution to full volume using a Pasteur pipette. The eggs floated up and settled on the underside of the upper plate, after which they were counted under a microscope. To determine the number of eggs per 1g of feces, the number of eggs found in each cell was multiplied by a factor of 7.6.

Anthelminthic agents

Complex herbal preparation 1 was made up of: 3 parts of *A. absinthium* infusion, 2 parts of *A. lerchiana* infusion, and 1 part of *H. perforatum*, *B. tripartita*, and *C. majus* infusions each. The preparation was given to sheep at a dosage of 200mL per head, three times at a 24-hour interval. Another complex herbal preparation 2 contained: 3 parts *A. lerchiana* infusion, 2 parts *A. absinthium* infusion, and 1 part *H. perforatum, B. tripartita,* and *C. majus* infusions each. The preparation was given to sheep at a dosage of 200mL per head, three times at a 24-hour interval. The anthelmintic Alvet suspension 10% was administered at a dose of 0.5mL of suspension per 10kg of animal weight (albendazole 5.0mg/kg) once. All drugs were administered individually, orally.

Preparation of medicinal plant infusions

The examined locally sourced medicinal plants *A. absinthium, A. lerchiana, H. perforatum, B. tripartita,* and *C. majus* were used in the form of infusions made according to conventional pharmacological methods. To prepare the infusions, a container with ground plant material was filled with room-temperature water. The mixture was cooked on a water bath with frequent stirring for 15min, then strained, squeezing the plant material, and cooled at room temperature (Karmaliev 2019).

Experimental design

The total sample of 40 sheep was divided into four groups: three experimental and one control. It was done using the principle of analogs (balanced by age, sex, and infection intensity). Animals were marked by spray and microchip for identification. Randomization was performed using a random number generator, and egg counts were conducted by laboratory personnel blinded to group assignments to minimize bias. Following was done to each group;

- **Group 1:** Complex herbal preparation 1 (*A. absinthium* 3 parts, *A. lerchiana* 2 parts, *H. perforatum, B. tripartita*, *C. majus* 1 part each). Dose: 200mL/head orally, given three times at 24-h intervals.
- **Group 2:** Complex herbal preparation 2 (*A. lerchiana* 3 parts, *A. absinthium* 2 parts, *H. perforatum, B. tripartita, C. majus* 1 part each). Same dosage and schedule.
- **Group 3:** Alvet suspension 10% (albendazole, 5 mg/kg orally, single dose).
- **Group 4:** Untreated control.

Anthelmintic efficacy was assessed by both control and critical tests (Arkhipov 2009). Prevalence efficacy (PE) was calculated as proportion of dewormed animals completely free of helminths. The intensity efficacy (IE) was calculated as the percentage reduction in mean EPG between pre- and post-treatment values. According to international criteria, IE ≥ 90% is considered high, 80–90% moderate, 60–80% low, and < 60% ineffective (Karmaliev et al. 2016). Hematological blood tests were performed using a Mindray BC-2800Vet hematology analyzer, and biochemical blood tests were performed using a Fugji Dri-Chem NX-500i biochemical analyzer. Humoral immunity factors were studied by determining the bactericidal activity of blood serum according to the method of Emelianenko et al. (1980).

RESULTS

Prior to the experiment, all animals underwent a complete clinical examination and blood testing. Clinically healthy animals were allowed to participate in the experiments. In studying the morphological composition of the blood, we determined the total counts of leucocytes, erythrocytes, hemoglobin, and platelets, as well as hematocrit and plateletcrit (Table 1).

Hematological tests in the first experimental group receiving complex herbal preparation 1 show that on the 14th day after the preparation was administered, the levels of (hemoglobin: 90–150g/L; erythrocytes: 9–15 $\times 10^{12}$/L; leukocytes: 4–12 $\times 10^{9}$/L; total protein: 60–79g/L). In the second experimental group treated with complex herbal preparation 2, hemoglobin, erythrocytes, leukocytes, platelets, hematocrit, and plateletcrit remained within the physiological norm by day 14 with minor changes. The blood tests in the third experimental group, which was administered 10% Alvet suspension 10%, also show all hematological parameters within the physiological norm. Finally, the control group, which received no treatment, had normal hematological parameters. Thus, after oral administration of complex herbal preparations 1 and 2, the hematological blood parameters in the first and second experimental groups were within the norm and did not differ from those of the control group. No pathological changes were observed.

