Effect of Artemisia supplementation on lamb's growth performance and some physiological parameters

Pakiza Hamira Wasman*, Sawin Sudad Azeez

Animal Production and Health Department, Agricultural Engineering Sciences College, University of Salahaddin -Erbil , Iraq
***Corresponding author e-mail: pakiza.wasman@su.edu.krd.**
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Abstract

The goal of this research was to investigate the impact of adding Artemisia on growth and physiological aspects of lambs. The research was conducted on a private farm located in Graw Village, within the Erbil governorate of the Kurdistan Region in Iraq. The experimental phase ran from December 1, 2024, to March 10, 2025. Meanwhile, lab tests were conducted at La Vie Animal Veterinary Lab in Erbil's English Village, at the start, middle, and end of the experiment. The lambs were randomly assigned to four different groups using a Completely Randomized Design (CRD), with each group containing five lambs. They are as follows: T0 (the control) received a basic diet, T1, T2, and T3 were supplemented with 0.5, 1.0, and 1.5% Artemisia. Our findings indicated significant variations ($P < 0.05$) among the treatments and sampling times for most of the biochemical markers (blood glucose, TSP, albumin, cholesterol, triglycerides, HDL, and LDL). In the second month, blood glucose, TSP, albumin, cholesterol, and HDL levels generally rose in groups T1 and T2, which received 0.5% and 1.0% Artemisia, whereas triglycerides and LDL levels showed a tendency to decrease in T1 and T2. The activity of enzymes (AST, ALT, and alkaline phosphatase) also showed notable differences; AST and alkaline phosphatase levels rose during the second month, while ALT declined in T1 and T2. This study concluded that incorporating Artemisia into the diet of lambs enhances growth outcomes by increasing body weight gain, feed consumption, and feed conversion ratio (FCR).

Keywords: Artemisia , supplementation , lambs , growth performance ,physiological parameter.

Introduction

Sheep occupy a significant position as the primary livestock in Iraq, with the most of revenue generated from the sale of lambs and mutton. Moreover, sheep farming in is expected to remain crucial in the future due to the growing human population and the increasing demand for meat [1].

The Karadi (Kurdi) breed, which accounts for roughly 18-20% of the sheep population, is indigenous to the northeastern mountainous villages and the dry-

farming plains of the Kurdistan region in Iraq [2]. The reproductive capabilities of sheep are essential for the financial success of a flock [3]. Rams play a particularly important role, contributing approximately 50% to the flock's overall reproductive potential. Supplementing their diet with plants containing active compounds offers a natural and eco-friendly approach to enhancing the reproductive health of farm animals [4].

Currently, medicinal plants are increasingly recognized worldwide as alternatives to conventional medicines. These plants and their derivatives, which are rich in active compounds, are widely used for their diverse therapeutic effects, including anti-inflammatory, antibacterial, antifungal, antiulcer, wound-healing, anti-cancer, and sedative properties [4 ,5].

Research has highlighted the pharmacological benefits of these plants, demonstrating their antioxidant, antimicrobial, and antiparasitic properties, as well as their positive effects on rumen function [6 ,7].The use of traditional herbs and medicinal plants is well-established, and their incorporation as dietary supplements for ruminants is becoming an increasingly common practice worldwide [8].

Artemisia, commonly known as wormwood, comprises more than 300 species distributed worldwide and is recognized for its effectiveness in traditional medicine. This has encouraged researchers to investigate various extracts from this plant to address specific physiological conditions. It is rich in lactones, which are natural compounds with numerous proven health benefits [9]. According to [10]. incorporating Artemisia into the diets of ruminants enhances health and environment, ultimately improving digestion, nutrient absorption, and elimination of harmful agents which can contribute to increased livestock productivity. This plant also contains antimicrobial compounds, antioxidants, vitamins (A, B1, and B2), minerals (such as calcium, phosphorus, and iron), immune-boosting factors [11].

It has become an important dietary supplement for livestock, improving digestibility in sheep when added to their feed at a rate of 4% per kg of feed [12]. Additionally, incorporating Artemisia into sheep diets at a level of 10% per kg of feed has been shown to enhance weight gain and improve digestion efficiency.

