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Addition of wild thyme in the rations of Awassi lambs and its impact on nutrient digestion coefficients and some rumen and blood traits

Muthanna A. M. Tayeb[1], Omar A. Alkurjia[1*] and Mohammed Al-Juhaishi[2]

[1] *University of Mosul, Department of Animal Production, College of Agriculture & Forestry, Mosul, Iraq*
[2] *Northern Technical University, Department of Animal Production, Technical Agricultural College, Mosul, Iraq*
[*] *Corresponding author:* omarkj@uomosul.edu.iq

Abstract

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This study was conducted to investigate the effect of incorporating wild thyme (*Thymus vulgaris*) into the diets of Awassi lambs on nutrient digestion coefficients, rumen fluid characteristics, and selected blood biochemical parameters. The study utilized four Awassi male lambs, approximately one-year-old, with an average body weight of 59.45 ± 3.71 kg. The experiment consisted of four dietary treatments in a digestion trial divided into four periods, each lasting 15 days (10 days for adaptation and 5 days for sample collection), totaling 60 days. A crossover design was employed, with the four lambs rotated across the treatments in each period.

The basal diet consisted of barley, wheat bran, soybean meal, and wheat straw, which was common to all treatments. Wild thyme was added to the four treatments at levels of 0, 5, 10, and 15 g/animal/day, respectively. The results indicated that the inclusion of wild thyme at varying levels significantly ($P < 0.05$) improved the digestion coefficients of dry matter (70.63, 72.17, 74.58, and 76.42%), organic matter (72.41, 74.88, 78.21, and 81.74%), crude protein (68.21, 69.08, 72.51, and 75.66%), ether extract (58.42, 61.88, 63.99, and 65.41%), acid detergent fiber (37.85, 43.77, 45.99, and 47.88%), and neutral detergent fiber (64.55, 65.62, 67.74, and 69.17%), bacterial and protozoal counts increased significantly ($P < 0.05$) with higher wild thyme levels. Also, no significant differences were detected in blood parameters. These findings suggest that wild thyme can enhance nutrient digestibility and rumen microbial activity without adversely affecting blood biochemical profiles in Awassi lambs.

Keywords: Awassi lambs; *Thymus vulgaris*; nutrient digestibility; rumen microorganisms; blood biochemistry; phytogenic feed additives

Introduction

The care and management of agricultural animals are essential for advancing animal husbandry and production practices, achieving desired economic gains, and ensuring optimal and high-quality production, to meet the demand for animal products with high biological value. One of the key factors contributing to the success of livestock production projects is nutrition, which is directly linked to maintenance, growth, and productivity. Nutrition significantly impacts the economic viability of livestock production projects, as it accounts for approximately 65-75% of production costs (Sultan and Taeb, 2024). Therefore, any inefficiency or improvement in feed utilization can have a clear and direct impact, either negative or positive, on the production process. Recent studies have shown a growing trend toward the use of feed additives, such as medicinal herbs, plant seeds, essential oils, yeasts, probiotics, bentonite, urea, and physical or chemical treatments, to enhance the efficiency of feed utilization and nutrient absorption (Almallah et al., 2021; Tayeb et al., 2020; Tayeb and Yaseen, 2018; Tayeb, 2017; Shamoon et al., 2011). This is particularly relevant for ruminants, which pos-

sess a complex stomach structure housing microbial populations capable of digesting complex nutrients and compounds that humans or monogastric animals, such as poultry, cannot utilize. These microbial populations can be positively influenced to improve nutrient utilization and overall feed efficiency. Among the medicinal and herbal additives, wild thyme (*Thymus serpyllum*) is a beneficial supplement for ruminant nutrition. It contains volatile oils, such as thymol, which act as digestive stimulants and reduce undesirable fermentations in the rumen. Additionally, wild thyme enhances saliva secretion and digestive enzyme activity in the gastrointestinal tract, promoting fiber digestion. It also reduces gas production and prevents bloat, thereby minimizing energy losses (Alsadan and Tayeb, 2021; Sultan, 2007; Sultan et al., 2007). This study was conducted to investigate the effects of different levels of wild thyme supplementation on nutrient digestion, rumen characteristics, and blood parameters in Awassi lambs.