In studying the dynamics of protein metabolism indicators, we examined the levels of total protein, albumins, and α, β, and γ-globulins (Table 2). Biochemical tests of the blood serum in the first experimental group receiving complex herbal preparation 1 show that on the 14th day after treatment, total protein, albumin, and α-, β-, and γ-globulins remained within the physiological norm with minor fluctuations. Blood serum biochemistry in the second experimental group, administered complex herbal preparation 2, shows that on the 14th day after treatment, total protein, albumin, and α-, β-, and γ-globulins remained within the physiological norm with minor changes. Biochemical blood tests of the third experimental group, treated with 10% Alvet suspension, found all parameters within physiological norms. In the control group, all biochemical parameters also fell within physiological norms. Thus, after oral administration of complex herbal preparations 1 and 2, there were no pathological changes and deviations from physiological norms in the biochemical parameters of blood.

The dynamics of bactericidal activity of the blood serum in sheep under treatment with different anthelmintic preparations are shown in Table 3. An increase in bactericidal activity is observed in the first, second, and third groups: 43.57±0.81-48.85±2.98; 42.98±0.64-47.23±2.64; and 41.12±0.82-47.08±1.83, respectively,

Table 1: Dynamics of some hematologic parameters before and after the experiment

Blood counts	Day				
	Pre-experiment	Treatment day 1	Treatment day 5	Treatment day 7	14 days post-treatment
Experimental group 1					
Hemoglobin, g/L	107.0±0.79	102.0±1.36	97.2±0.96	104.2±1.56	106.2±1.74
Erythrocyte count, 10^{12}/L	10.48±0.230	9.34±0.057	9.28±0.143	9.38±0.065	10.08±0.096
Leukocyte count, 10^9/L	8.4±0.096	9.8±0.272	10.3±0.136	10.1±0.193	9.7±0.079
Platelet count, 10^9/L	397±1.2	301±2.0	286±0.8	326±1.4	348±1.9
Hematocrit, %	31.48±0.98	28.42 ±0.23	28.12±0.27	29.74 ±0.09	29.20±0.27
Plateletcrit, %	0.32±0.011	0.30±0.005	0.27 ±0.005	0.28±0.004	0.29±0.005
Experimental group 2					
Hemoglobin, g/L	102.0±1.27	94.0±1.58	92.2±1.08	95.4±1.95	97.2±1.29
Erythrocyte count, 10^{12}/L	9.84±0.075	9.56±0.115	7.28±0.082	8.98±0.185	9.40±0.209
Leukocyte count, 10^9/L	8.4±0.093	9.8±0.169	10.1±0.234	9.7±0.127	9.4±0.209
Platelet count, 10^9/L	402±1.4	364±2.1	352±1.0	368±2.9	385±1.5
Hematocrit, %	30.40±0.57	28.82±0.22	28.32±0.11	29.40±0.20	29.74±0.40
Plateletcrit, %	0.28±0.005	0.26±0.005	0.25±0.009	0.26±0.014	0.26±0.016
Experimental group 3					
Hemoglobin, g/L	151.2±0.42	141.0±0.50	138.0±0.35	138.0±0.50	143.2±0.74
Erythrocyte count, 10^{12}/L	12.4±0.447	11.7±0.602	10.6±0.273	11.4±0.570	11.6±0.570
Leukocyte count, 10^9/L	8.8±0.418	10.0±0.500	10.4±0.447	9.4±0.570	9.0±0.353
Platelet count, 10^9/L	531±0.4	531±0.5	470±8.8	493±3.3	489±4.4
Hematocrit, %	44.60±0.27	43.90±0.57	41.20±0.42	41.80±0.65	42.60±0.57
Plateletcrit, %	0.35±0.008	0.31±0.009	0.29±0.006	0.29±0.004	0.28±0.005
Control group					
Hemoglobin, g/L	110.0±0.93	107.4±0.57	98.0±0.79	101.0±1.27	102.0±0.93
Erythrocyte count, 10^{12}/L	9.4±0.032	8.2±0.041	8.2±0.079	8.5±0.074	9.0±0.144
Leukocyte count, 10^9/L	9.2±0.111	10.4±0.290	10.8±0.169	10.1±0.127	9.8±0.191
Platelet count, 10^9/L	526±3.2	489±3.8	445±5.0	495±5.6	501±4.8
Hematocrit, %	30.50±0.60	29.70±0.50	26.70±0.49	27.80±0.29	28.60±0.60
Plateletcrit, %	0.32±0.007	0.29±0.008	0.27±0.004	0.29±0.006	0.30±0.006