The benefits of Artemisia are linked to the presence of alkaloids, flavonoids, and phenolic compounds throughout the plant, which are known for their roles in food preservation. This effect are largely due to the plant's aromatic compounds and antioxidants [13]. The aim of this study is to evaluate the impact of Artemisia on lamb's growth performance, selected blood serum parameter determinations, and reproduction during growth.

Materials and Methods

Housing and Experimental Design

Lambs feeding

The nutritional diet was formulated to meet the nutrient requirements of lambs according to NRC (1977) guidelines. The in total mixed ration and the nutrient

composition of the diet are shown in Table 1 and 2 respectively. All diet was fed twice daily morning and evening. Fresh water was available ad libitum. Daily feed consumption was recorded by measuring the amount of feed offered and the corresponding refusals. The remaining feed residue was collected, recorded and replaced with fresh feed.

Table (1): Total mixed ration composition

Nutrient	Content
Soybean meal (%)	15
DH- Sunflower Meal (%)	5
Crushed Chickpear (%)	8
Yellow Corn (%)	15
Wheat Bran (%)	14
Wheat Flour (%)	10
Barley (%)	27
Molasses (%)	2
limestone (%)	1.5
Rumix - 1%	1
Salt (%)	1
Sodium Bicarbonate (%)	0.5

Table (2): Nutrient composition of the diet.

Nutrient	**Fresh**	**Dry Matter**
Crude Protein	18.10%	20.07%
Dry Matter	90.19%	100.00%
Crude Fat	2.63%	2.92%
Crude Fiber	5.42%	6.01%
Crude Ash	6.55%	7.27%
NFE	57.47%	63.72%
M. Energy	2760.79 K.cal /kg	3061.04 K.cal /kg
Starch	37.18%	41.22%
PDIA	54.76 g/kg	60.72 g/kg
PDIN	117.87 g/kg	130.69 g/kg
PDIE	102.71 g/kg	113.88 g/kg
NDF	17.29%	19.17%
ADF	6.28%	6.96%
Lignin	1.36%	1.51%
I-NSP	16.56%	18.36%

Productive performance

Body weight (BW) of newly weaned sheep was recorded at the start of the experiment and monitored weekly throughout the experimental duration using a weighing scale. Body weight gain (BWG) was calculated on a weekly basis and cumulatively for the entire experimental duration. Feed intake was recorded daily by measuring feed offered and refusals for each replicate. Weekly and total feed intake were calculated accordingly. Feed conversion ratio (FCR) was determined weekly and for the overall experimental period based on feed intake relative to body weight gain.

Collecting of blood samples

Blood samples were collected from the jugular vein at three periods during the experiment: (The first, fourth and eighth weeks) to estimate the level of lipids, cholesterol, triglycerides and high-density lipoprotein (HDL). Low- density lipoprotein (LDL). Cholesterol concentration was measured by the enzymatic hydrolysis method of cholesterol according to the method of [14]. Through the use of an analysis kit (Kit) manufactured by the German company Human. The level of triglycerides in blood serum was estimated by the method of [15], using a kit manufactures by the Spanish company Human the tests were conducted in laboratories affiliated with the private sector. While HDL and LDL were calculated according to the equations developed by [16].

Hematological Analysis

Hematological evaluation was performed using a complete blood count (CBC) to assess oxygen transport capacity, immune status, and general health [17]. Erythrocyte parameters, including RBC count, hemoglobin (Hb), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC), were measured using an automated hematology analyzer following standard procedures [18 ,19].Red cell distribution width (RDW-CV and RDW-SD) was determined to evaluate erythrocyte size variability and anisocytosis [20].Leukocyte analysis included total white blood cell count and differential leukocyte count (DLC) to assess immune function [21].. Serum biochemical analyses, including total protein profiles, were conducted using an automated clinical chemistry analyzer [22]. Liver function was evaluated by measuring serum alanine aminotransferase (ALT) and aspartate aminotransferase (AST) activities according to IFCC kinetic methods [23].

Blood Glucose Determination

Blood glucose concentration was measured using an automated clinical chemistry analyzer [24].Serum lipid profile parameters, including total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C), were analyzed using an automated clinical chemistry analyzer (Exigo C200, Boule Diagnostics, Sweden) with enzymatic colorimetric reagent kits according to manufacturer instructions [25, 26].Total cholesterol and triglycerides were determined using standard enzymatic oxidation methods, HDL-C

was measured by a direct homogeneous enzymatic assay, and LDL-C was calculated using the Friedewald approach [15].