Materials and Methods

This study was conducted to investigate the effect of incorporating wild thyme (*Thymus serpyllum*) into the diets of Awassi lambs on nutrient digestion coefficients, rumen fluid characteristics, and selected blood biochemical parameters. Four Awassi male lambs, approximately one-year-old, with an average body weight of 59.45 ± 3.71 kg, were used in the experiment. The study consisted of four dietary treatments in a digestion trial divided into four periods, each lasting 15 days (10 days for adaptation in metabolic cages and 5 days for sample collection, during which the animals were placed in specially designed iron digestion cages to separate feces from urine), the following morning throughout the collection period, fecal samples were collected randomly (one sample from each animal), then weighed. A 20% of every sample was preserved, then mixed through the five-day period. After that, a sample was taken for chemical analysis. Rations for all treatments were prepared before the study and a random sample was taken from different and separate parts of the rations for chemical analysis in the laboratory. The experiment lasted 60 days, with the four lambs rotated across the treatments in each period using a crossover design.

The basal diet (Table 1) consisted of barley, wheat bran, soybean meal, and wheat straw, which was common to all treatments. Wild thyme was added to the four treatments at levels of 0, 5, 10, and 15 g/animal/day, respectively. The lambs were fed ad libitum, with two meals provided daily (morning and evening). The leftover feed was weighed the following morning and subtracted from the total feed intake to calculate daily consumption.

Table 1. Composition and chemical analysis of the diet used

Component Ingredients (%)	Treatment 1 (Control)
Barley	57
Wheat bran	32
Soybean meal	5
Wheat straw	5
Salt and limestone	1
Dry matter (DM)	93.14
Organic matter (OM)	96.23
Crude protein (CP)	13.82
Crude fat (EE)	4.89
Ash	3.81
Metabolizable energy (kcal/kg)	2501*

*Calculated on a dry matter basis as Al-Khawaja et al. (1978).
Source: Authors' own elaboration

Feed samples were collected at various intervals during the experimental period, ground, and stored for chemical analysis. Fecal samples were collected during the last five days of each period. Feed and fecal samples were analyzed to determine dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), and fiber content, as described in the Association of Official Analytical Chemists (AOAC, 2000).

Rumen fluid was collected before feeding in the morning and two hours after feeding using a suction pump (Bailey and Scott, 1998), with a volume of 200 mL per sample. The pH of the rumen fluid was measured immediately using a pH meter. The fluid was then filtered through medical gauze, and samples were preserved in 20 mL bottles, as described by Shamoon (1983). For ammonia determination, 1 mL of 10% hydrochloric acid was added to the sample, and ammonia concentration was measured according to the method described by Broderick and Kang (1980). Additionally, 1 mL of the sample was mixed with 10 mL of 10% formalin and stored in plastic containers at 5°C for bacterial and protozoal counts, following the procedure outlined by Atlas et al. (1995). The counts were expressed as logarithms of their numbers.

Blood samples were obtained from the jugular vein following the procedure outlined by Jain et al. (1987). Blood pH was assessed with a pH meter two hours post the evening meal. Serum was isolated by centrifugation at 3000 rpm for 10 minutes and subsequently stored at -20°C until further analysis. The levels of urea, total protein, albumin, triglycerides, and the enzymes AST and ALT were quantified using ready-to-use French Biolabo kits, adhering to the methodology described by Burtis and Ashwood (1999), with readings taken using a spectrophotometer of British origin.

Data were analyzed using a completely randomized design (CRD) according to the equation:

$$Yij = U + Ti + eij$$

where: *Yij* represents the observed value j of treatment i (any observed value), *U* represents the overall mean of the experiment; *Ti* represents the effect of treatment i on the observed value; *eij* represents the experimental error for observation j of treatment i.

For the assessment of the significance of differences between means, Duncan's multiple range test (Duncan, 1955) was employed. The statistical analysis was conducted using the Statistical Analysis System (SAS, 2002) software on a computer.

