

## Research Article

# Effect of *Moringa oleifera* Aqueous Seed Extract on Growth and Nutrient Digestion in Awassi Lambs

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## Abstract

**Background:** Recently, there has been increased interest in studying extracts of medicinal and aromatic plants and their use in improving animal production. Therefore, this research aimed to study the effect of aqueous extract of *Moringa oleifera* seeds (MSE) on growth and nutrient digestion in Awassi lambs. Sixty lambs of similar weight ( $23 \pm 2$  kg) and age (3 months  $\pm$  4 days) were divided into four groups (G1 control, G2, G3 and G4), each containing 15 lambs. They were fed a standardized concentrated diet for all groups. MSE was added at a rate of 0, 20, 40 and 60 ml/L of water.

**Results:** The results showed a significant improvement ( $P < 0.05$ ) in the final weight of the lambs, the daily and total weight gain rate, the feed conversion ratio, and the digestibility coefficients of nutrients in the two groups G3 and G4, which were given drinking water containing 40 and 60 ml/liter, compared to the control groups G1 and G2, which were treated with 20 ml/liter, and which also outperformed the control group G1.

**Conclusions:** Addition of moringa seed aqueous extract to drinking water improved growth rates, feed conversion, and nutrient digestibility in Awassi lambs.

**Keywords:** *Moringa oleifera*, Growth, Nutrient digestion, Awassi lambs

## Introduction

*Moringa oleifera* (*Moringa oleifera* L.) is a fast-growing tree native to tropical and subtropical regions, but it can also be cultivated in arid regions, where it contributes to improving ecological balance and providing food for many organisms [1]. It is known as the “tree of life” and is sometimes called the “miracle tree” due to its high value in nutrition and alternative medicine [2]. Its leaves are rich in vitamins and minerals [3] and are an excellent source of iron, calcium, and vitamin C. They play a role in increasing energy levels and strengthening the immune system [4]. They are also an excellent source of biologically active compounds, such as polyphenols (tannins or flavonoids), in addition to containing small amounts of anti-nutritional factors, such as tannins and saponins. [5,6]. In recent years, the use of *Moringa* plant parts (leaves, seeds, flowers, and roots) or their extracts as feed additives in animal nutrition has been gaining popularity, improving health and productivity. An experiment replacing cottonseed meal in the diet of growing sheep with *M. oleifera* leaf powder (dry matter 20%) resulted in improved dry matter digestibility and increased growth rate (20%) [7]. Feeding lambs defatted *M. oleifera* seeds at rates of 2, 4, and 6 g of dry matter/lamb/day had no effect on feed intake, nutrient digestibility, or nitrogen levels; however, the highest daily weight gain of lambs was achieved [8]. In addition, adding moringa to the diets of Najd ewes led to a higher average daily weight gain and milk production compared to those fed alfalfa diets [9]. Some studies also found that using moringa leaves in diets led to an improvement in the feed conversion factor and growth [10], and the results of feeding lambs at 0 and 25 And 50 g/kg of moringa roots

showed improvements in feed efficiency and nitrogen absorption in the body, which led to a higher average daily weight gain for these lambs [11]. Adding 4 g of moringa seeds daily to the diets of male Barki sheep resulted in increased final body weight and significantly improved daily weight gain [12]. Adding 25% *Moringa oleifera* leaves to sheep diets increased nutrient digestibility [13]. Studies have shown that *M. oleifera* extract improves the digestibility of organic matter (OM), dry matter, and neutral detergent fiber (NDF) in Nubian goats [14]. Therefore, this study aimed to investigate the effect of adding aqueous extract of *Moringa oleifera* seeds to the drinking water of Awassi lambs on growth and nutrient digestibility.

## Materials and Methods

### Animals, Treatments and Experimental Design

The study was conducted using 60 male Awassi lambs, similar in age (3 months  $\pm$  4 days) and weight ( $23 \pm 2$  kg, mean  $\pm$  standard deviation), in a private sheep farm in the south of Hama city. The experimental lambs were fed a standardized concentrated ration twice daily at 7 a.m. and 4 p.m. It consisted of barley, bran, and cottonseed cake, in addition to salt, vitamins, minerals, calcium carbonate, and an antifungal as shown in Table 1.