Statistical analysis

In a complete randomized design (CRD), all data were evaluated using the Statistical Analysis System [27], according to variance. Significant variations among treatment means were assessed using Duncan's multiple range tests at a level of significance of 0.05 [28].

Results and Discussion

Effect of Artemisia on some biochemical parameters;

The results reported in Table (3) indicate that, there were a significant difference ($P < 0.01$) in the studied serum biochemical variables among the different treatments at the varies period. These variables included random blood sugar, T.S.P, albumin, serum cholesterol, Triglycerides, and HDL.

The blood sugar level was higher in the 2nd month than the 1st month, of the treatment, and the higher level of blood sugar was observed in T1 in the 2nd month (6.600± 0.97 mg/dL) followed by T1 in the 1st month (981.60 ± 0.88 mg/dL).

The T.S.P (g/dL) in the second month of the experiment was higher (P value) than the first month.

Significantly higher T.S.P level was observed in T2 during 2nd month (8.24±0.13 g/dL), followed by T1 in 2nd month (7.98± 0.18 g/dL). The lowest T. S. P level was recorded in T0 in the 1st month which was (7.127.98± 0.10 g/dL) and T1 in the 1st month which was (7.09± 0.17 g/dL).

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The albumin level had significantly higher level in the 2nd month compared to the 1st month. The higher levels of albumin were recorded in T1 during the 2nd month (3.34±0.16 g/dL), and also T2 during the 2nd month levels of albumin was (3.30±0.21 g/dL), however, the lowest level of albumin recorded in T3 of the 1st month (2.51± 0.34 g/dL) and of T1 in the 1st month was (2.60±0.19 g/dL).

The serum cholesterol levels were higher in the 2nd month than the 1st month. The higher serum cholesterol level was obtained in T0 in during the 2nd month (83.68±1.36 mg/dl), and in T1 during the 1st month (38.62±2.69 mg/dl). Serum Triglycerides levels were higher in the 1st month than the 2nd month. The highest level was observed in T3 during the 1st month (22.24±1.23 mg/dl), followed by T3 in the 2nd month (22.24±1.23 mg/dl).

High-density lipoprotein (HDL) cholesterol levels increased significantly in the 2nd month, with the highest value recorded in T0 (27.32 ± 0.65 mg/dL), followed by T2 (22.34 ± 1.72 mg/dL).

Low density lipoprotein (LDL) cholesterol levels were higher in the 1st month compared to the 2nd month and the highest level of LDL was obtained in T3 during the 2nd month (34.60±1.56 mg/dL), and in T3 during the 1st month (34.60±1.56 mg/dL).

Table (3): Effect of Artemisia additive in lambs diet on random blood sugar, total serum protein (TSP),, albumin, serum cholesterol, Triglyceride (TG), high density lipoprotein (HDL); low density lipoprotein (LDL), (Mean± SED or SEM).

	First month				Second month			
Treat-ments	**T0**	**T1**	**T2**	**T3**	**T0**	**T1**	**T2**	**T3**
R. Blood Sugar mg/dL	68.52± 0.97^{a}	81.60± 0.88^{c}	73.92± 1.56^{b}	69.16± 1.10^{a}	73.08± 1.21^{c}	86.600± 0.97^{a}	78.12± 2.10^{b}	69.16± 1.10^{c}
T.S.P g/dL	7.12± 0.10^{a}	7.09 ± 0.17^{a}	7.15± 0.074^{a}	7.41± 0.28^{a}	7.98± 0.17^{a}	7.76± 0.07^{ab}	8.24± 0.13^{a}	7.41± 0.28^{b}
Albumin g/dl	2.69± 0.12^{a}	2.60± 0.19^{a}	2.67± 0.17^{a}	2.51± 0.14^{a}	2.87± 0.11^{ab}	3.34± 0.16^{a}	3.30± 0.21^{a}	2.51± 0.14^{b}
S. Cholestrole MG/DL	76.42± 1.62^{d}	38.62± 2.69^{a}	53.32± 2.63^{b}	63.80± 4.21^{c}	83.68± 1.36^{a}	45.18± 4.13^{c}	55.04± 2.36^{b}	63.80± 4.21^{b}
Triglyceride (TG) MG/DL	21.94± 1.27^{a}	19.74± 0.82^{a}	20.68± 0.70^{a}	22.24± 1.23^{a}	20.14± 1.23^{ab}	17.46± 1.20^{b}	18.00± 0.24^{b}	22.24± 1.23^{a}
HDL Mg/dl	22.46± 1.07^{a}	22.68± 1.144^{a}	26.02± 1.00^{b}	25.18± 0.66^{ab}	27.32± 0.65^{b}	26.38± 1.83^{b}	32.34± 1.72^{a}	25.18± 0.66^{b}
LDL Mg/dl	36.60± 1.53^{a}	32.60± 2.50^{a}	34.40± 1.56^{a}	34.60± 1.56^{a}	31.40± 1.07^{ab}	28.20± 1.65^{b}	29.60± 1.36^{b}	34.60± 1.56^{a}