Table 2: Dynamics of protein metabolism indicators during treatment with anthelmintic drugs

Blood counts	Day				
	Pre-experiment	Treatment day 1	Treatment day 2	Treatment day 3	14 days post-treatment
Experimental group 1					
Total protein, g/L	72.10±0.370	69.00±0.395	70.00±0.790	70.30±0.602	72.40±0.570
Albumins, g/L	39.40±0.570	39.90±0.370	40.20±0.418	40.60±0.480	39.70±0.418
α-globulins, %	21.60±0.414	21.50±0.250	21.80±0.418	21.90±0.447	20.80±0.418
β-globulins, %	11.60±0.209	11.50±0.250	11.30±0.335	11.10±0.325	10.90±0.370
γ-globulins, %	19.20±0.651	19.80±0.418	20.30±0.335	20.70±0.547	22.40±0.410
Experimental group 2					
Total protein, g/L	72.80±0.418	66.60±0.570	67.50±0.559	69.40±0.570	70.00±0.790
Albumins, g/L	39.40±0.570	39.90±0.370	38.40±0.447	38.60±0.447	38.80±0.651
α-globulins, %	20.40±0.570	21.10±0.273	21.8±0.418	22.10±0.447	22.10±0.370
β-globulins, %	13.40±0.447	13.80±0.418	13.50±0.250	13.90±0.370	13.70±0.418
γ-globulins, %	21.50±0.250	22.10±0.370	22.0±0.353	22.30±0.418	21.80±0.418
Experimental group 3					
Total protein, g/L	69.60±0.908	67.30±0.782	65.10±0.715	63.50±0.745	64.40±0.570
Albumins, g/L	37.00±0.790	37.40±0.447	38.50±0.612	38.80±0.821	38.80±1.193
α-globulins, %	19.80±0.961	20.40±0.670	20.80±0.651	21.60±0.570	21.40±0.570
β-globulins, %	11.40±0.447	11.60±0.447	11.80±0.418	11.40±0.447	11.30±0.894
γ-globulins, %	21.50±0.559	22.40±0.758	21.60±0.570	21.00±0.353	21.20±0.741
Control group					
Total protein, g/L	71.10 ±0.570	68.20 ±0.651	64.80±0.741	65.80±0.894	67.40±0.570
Albumins, g/L	38.40±0.570	38.70±0.894	39.80±0.821	39.40±0.570	39.20±0.651
α-globulins, %	20.30±0.418	20.80±0.741	21.40±0.570	21.60±0.570	22.00±0.353
β-globulins, %	11.80±0.547	12.40±0.670	12.00±0.612	11.80±0.741	11.60±0.447
γ-globulins, %	27.30±0.418	26.60±0.570	25.80±0.418	26.20±0.741	26.00±0.935

Table 3: Dynamics of bactericidal activity indices in blood serum in sheep when using anthelmintic drugs

Group	Day				
	Pre-experiment	Treatment day 1	Treatment day 2	Treatment day 3	14 days post-treatment
Experimental 1	43.57±0.81	44.68±0.34	45.01±0.67	46.56±0.87	48.85±2.98
Experimental 2	42.98±0.64	43.97±1.98	44.78±1.65	45.92±0.62	47.23±2.64
Experimental 3	41.12±0.82	42.58±0.87	43.73±0.47	45.17±0.35	47.08±1.83
Control	42.13±0.55	42.08±0.66	42.01±0.45	41.5±1.18	37.65±0.24

by day 14, which represents a significantly higher level than at the start of the experiment. In the control group, which was left untreated, there is a decrease in the bactericidal activity of blood serum 42.13±0.55-37.65±0.24. Thus, after oral administration of complex herbal preparations 1 and 2, the bactericidal activity of blood serum increased significantly in the first and second experimental groups, as well as in the third group, which shows the positive effect of complex herbal preparations 1 and 2 on natural resistance.