The ration was formulated to meet the nutritional requirements of lambs according to guidelines of the national research council NRC [15]. Wheat straw was offered ad libitum to the experimental groups. The experimental period lasted for 3 months, during which the lambs were divided using a completely randomized design into

**Table 1:** Ingredients and chemical composition of diet.

Item	Feed ingredient ratios %	
<b>Ingredients</b>		
Barley	64	
Bran	14	
Urea	0	
Decorticated cottonseed	18	
Salt	1	
Calcium carbonate	1	
Vitamins and minerals <sup>1</sup>	1.75	
Antifungal <sup>2</sup>	0.25	
<b>Chemical composition</b>		<b>Wheat straw</b>
Dry Matter	89.13	91
Organic Matter	95.85	93.3
Crude Protein	15.23	4.2
Ether Extract	3.09	1.4
Crude Fiber	7.39	41.5
Ash	4.15	6.7
Nitrogen Free Extract	66.23	46.2
Metabolic Energy Kcal/Kg	2576	997

G1: Control group: water devoid of MSE. G2: drinking water containing 20 ml of MSE. G3: drinking water containing 40 ml of MSE. G4: drinking water containing 60 ml of MSE  
<sup>1</sup> Each kg contained: vitamin A (2000000 IU), vitamin D3 (500000 IU), vitamin E (2500 mg), iron sulphate (5000 mg), manganese sulphate (1000 mg), copper sulphate (3000 mg), potassium iodide (100 mg), zinc sulphate (5000 mg), cobalt sulphate (50 mg), sliat sodium (100 mg), sodium chloride (25000 mg).  
<sup>2</sup>Contains: Calcium propionate, Benzoic acid, Calcium formate, Citric acid, Calcium lactate, Plant essential oil extracts.

four treatment groups as follows = 15 lambs/treatment: The first group (G1): was given drinking water devoid of *Moringa oleifera* seed extract (MSE) (control group); the second group (G2): was given drinking water containing 20 ml of MSE /L of water; The third group (G3) was given drinking water containing 40 ml of MSE /L of water, and the fourth group (G4) was given drinking water containing 60 ml of MSE /L of water. The MSE -containing drinking water was provided ad libitum after the morning and evening feeds were provided.

During the experimental period, all lambs were housed in pens that met health care requirements and were numbered for easy monitoring and recording of results. They received preventive vaccinations and were treated for internal and external parasites before the start of the experiment.

### Moringa Oleifera Seed Extract

*Moringa* seeds were obtained from private herbal shops in Hama Governorate. They were cleaned, removed from leaves and foreign matter, dried, and ground using a special mill for medicinal plants until a fine powder was obtained. 100 g of the powder was then mixed with 1000 ml of distilled water (ratio 1: 10) using an electric mixer. The mixture was then left to stand for 24 hours at room temperature. The mixture was then filtered using several layers of medical gauze to remove suspended particles. The mixture was then placed in a centrifuge (Bio-Rad, USA) at 3000 rpm for 10 minutes. The extract

was then filtered using Whatman No. 101 filter paper to obtain a clear solution. The extract was then diluted with clean drinking water to obtain the daily doses given to the lambs [16].

### Growth Performance

The growth performance was recorded during the period from the beginning of March until the end of June 2024, where the initial weight of the lambs was taken at the beginning of the experiment, and at the end of the experiment the final weights of the lambs were taken. During the experimental period, the amounts of feed offered and orts were recorded daily, to calculate the daily dry matter intake (DMI) by the difference between the offered and orts. The feed conversion ratio as was also calculated. as follows:

Feed conversion ratio = amount of feed consumed (g) / rate of weight gain (g)

### Digestion Experiment

After the fattening experiment was completed, on the first day of July, the digestion experiment began. 16 male Awassi lambs were selected for use in the fattening experiment, with an average age of (6 months ± 4 days) and a weight of (44.5 ± 3 kg). were selected for easy collection of dung and urine. They were divided into four groups, each group containing 4 male lambs, and placed in metabolic cages measuring (1.2 × 0.75) meter. Bags dedicated to collecting dung and urine were attached with special ties, after each meal provided in order to calculate the digestibility coefficients of dry matter, crude protein, ether extract, crude fiber, organic matter, and total digestible nutrients (TDN). The offerd and refusals of the diets manure and urine samples were collected and recorded daily and for a 10-day period to calculate the digestibility coefficients for dry and organic matter, crude protein, crude fat, and crude fiber [17]. Chemical analyzes of the feed, urine and feces were conducted following the methods described in reference [17].