T1;0.5%, T2:1.0%, T3:1.5% Artemisia

Means within the same row of different litters are significantly different at (P < 0.05)

Effect of Artemisia on Enzyme

The results observed in Table (3) that, there was a significant difference (P < 0.01) of the studied enzymes among different times that includes S.G.O.T (AST), ALT, alkaline phosphatase. The S.G.O.T enzymes level higher in the 2nd month of the treatment than the first month. The higher level was also observed in T1 during the 2nd month (88.00± 2.52 U/l) and in T1during the 2nd month (81.28 ± 1.22 U/l) compared to other treatments during another experimental period.

The ALT enzyme showed a higher level in the 1st month of treatment in comparison to the 2nd month. The higher level of ALT was observed in T0 during the 1st month (7.04± 0.19 U/l) and in T1 and T2 during the 2nd month (7.1 ± 0.20 and 7.02 ± 0.21 U/l, respectively).

The higher level of alkaline phosphatase was recorded in the 2nd month of treatment compared to the 1st month and the higher level was measured in T0 of the 2nd month (218.00± 0.5.38 U/l). in the levels of alkaline phosphatase in T1 and T2 during the 2nd month was (179.60 ± 6.79 and 178.00 ± 8.27 U/l, respectively). However, the lower alkaline phosphatase level recorded in T2 of the 1st month (167.80± 5.43 U/l) and in T1 (170.20±7.80 U/l).

Among the plants in the Artemisia genus, A. annua contains the highest content of artemisinin according to the result of the present study. The aerial parts of A. annua, especially during flowering, had the highest artemisinin content. Therefore, A. annua was selected for the in vivo study. The artemisinin level in broiler feed was fixed at 5 ppm according to [29]. Interactions among compounds are mainly relevant to in vitro studies.

The present findings agree with those of [30]. AST, ALT, and ALP levels decreased with increasing Artemisia supplementation, indicating improved liver function. Urea and creatinine levels also decreased following Artemisia addition, suggesting a beneficial effect on kidney function.

Table (4): Effect of Artemisia additive in lamb's diet on AST, aspartate aminotransferase; ALT, alanine aminotransferase in response to Artemisia supplementation, (Mean± SED or SEM).

	First Month				Second Month			
	T0	T1	T2	T3	T0	T1	T2	T3
S.G.O.T (AST) U/	74.54± 1.33^{a}	73.12± 2.100^{a}	79.08± 2.49^{a}	74.58± 1.13^{a}	77.16± 1.75^{bc}	81.28± 1.22^{b}	88.00± 2.52^{a}	74.58± 1.13^{c}
ALT (U/l	7.04± 0.19^{a}	7.01± 0.20^{a}	7.02± 0.21^{a}	6.96± 0.22^{a}	6.08± 0.19^{b}	6.98± 0.25^{a}	6.18± 0.20^{b}	6.96± 0.22^{a}
Alkaline Phosphat U/L	175.20± 8.33^{a}	170.20± 7.80^{a}	167.80± 5.43^{a}	174.60± 6.96^{a}	218.00± 5.38^{b}	179.60± 6.79^{a}	178.00± 8.27^{a}	176.60± 6.96^{a}

T1:0.5%, T2:1.0%, T3:1.5% Artemisia

Means within the same row of different litters are significantly different at (P < 0.05)

Effect of Artemisia on Growth hormone (GH) and thyroid stimulating hormone (TSH) hormone:-

Results of the current study in Table (5) found that, there was a significant difference (P < 0.01) of the studied growth hormone and (TSH), hormones among different treatments at different times of experiments.