The efficacy of complex herbal preparations 1 and 2 was tested on sheep compared with synthetic antihelminthic agents. For this purpose, we used 40 sheep spontaneously infected with monieziasis and gastrointestinal strongyloidiases (Fig. 2). The control and critical tests show that in the first group of animals, the IE of the preparation against monieziasis amounts to 90% and the PE to 90.0%. In the case of gastrointestinal strongyloidiases, the IE reaches 95%, and the PE totals 90.0%. In the second group, the IE against monieziasis amounts to 80.5%, and the PE equals 80.0%. In gastrointestinal strongyloidiases, the IE of the preparation is 90.2% and PE is 80.0%. In the third group, the IE for monieziasis was 97%, and the PE was 90.0%. In the case of gastrointestinal strongyloidiases, the IE amounted to 99.0%, and PE was 90.0%. The control group was infested with moniziae and gastrointestinal strongyloidiases throughout the experiment (II – 100%).

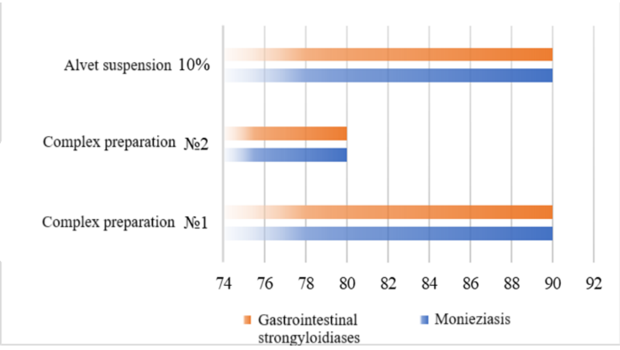

Fig. 2: Anthelmintic efficacy of preparations in monieziasis and gastrointestinal strongyloidiases in sheep.

Thus, according to the results of *in vivo* methods of control and critical tests, complex herbal preparation 1 showed high anthelminthic efficacy in gastrointestinal helminthiasis of ruminants at the same level as the standard anthelmintic Alvet suspension. Notably, complex herbal preparation 2 also demonstrated good anthelmintic efficacy in gastrointestinal strongyloidiases in terms of the IE. Overall, both complex herbal preparations were safe. They maintained normal hematological and biochemical profiles and improved bactericidal activity of serum. Preparation 1 achieved efficacy comparable to Alvet whereas preparation 2 showed moderate efficacy against *Moniezia*.

DISCUSSION

Our present study assessed the anthelmintic efficacy of *Artemisia absinthium*, *Hypericum perforatum*, *Bidens tripartita*, and *Chelidonium majus* extracts in naturally infected sheep. Our study revealed significant reductions in fecal egg counts and improvements in hematological parameters. Our study highlighted the potential of polyherbal formulations in sustainable parasitic management. Our study further aligns with the growing body of research supporting plant-based alternatives to synthetic anthelmintics in small ruminants.

Our results are in conformation with multiple recent reports, which showed the promising anthelmintic efficacy of herbal extracts. For instance, Karim et al. (2019) found that *Artemisia sp.* methanolic extract reduced *Haemonchus contortus* egg hatchability by over 85% in-vitro. These finding are similar to high reduction rates in our study (Higuera-Piedrahita et al. 2021). Likewise, another study reported significant reduction in fecal egg count in sheep treated with *Artemisia abyssinica*. This indicated the broad-spectrum activity of genus across species and extraction methods (Higuera-Piedrahita et al. 2022).

Hypericum perforatum has been less extensively studied as an anthelmintic. However, in a study Selvi et al. (2023), it is demonstrated that *Hypericum* ethanolic extract inhibited larval motility of gastrointestinal nematodes in goats. This finding is also congruent with our observed efficacy in-vivo. The activity is attributed to hypericin and flavonoids that disrupt parasite neuromuscular coordination.

In parallel, our findings on *Bidens tripartita* align with work of Кармалиев et al. (2025), who reported noteworthy ovicidal and larvicidal activity of Asteraceae family members, (including *Bidens*) against strongyle-type nematodes. Similarly, plant polyphenols from *Bidens pilosa* were shown to interfere with parasite metabolism. This reinforced the importance of this genus as source of natural anthelmintics.

Chelidonium majus is traditionally recognized for alkaloids such as chelidonine (Li et al. 2024). It has also demonstrated efficacy, which is consistent with our observations. Another recent work confirmed that isoquinoline alkaloids impair mitochondrial functions of helminths. This leads to reduced viability of parasite (Faixová et al. 2021). This study supports our hypothesis that multiple phytoconstituents in *Chelidonium* act synergistically to exert effects against nematodes.