Results and Discussion

The results presented in Table 2 indicate that the addition of wild thyme at varying levels significantly (P<0.05) improved the digestion coefficients of dry matter (70.63, 72.17, 74.58, and 76.42%), organic matter (72.41, 74.88, 78.21, and 81.74%), crude protein (68.21, 69.08, 72.51, and 75.66%), ether extract (58.42, 61.88, 63.99, and 65.41%), acid detergent fiber (37.85, 43.77, 45.99, and 47.88%), and neutral detergent fiber (64.55, 65.62, 67.74, and 69.17%). The significant improvement in nutrient digestion coefficients observed in the treatments supplemented with wild thyme may be attributed to enhanced digestion due to an increase in beneficial bacterial populations, which in turn improved the breakdown of nutrients. Wild thyme contains volatile oils and phenolic compounds that stimulate the secretion of digestive enzymes in the gastrointestinal tract, thereby enhancing the efficiency of protein, fat, and carbohydrate digestion.

The results in Table 3 showed no significant effect on rumen fluid pH compared to the control group, with values of 6.3, 6.4, 6.3, and 6.2 before feeding and 5.74, 5.81, 5.69, and 5.71 two hours after feeding, respectively. Similarly, no significant differences were observed in rumen ammonia concentration, which was 9.21, 9.17, 8.97, and 9.14 mmol/100 mL before feeding and 11.83, 11.74, 11.13, and 11.28 mmol/100 mL two hours after feeding, respectively. The lack of significant differences in rumen pH and ammonia concentration may be due to the uniformity of the diet and similar feed intake levels, which resulted in consistent carbohydrate and protein consumption. These findings are consistent with the results of Alsadan and Tayeb (2021), El-Essawy et al. (2019), and Khamisabad et al. (2016).

However, the results indicated a significant (P<0.05) increase in bacterial counts, corresponding to the increasing levels of wild thyme supplementation. The logarithmic bacterial counts before feeding were 9.344, 9.527, 9.624, and 9.643/mL of rumen fluid, and two hours after feeding, they were 11.414, 11.461, 11.612, and 11.642/mL of rumen fluid. A significant increase in protozoal counts was also observed, with logarithmic values before feeding of 6.32, 6.44, 6.55, and 6.63/mL of rumen fluid and two hours after feeding of 6.76, 6.97, 6.95, and 6.94/mL of rumen fluid for the four treatments, respectively. The increase in bacterial and protozoal populations in the rumen with the addition of wild thyme may be due to the inhibition of harmful bacteria, allowing beneficial bacteria to proliferate, as well as the improvement of the rumen environment due to the antioxidant and anti-inflammatory properties of thyme. The stabilization of rumen pH further supported the growth of protozoa. Improved fiber and starch digestion provided additional nutrients for bacteria and protozoa, indicating that while wild thyme did not affect rumen pH or ammonia concentration, it enhanced the rumen environment, leading to increased microbial populations.

The statistical analysis of the data presented in Table 4 revealed no significant differences among the four treatments in plasma glucose concentration, which ranged between 101.87–108.22 mg/100 mL, triglycerides (50.76–52.78 mg/100 mL), cholesterol (68.11–69.55 mg/100 mL), total protein (6.45–6.64 g/100 mL), or urea (24.21–26.456 mg/100 mL). Similarly, no significant differences were observed in blood pH, which was 7.33, 7.37, 7.34, and 7.39

Table 2. Effect of wild thyme on nutrient digestibility coefficients in Awassi lambs

Trait \ Treatment	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Dry matter digestibility (%)*	70.63 ± 0.23 c	72.17 ± 0.71 c	74.58 ± 0.41 b	76.42 ± 0.17 a
Organic matter digestibility (%)*	72.41 ± 0.82 c	74.88 ± 0.47 c	78.21 ± 0.17 b	81.74 ± 0.43 a
Crude protein digestibility (%)*	68.21 ± 0.72 c	69.08 ± 0.92 c	72.51 ± 0.71 b	75.66 ± 0.23 a
Ether extract digestibility (%)*	58.42 ± 0.85 c	61.88 ± 1.43 b c	63.99 ± 0.94 b	65.41 ± 1.61 a
Acid detergent fiber (ADF) digestibility (%)*	37.85 ± 0.84 d	43.77 ± 0.66 c	45.99 ± 1.02 b	47.88 ± 1.09 a
Neutral detergent fiber (NDF) digestibility (%)*	64.55 ± 0.77 c	65.62 ± 0.37 c	67.74 ± 1.25 b	69.17 ± 0.28 a

*Different letters a,b,c,d horizontally indicate significant differences (P < 0.05) between treatments.