The growth hormones during the 2nd month of the treatment were higher compared to the 1st month. The higher levels of GH were recorded in T1 and T2 during the 2nd month (8.32± 0.29 ng/ml and 7.58 ± 0.34 ng/ml , respectively).

The TSH hormones during the 2nd month of treatment lambs were higher than its level during the 1st month. The higher levels of TSH hormone were obtained in T2

(4.71± 0.17 mlU/mL) and T1 (4.56 ± 0.17 mlU/mL) during the 2nd month of the studied lambs.

The findings of the present study can be attributed to the biological activity of artemisinin (ART), a well-established antimalarial agent with documented antioxidant properties. Artemisinin exerts protective effects through modulation of the L1 cell adhesion molecule, which has been reported to enhance thyroid function in adult male hypothyroid rats, indicating its potential as a therapeutic agent for hypothyroidism**.**

Table (5): Effect of Artemisia additive in lambs on Growth hormone and TSH hormone, (Mean± SED or SEM).

	First Month				Second Month			
	T0	**T1**	**T2**	**T3**	**T0**	**T1**	**T2**	**T3**
Growth Hormone ng/ml	4.88± 0.20^{a}	4.98± 0.28^{a}	4.94± 0.11^{a}	5.20± 0.36^{a}	6.24± 0.17^{b}	7.58± 0.34^{a}	8.32± 0.29^{a}	7.20± 0.36^{a}
TSH Miu/mL	2.52± 0.15^{a}	2.62± 0.12^{a}	2.56± 0.11^{a}	2.68± 0.14^{a}	3.88± 0.11^{b}	4.56± 0.17^{a}	4.71± 0.17^{a}	4.68± 0.16^{a}
	First Month				Second Month			
	T0	T1	T2	T3	T0	T1	T2	T3
Growth Hormone ng/ml	4.88± 0.20^{a}	4.98± 0.28^{a}	4.94± 0.11^{a}	5.20± 0.36^{a}	6.24± 0.17^{b}	7.58± 0.34^{a}	8.32± 0.29^{a}	7.20± 0.36^{a}
TSH Miu/mL	2.52± 0.15^{a}	2.62± 0.12^{a}	2.56± 0.11^{a}	2.68± 0.14^{a}	3.88± 0.11^{b}	4.56± 0.17^{a}	4.71± 0.17^{a}	4.68± 0.16^{a}

Means within the same row of different litters are significantly different at ($P < 0.05$)

Effect of Artemisia on on the studied hematological parameters: -

The hematological parameters reported in Table (6) provide valuable insights into the effect of different inclusion levels of Artemisia (T1: 0.5%, T2: 1.0 %, T3: 1.5 %) on the erythrogram of the examined animals across the first and second months of the experiment.

Red Blood Cells (RBCs)

The results of the current study found that there were no significant differences with regards of RBC counts among treatments during the first month, while during the second month, RBCs were numerical increased, particularly in T3 (2.62 ± 0.14 $\times 10^{6}/\mu L$). This suggests that prolonged supplementation may gradually stimulate erythropoiesis. The bioactive compounds of Artemisia (e.g., flavonoids, terpenoids) are known to enhance antioxidant capacity, reduce oxidative stress, and potentially improve hematopoietic function, leading to improved red cell indices over time [31,32].

Hemoglobin (HGB) and Hematocrit (HCT)

Hemoglobin levels showed a significant increase in T3 during the 2nd month (12.80 ± 0.19 g/dL) compared to the control and other treatments. Similarly, hematocrit levels were higher in supplemented groups of lambs, especially in T3, indicating enhanced oxygen-carrying capacity of the blood. These improvements could be attributed

to the presence of iron, vitamins, and polyphenols in Artemisia, which support erythropoiesis and hemoglobin synthesis [33].Such findings align with previous reports that herbal additives can improve hematological parameters in ruminants by reducing anemia and enhancing nutrient utilization.