In our study, we utilized polyherbal combination that yielded higher efficacy than individual plant extracts. This also resonates with findings by Singh et al. (2018), where they used blend of Poly Herbal Mixtures (PHM) *of Chenopodium album (leaves), Allium sativum (cloves)* and *Azadirachta indica*. Their blend outperformed the single extracts in reduction of fecal egg counts in goats. The relevance of our findings becomes clearer against the backdrop of widespread anthelmintic resistance. Another research documented the increase in resistance in *Haemonchus* and *Trichostrongylus* species. The study urged urgent exploration of sustainable control strategies (Wondimu and Bayu 2022). In this context, our study strengthens the argument that plant-derived alternatives represent viable adjuncts or replacements for synthetic drugs.

The anthelmintic activity of the tested plants can be credited to multiple phytochemical pathways. The tannins from *Bidens* and *Artemisia* bind to cuticular proteins. This binding impairs the integrity of parasite (Greiffer et al. 2022). Likewise, flavonoids in *Hypericum* and *Bidens* interfere with energy metabolism and neuromuscular signaling (Saeed et al. 2024). Isoquinoline alkaloids present in *Chelidonium* hinder the activity of mitochondrial enzymes (Li et al. 2024). Also, artemisinin derivatives from *Artemisia* target redox systems of the parasite (Vallières et al. 2023). This multiplicity of action enhances potency and slows the development of resistance when compared to single-target synthetic drugs.

Emerging recent literature emphasizes the role of gut microbiota in mediation of efficacy of plant extract. Yuan et al. (2023) demonstrated that inulin supplementation reshapes ruminant gut microbiomes. It indirectly enhances resistance against helminth colonization. Similarly, Inda et al. (2019) claimed for microbiome engineering as a next frontier in helminth control. Our study contributes to this discussion by suggesting that plant-based formulations act directly on parasites and support host resilience via gut ecological modulation.

Although our findings are encouraging but there are certain challenges. The diversity in phytochemical content due to plant origin, season, and extraction method may influence outcomes, as noted by Azaizeh (2015) in livestock systems in Ethiopia. Standardization of extracts with pharmacokinetic and toxicological evaluations is essential before its widespread adoption. Furthermore, scalability and adoption by farmer is always centered on cost-effectiveness and ease of administration. de Negreiros Meireles et al. (2024) highlighted these socio-economic barriers in Brazil’s livestock systems that could hinder uptake of plant-based therapies. Addressing these issues will be pivotal in translation of laboratory findings to field practice.

Overall, our study reinforces the growing agreement that polyherbal formulations offer a potent, eco-friendly substitute to synthetic anthelmintics. Nevertheless, formulation optimization, standardization, and integration into holistic parasite management strategies are essential to fully realize their potential in global small ruminant health.

Conclusion

The study showed that polyherbal formulations that have *Artemisia absinthium*, *Artemisia lerchiana*, *Hypericum perforatum*, *Bidens tripartita*, and *Chelidonium majus* were effective against gastrointestinal helminthiases in sheep under natural infection conditions. Complex herbal preparation 1 achieved efficacy levels comparable to the standard synthetic drug Alvet, while preparation 2 showed moderate but hopeful activity. Both preparations were safe ad maintained normal hematological and biochemical profiles, and enhanced bactericidal activity. These findings support the potential of locally sourced medicinal plants as eco-friendly alternatives to synthetic anthelmintics in sustainable sheep farming. Future research should focus on dose optimization, long-term safety evaluation, and large-scale field trials to validate their practical application and support integration into parasite control programs.

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REFERENCES

Abutalip A, Suchshikh V, Aitzhanov B, Ospanov Y and Kanatov B, 2024. Current State of Animal Anthrax Problems in the Republic of Kazakhstan and Ways to Solve it. International Journal of Veterinary Science 13(6): 922-930. https://doi.org/10.47278/journal.ijvs/2024.198

Arkhipov IA, 2009. Anthelmintics: pharmacology and application. Moscow: Russian Academy of Agricultural Sciences.

Avdachenok VD, 2017. Using preparations of perforate St John's-wort in mixed invasions in ruminants. Methodological recommendations. Vitebsk: VGAVM 2017: 12.