Source: Authors' own elaboration

Table 3. Effect of wild thyme on some rumen fluid measurements before and two hours after feeding in Awassi lambs

Trait \ Treatment	Treatment 1	Treatment 2	Treatment 3	Treatment 4
pH before feeding	6.3 ± 0.12	6.4 ± 0.33	6.3 ± 0.77	6.2 ± 0.54
pH after feeding	5.74 ± 0.31	5.81 ± 0.12	5.69 ± 0.28	5.71 ± 0.17
Ammonia concentration before feeding (mg/100 mL)	9.21 ± 2.49	9.17 ± 1.22	8.97 ± 1.71	9.14 ± 1.8
Ammonia concentration after feeding (mg/100 mL)	11.83 ± 3.9	11.74 ± 3.1	11.13 ± 1.94	11.28 ± 3.6
Logarithm of bacterial count before feeding (/mL)	9.344 ± 0.1 c	9.527 ± 0.1 b	9.624 ± 0.1 a	9.643 ± 0.11 a
Logarithm of bacterial count after feeding (/mL)	11.414 ± 0.14 c	11.461 ± 0.13 b c	11.612 ± 0.11 a	11.642 ± 0.1 a
Logarithm of protozoal count before feeding (/mL)	6.32 ± 0.22 b	6.44 ± 0.19 a b	6.55 ± 0.21 a	6.63 ± 0.31 a
Logarithm of protozoal count after feeding (/mL)	6.76 ± 0.71	6.97 ± 0.44	6.95 ± 0.12	6.94 ± 0.17

*Different letters a,b,c, horizontally indicate significant differences ($P < 0.05$) between treatments.
Source: Authors' own elaboration

Table 4. Effect of wild thyme on some blood measurements in Awassi lambs

Trait \ Treatment	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Glucose (mg/100 mL)	101.87 ± 5.37	103.14 ± 2.18	108.22 ± 1.98	104.21 ± 2.41
Triglycerides (mg/100 mL)	50.76 ± 6.36	51.02 ± 2.75	52.71 ± 1.64	52.78 ± 4.08
Cholesterol (mg/100 mL)	68.22 ± 5.21	68.11 ± 6.03	69.55 ± 7.21	68.13 ± 6.88
Total protein (g/100 mL)	6.49 ± 1.23	6.47 ± 2.12	6.64 ± 1.52	6.45 ± 0.85
Urea (mg/100 mL)	26.45 ± 1.21	24.21 ± 5.15	25.74 ± 4.12	25.88 ± 4.28
Blood pH	7.33 ± 0.22	7.37 ± 0.17	7.34 ± 0.89	7.39 ± 0.19

Source: Authors' own elaboration

for the four treatments, respectively. These blood parameters were within the normal ranges for sheep (Stanislaw and Sobiech, 2012). The results of this study align with those of Alsadan and Tayeb (2021), but differ from the findings of El-Essawy et al. (2019) and Hashem and Tayeb (2023). The lack of significant changes in blood parameters may be due to insufficient physiological changes caused by thyme supplementation, to significantly impact blood indices. This could be attributed to the fact that thyme did not directly affect the animal's basal metabolism, and digestion and absorption processes remained stable without altering nutrient balance. Additionally, thyme did not influence lipid metabolism, protein breakdown, or urea production, and the body's strict regulation of blood pH prevented any significant changes in blood acidity. It is possible that the dosage of thyme was not sufficient to produce a significant effect on blood parameters.

Conclusions

The addition of wild thyme to the diet of Awassi lambs led to improved digestion through enhanced microbial populations in the rumen.

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Conflict of interest

Authors hereby state that there are no competing interests concerning the publication of this research.

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