Erythrocyte Indices (MCV, MCH, MCHC)

The results of the present study showed that, the MCV values remained consistent across treatments and the study periods (~39–41 fl), indicating stable red cell size, with no evidence of macrocytosis or microcytosis. While, the MCH showed significant improvement in the second month, particularly in T3 (10.52 ± 0.27 pg), and suggesting that Artemisia supplementation increased hemoglobin content per cell. Also,the results of the current study found that the MCHC values (31–32 g/dl) were within the normal physiological range, indicating adequate hemoglobin concentration per unit volume of erythrocyte. This implies that supplementation helped maintain normal erythrocyte function without inducing hemolysis or anemia.

This findings indicate that supplementation with Artemisia, particularly at 0.15% (T3), positively influenced hematological parameters over time, especially hemoglobin concentration and hematocrit (REF). The results of the present study suggest an improvement in oxygen transport and overall physiological status, which may enhance growth and performance of the lambs. No significant changes in MCV and MCHC in the present study confirms that Artemisia acts primarily by increasing hemoglobin synthesis rather than altering red cell morphology.

Previous studies reported similar trends in sheep and goats which where supplemented with phytogenic feed additives, including Artemisia and other herbs, improved hematological and immune parameters [32,33]. I n particular, increases in HGB and HCT have been associated with improved metabolic status and resilience against stress. However, the dose-dependent effect observed here highlights the importance of optimizing the inclusion level, as lower concentrations in T1, and T2 lambs which showed minimal effects compared to T3 lambs.

Table (6): Effect of Artemisia additive in lambs diet on erythrocytes profile (RBCs, HGB, HCT, MCV, MCH and MCHC), (Mean± SED or SEM).

	First Month				Second Month			
Treatments	**T0**	**T1**	**T2**	**T3**	**T0**	**T1**	**T2**	**T3**
RBCs ($\times 10^6$/µL)	2.02± 0.10^{a}	2.08± 0.177^{a}	2.10± 0.14^{a}	2.18± 0.13^{a}	2.58± 0.13^{ab}	2.54± 0.22^{a}	2.52± 0.19^{a}	2.62± 0.14^{a}
HGB (g/dL)	10.96± 0.22^{a}	10.74± 0.25^{a}	10.56± 0.25^{a}	12.02± 0.53^{b}	11.88± 0.17^{a}	11.82± 0.19^{a}	11.36± 0.23^{a}	12.80± 0.19^{b}
HCT %	10.48± 0.51^{a}	9.44± 0.90^{a}	9.40± 0.81^{a}	9.12± 0.57^{a}	11.18± 0.35^{a}	10.42± 0.79^{a}	9.82± 0.65^{a}	10.12± 0.45^{b}
MCV (fl)	31.66± 7.92^{a}	39.42± 0.40^{a}	39.86± 0.41^{a}	39.86± 0.36^{a}	40.68± 0.38^{a}	40.70± 0.36^{a}	40.82± 0.37^{a}	40.68± 0.37^{a}

MCH (pg)	7.68± 0.28^{b}	6.20± 0.24^{a}	7.12± 0.18^{b}	9.36± 0.35^{c}	9.10± 0.32^{b}	7.18± 0.24^{a}	8.38± 0.12^{b}	10.52± 0.27^{c}
MCHC (g/dL)	28.66± 0.55^{a}	28.66± 0.33^{a}	28.40± 0.81^{a}	28.38± 0.88^{a}	31.32± 0.42^{a}	32.82± 0.34^{a}	32.18± 0.58^{a}	31.76± 0.63^{a}

T1:0.5%, T2:1.0%, T3:1.5% Artemisia

RBC, red blood cells; HGB, hemoglobin; HCT, hematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; RDWa, red cell distribution width

Means within the same row of different litters are significantly different at (P < 0.05)

Effect of Artemisia on hematological parameters

the results of the present study reported that, there was a significant difference (P < 0.01) of the studied hematological parameters that includes (WBCs and lympho-cytes), among different treatments at different times of experiments (Table 7).