Azaizeh H, Mreny R, Markovics A, Muklada H, Glazer I and Landau SY, 2015. Seasonal variation in the effects of Mediterranean plant extracts on the exsheathment kinetics of goat gastrointestinal nematode larvae. Small Ruminant Research 131: 130-135. https://doi.org/10.1016/j.smallrumres.2015.08.004

de Negreiros Meireles R, de Souza Macedo JR, de Freitas Lins Neto EM, da Silva DT and Ferreira FS, 2024. Relationships between the Use of Medicinal Plants and Animals and Sociodemographic Factors in Brazil: a Systematic Review. Human Ecology 52(6): 1217-37. https://doi.org/10.1007/s10745-024-00564-8

Eliseeva T and Tkacheva N, 2018. St. John's wort (lat.

Hypericum). Journal.edaplus.info 1(3): 21-30.
Emelianenko PA, Gryzlova ON and Denisenko VN, 1980. Methodical guidelines for testing the natural resistance of calves. Moscow: VO "Agropromizdat".
Faixová D, Hrčková G, Kubašková TM and Mudroňová D, 2021. Antiparasitic effects of selected isoflavones on flatworms. Helminthologia 58(1): 1. https://doi.org/10.2478/helm-2021-0004
Greiffer L, Liebau E, Herrmann FC and Spiegler V, 2022. Condensed tannins act as anthelmintics by increasing the rigidity of the nematode cuticle. Scientific Reports 12(1): 18850. https://doi.org/10.1038/s41598-022-23566-2
Higuera-Piedrahita RI, Dolores-Hernández M, de la-Cruz-Cruz HA, Andrade-Montemayor HM, Zamilpa A, López-Arellano R, González-Garduño R, Cuéllar-Ordaz JA, Mendoza-de-Gives P and López-Arellano ME, 2022. An Artemisia cina n-hexane extract reduces the Haemonchus contortus and Teladorsagia circumcincta fecal egg count in naturally infected periparturient goats. Tropical Animal Health and Production 54(2): 95. https://doi.org/10.1007/s11250-022-03103-z
Higuera-Piedrahita RI, Dolores-Hernández M, Jiménez-Pérez LG, Camacho-Enríquez BC, Zamilpa A, López-Arellano R, Mendoza-de-Gives P, Cuéllar-Ordaz JA and López-Arellano ME, 2021. In vitro nematocidal effect and anthelmintic activity of Artemisia cina against Haemonchus contortus in gerbils and relative expression of Hc29 gene in transitional larvae (L3–L4). Acta Parasitologica 66(3): 938-946. https://doi.org/10.1007/s11686-021-00364-w
Iatusevich AI, 2017. Parasitology and invasive diseases of animals: textbook. Minsk: Information and Computing Center of the Ministry of Finance of the Republic of Belarus.
Inda ME, Broset E, Lu TK and de la Fuente-Nunez C, 2019. Emerging frontiers in microbiome engineering. Trends in Immunology 40(10): 952-973. https://doi.org/10.1016/j.it.2019.08.007
Karim MA, Islam MR, Lovelu MA, Nahar SF, Dutta PK and Talukder MH, 2019. In vitro evaluation of anthelmintic activity of tannin-containing plant Artemisia extracts against Haemonchus contortus from goat: Anthelmintic activity of tannin-containing plants Artemisia. Journal of the Bangladesh Agricultural University 17(3): 363-368. https://doi.org/10.3329/jbau.v17i3.43216
Karmaliev RS, Bozymova AK and Kuzhebaeva UZ, 2016. Methods of evaluation of veterinary anthelmintics: textbook. Uralsk: ZKF "NTsNTI".
Karmaliev RS, 2019. Veterinary pharmacology: textbook. Almaty: "Izdatelskii dom Almanakh" LLP.
Karmaliev RS, Sidikhov BM, Usenov ZT, Ertleuova BO and Gabdullin DE, 2020. Helminthiases of cattle in West Kazakhstan region and measures to combat them: monograph. http://hdl.handle.net/123456789/1411
Karmaliev RS, 2021. Effectiveness of antihelminthic forage supplement in helminthiasis of digestive tract of ruminants. Herald of Science of S. Seifullin Kazakh Agrotechnical Research University 1(108): 146-155.