The WBCs showed a higher level during the 1st month compared to the 2nd month of the experiment. The level of WBCs was higher in the T3 in the 1st month (19.16± 0.56 10^3/µL), followed by T2 during the 2nd month (18.80±0.30 10^3/µL), while, the lower level of WBCs was observed in T0 during the 1st month (11.28±0.42 10^3/µL), and T3 during the 2nd month (16.34±1.18 10^3/µL)

The lymphocytes showed a higher level in treatment higher than its level at the 1st month and the higher level observed in 2nd month. The lymphocytes observed higher level in T2 during the 1st month as it was (10.28± 0.9110^3/µL) followed by its level in T3 in the 1st (10.46±0.65 10^3/µL).

This indicated that, the increasing level of Artemisia improve the hematological parameters of lambs. this result agreed with those of [34], where they found that, the values of all blood parameters improved with increasing level of Artemisia in the sheep ration.

Table (7): Effect of Artemisia additive in lambs diet on hematological parameters, WBCs, Lym and Lym% (Mean± SED or SEM).

	First Month				**Second Month**			
Treat-ments	**T0**	**T1**	**T2**	**T3**	**T0**	**T2**	**T2**	**T3**
WBC (×10^3/µL)	11.28± 0.42^{a}	17.46± 0.42^{b}	17.72± 0.90^{b}	19.16± 0.56^{b}	16.88± 0.37^{ab}	18.80± 0.30^{b}	16.86± 0.33^{ab}	16.34± 1.18^{a}
LYM (×10^3/µL)	7.48± 0.63^{a}	8.92± 0.57^{ab}	10.28± 0.91^{b}	10.46± 0.65^{b}	7.36± 0.51^{ab}	5.98± 0.29^{a}	8.90± 1.57^{b}	5.24± 0.30^{a}
LYM%	49.20± 0.35^{c}	48.400± 2.70^{bc}	42.70± 2.19^{a}	43.46± 0.67^{ab}	52.08± 0.54^{c}	28.20± 1.01^{a}	45.10± 1.67^{b}	46.56± 0.82^{b}

T1:0.5%, T2:1.0%, T3:1.5% Artemisia

Means within the same row of different litters are significantly different at (P < 0.05)

Effect of Artemisia on body weight gain during the periods of experiment:

This study demonstrated that Artemisia supplementation had a significant ($P < 0.05$) effect on lambs' body weight gain, with different Artemisia treatments resulting in notable variations (Table 8). From the first to the second week of the trial, the body weight gain of lambs grew progressively, with the highest body weight rise being noted at the eighth week. T1 and T2 showed the largest increases in body weight (39.64± 1.94 kg and 35.06± 0.63 kg, respectively), whereas T0 and T3 showed the smallest increases (33.72± 1.43 kg and 30.84± 2.18 kg, respectively).

Lambs supplemented with Artemisia showed improvements in body weight and weight gain, which were linked to the anticoccidial properties of Artemisia and its active ingredient, artemisinin. According to mechanistic investigations, this chemical caused oxidative stress by breaking down the iron-implicated peroxide complex, which produced reactive oxygen species (ROS) (REF). Especially, ROS has been shown to directly prevent Eimeria species from sporulating and forming cell walls, as well as other parasite infestations that cause the animals' body weight to decrease and interfere with their life cycle (Ref). Additionally, birds can maintain commensal microbiota and absorb huge amounts of nitrogen thanks to the abundance of phytochemicals, flavonoids, and phenolic compounds found in A. annua. Commensal bacteria significantly increase poultry's innate and acquired immunological responses, as well as food digestion and nutrient absorption [35].

Table (8) : Effect of Artemisia additive in lambs diet weight gain during the period, (Mean± SED or SEM).

Treatments	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week
T0	21.40 ± 0.24^{a}	23.30± 0.56^{a}	25.30± 1.17^{a}	26.42± 1.63^{a}	29.34± 0.75^{a}	30.50± 1.55^{a}	32.10± 1.27^{ab}	33.72± 1.43^{a}
T1	24.00± 0.31^{b}	26.80± 0.93^{b}	29.40± 0.82^{b}	31.38± 1.24^{b}	33.90± 1.80^{b}	36.40± 2.10^{b}	37.32± 2.274^{b}	39.64± 1.94^{b}
T2	21.20± 0.37^{a}	24.00± 0.47^{a}	27.60± 0.62^{ab}	28.94± 0.57^{ab}	31.42± 0.58^{ab}	33.28± 0.51^{ab}	34.04± 0.65^{ab}	35.06± 0.63^{ab}
T3	21.40± 0.92^{a}	22.62± 1.05^{a}	24.62± 1.36^{a}	26.54± 1.72^{a}	28.24± 2.01^{a}	24.46± 1.91^{a}	29.90± 2.03^{a}	30.84± 2.18^{a}
Pr > F	0.005	0.010	0.019	0.066	0.060	0.037	0.041	0.013

T1:0.5%, T2:1.0%, T3:1.5% Artemisia
Means within the same row of different litters are significantly different at ($P < 0.05$)

Total weight gain, Feed intake, and FCR.

Results presented in Table (9), found that there is a significant difference (P 0. 05) in total weight gain, feed intake, and FCR among the various treatments groups of lambs in response to Artemisia supplementation. The data on total weight gain indicated that T2 had the highest weight gain at 78. 2 Kg, followed by T3 with 69. 30 Kg, while T1 and T0 had lower weight gains. Total feed intake was highest in T2 at 43. 84 Kg and T3 at 40.09 Kg, while T1 and T0 recorded lower feed intakes of 37.67 Kg and 36. 55 Kg, respectively. The FCR results revealed a significant difference (P 0. 05)

among the various treatments of Artemisia, with T2 showing the best FCR at 560, T3 at 5.78 and poorer FCR levels in T1 at 6.11 and T0 at 7. 74. These findings align with the work of Engberg et al. in 2012, which indicated that the aerial parts of the A. annua plant tended to enhance FCR.

Additionally, [36]. found that the alcoholic extract of A. annua improves performance and boosts both cellular and humoral immunity in healthy animals and birds. Therefore, this in vivo study suggests that further focus on this ethanolic extract could be beneficial for managing infections [37]. These results also support the observations by [38]. The outcomes indicated that adding the herb to complete feed resulted in a positive impact on the digestible energy (DE) and metabolizable energy (ME) available from the feed. The enhancement in DE due to the herb could be attributed to the greater digestibility of these nutrients, which leads to increased nutrient availability for animals in the treatment group [38]. There is a growing interest in how plant secondary metabolites like saponins and tannins can help reduce CH4 emissions [39].

Table (9): Effect of Artemisia additive in lambs diet on total weight gain, feed intake, and FCR, (Mean± SED or SEM).

Treatment	Total Weight Gain (Kg)	Total Feed Intake (Kg)	FCR
T0	47.2 ± 0.22^{D}	36.55 ± 0.55^{A}	7.74 ± 0.74^{A}
T1	61.6 ± 0.22^{C}	37.67 ± 0.67^{A}	6.11 ± 0.66^{B}
T2	78.2 ± 0.23^{A}	43.84 ± 0.44^{A}	5.60 ± 0.66^{C}
T3	69.3 ± 0.33^{B}	40.09 ± 0.45^{A}	5.78 ± 0.57^{D}

T1:0.5%, T2:1.0%, T3:1.5% Artemisia
Means within the same row of different litters are significantly different at ($P < 0.05$)

Previous results cleared that, the inclusion of the Artemisia to sheep ration improve the hematological, immunological characters of sheep with improvement of productive parameters of lambs (Feed intake, feed efficiency, body weight and body weight gain) and so improve the economic return of growing lambs.

These results agreed with those of [34].where they reported that Artemisia absinthium, belongs to the family Asteraceae, is found commonly throughout the Kashmir valley and has been reported to improve CP and EE digestibility, nitrogen balance and rumen fermentation due to the presence of health- promoting compounds and essential oils [40].It also contains essential micronutrients, hormone-like agents, antimicrobial agents, probiotics, antioxidants, vitamins (vitamins A, B1, B2 and C), minerals (Ca, P and Fe) and immune-promoting agents with antioxidant properties [11].

Overall, the high nutritional value and antioxidant activity of Artemisia absinthium, along with its low levels of anti-nutritive factors, support its use as a potential herbal tonic for humans and as a valuable feed additive in livestock production systems. The Artemisia absinthium has been found to enhance the digestibility of DM, OM and NDF when incorporated in complete feed at 4% level [41]. Concentration of TVFA, total N and TCA- ppt. N was also higher when Artemisia was used as a feed additive [41].

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