Karmaliev RS, Nurzhanova FK, Ertleuova BO and Sidikhov BM, 2024. Evaluation of antimicrobial properties of medicinal plants for the development of a complex herbal preparation. Science and Education 1(74): 28-40. https://doi.org/10.52578/2305-9397-2024-1-1-28-40
Karomatov ID and Abduvokhidov AT, 2017. Three-part beggarticks as a well-known medicinal plant. Biology and Integrative Medicine 9: 12-22.
Kositsa EA, 2020. Antihelminthic properties of horse sorrel (Rumex confertus Willd.) in gastrointestinal nematodes of sheep. Veterinary Journal of Belarus 1(12): 43-51.
Li XL, Sun YP, Wang M, Wang ZB and Kuang HX, 2024. Alkaloids in Chelidonium majus L: A review of its phytochemistry, pharmacology and toxicology. Frontiers in Pharmacology 15: 1440979. https://doi.org/10.3389/fphar.2024.1440979
Magerramov SG, 2013. Anthelmintic effect of plants and their mixtures with chemical agent. University proceedings Volga region Natural Sciences 2(2): 64-68.
Mavrot F, Hertzberg H and Torgerson P, 2015. Effect of gastro-intestinal nematode infection on sheep performance: a systematic review and meta-analysis. Parasites & Vectors 8: 557. https://doi.org/10.1186/s13071-015-1164-z
Nametov A, Yertleuova B, Orynkhanov K, Semenenko MP, Sidikhov B, Murzabayev K, Dushayeva L, Ichshanova A and Marat M, 2023. Evaluation of the antibacterial effect of Artemisia lerchiana compared with various medicines. Brazilian Journal of Biology 83: e277641. https://doi.org/10.1590/1519-6984.277641
Novruzova LA, 2023. In vivo anthelmintic efficacy of some plant species of the family Compositae Cisece. Russian Journal of Parasitology 17(2): 276-283. https://doi.org/10.31016/1998-8435-2023-17-2-276-283
Rodin MN, Bokov DO and Samylina IA, 2022. Composition of biologically active compounds of three-part beggarticks herb. Pharmacy 71(2): 22-26. https://doi.org/10/29296/25419218-2022-02-04
Saeed M, Tasleem M, Haque A, Shoaib A and Rizvi SM, 2024. Muscular dystrophies and therapeutic potential of medicinal plants. ScienceOpen Preprints. https://doi.org/10.14293/PR2199.001353.v1
Sargison ND, 2012. Pharmaceutical treatments of gastrointestinal nematode infections of sheep — future of anthelmintic drugs. Veterinary Parasitology 189: 79-84. https://doi.org/10.1016/j.vetpar.2012.03.035
Selvi S, Koç FA and Satıl, 2023. An ethnoveterinary study on plants used for in the treatment of livestock diseases in Ayvalık (Balıkesir, Turkey). Indian Journal of Natural Products and Resources (IJNPR)[Formerly Natural Product Radiance (NPR)] 14(2): 300-312.
Singh D, Pal VK, Singh A, Kumar V, Rewani SK and Gawali VM, 2018. In-vivo anthelmintic activity of three herbal plant mixtures against gastrointestinal nematodes in goats. Seminar Nduat Ayodhya 8: 318-320.
Vallières C, Golinelli-Cohen MP, Guittet O, Lepoivre M, Huang ME and Vernis L, 2023. Redox-based strategies against infections by eukaryotic pathogens. Genes 14(4): 778. https://doi.org/10.3390/genes14040778
Wondimu A and Bayu Y, 2022. Anthelmintic drug resistance of gastrointestinal nematodes of naturally infected goats in Haramaya, Ethiopia. Journal of Parasitology Research (1): 4025902. https://doi.org/10.1155/2022/4025902
Yuan C, Wang S, Gebeyew K, Yang X, Tang S, Zhou C, Khan NA, Tan Z and Liu Y, 2023. A low-carbon high inulin diet improves intestinal mucosal barrier function and immunity against infectious diseases in goats. Frontiers in Veterinary Science 9: 1098651. https://doi.org/10.3389/fvets.2022.1098651
Кармалиев РС, Нуржанова ФХ, Сидихов БМ, Ертлеуова БО and Терлецкая НВ, 2025. Сравнительная оценка антгельминтной эффективности комплексного растительного препарата. Ġylym žǎne bìlìm 1(78): 141-53. https://doi.org/10.52578/2305-9397-2025-1-1-141-153