### Statistical Analysis

All data were analyzed statistically using SPSS 26 software through One Way ANOVA at a significance level of 5%, and performed the Duncan multiple range test to assess the significance of differences between the means [18].

The mathematical model was as follows:  $Y_{ij} = \mu + T_i + e_{ij}$

Where:

$Y_{ij}$  = Individual observation.

$\mu$  = The overall mean for the trial under consideration.

$T_i$  = The effect of the  $i^{th}$  treatment.

$e_{ij}$  = Random residual error.

### Results

#### Growth, Feed Intake and Feed Conversion Ratio

The results in Table 2 indicated a significant increase ( $P < 0.05$ ) in the final weight, average daily weight gain, and total weight gain of lambs in groups G3 and G4. The final live weight of lambs was 46.74

**Table 2:** The effect of *Moringa oleifera* aqueous seed extract on growth performance of lambs.

Growth performance	Experimental groups (Mean ± SD)				
	G1	G2	G3	G4	P-value
Initial weight (kg)	23.72 ± 0.45	23.64 ± 0.21	23.86 ± 0.24	23.56 ± 0.14	-
Final weight (kg)	43.45 ± 2.13 <sup>c</sup>	44.24 ± 1.43 <sup>b</sup>	46.74 ± 1.61 <sup>a</sup>	47.04 ± 1.23 <sup>a</sup>	0.03
Total weight gain (kg)	19.73 ± 6.47 <sup>c</sup>	20.6 ± 8.58 <sup>b</sup>	22.88 ± 7.59 <sup>a</sup>	23.48 ± 7.13 <sup>a</sup>	0.02
Average daily gain (g)	219.22 ± 6.32 <sup>c</sup>	228.89 ± 9.89 <sup>b</sup>	254.23 ± 13.40 <sup>a</sup>	260.89 ± 12.44 <sup>a</sup>	0.04
Feed intake (g/d)	1103 ± 51 <sup>ns</sup>	1113 ± 75 <sup>ns</sup>	1115 ± 63 <sup>ns</sup>	1122 ± 60 <sup>ns</sup>	0.03
Feed conversion ratio	5.03 ± 0.28 <sup>c</sup>	4.86 ± 0.38 <sup>b</sup>	4.38 ± 0.40 <sup>a</sup>	4.30 ± 0.35 <sup>a</sup>	0.01

G1: Control group: water devoid of MSE. G2: drinking water containing 20 ml of MSE.

G3: drinking water containing 40 ml of MSE. G4: drinking water containing 60 ml of MSE

Different letters a, b, c within the same line indicates significant differences between groups at a level of (P<0.05).

**Table 3:** The effect of *Moringa oleifera* aqueous seed extract on the nutrient's digestibility and the diet's nutritional value for lambs.

Digestibility coefficient (%)	Experimental groups (Mean ± SD)				
	G1	G2	G3	G4	P-value
Dry Matter	75.42 ± 2.3 <sup>c</sup>	77.99 ± 1.5 <sup>b</sup>	80.98 ± 2.72 <sup>a</sup>	81.38 ± 3.32 <sup>a</sup>	0.04
Organic Matter	76.85 ± 2.34 <sup>c</sup>	78.85 ± 1.19 <sup>b</sup>	82.01 ± 1.61 <sup>a</sup>	82.31 ± 1.21 <sup>a</sup>	0.02
Crude Protein	77.50 ± 1.9 <sup>c</sup>	79.01 ± 1.73 <sup>b</sup>	81.51 ± 2.62 <sup>a</sup>	81.79 ± 1.65 <sup>a</sup>	0.03
Crude Fiber	59.54 ± 1.06 <sup>c</sup>	62.30 ± 1.82 <sup>b</sup>	64.24 ± 1.45 <sup>a</sup>	64.71 ± 1.55 <sup>a</sup>	0.04
Ether Extract	78.23 ± 1.87 <sup>c</sup>	82.81 ± 1.95 <sup>b</sup>	84.69 ± 1.68 <sup>a</sup>	85.06 ± 2.28 <sup>a</sup>	0.01
Total Digestible Nutrients	74.63 ± 2.10 <sup>c</sup>	76.7 ± 2.21 <sup>b</sup>	78.69 ± 1.52 <sup>a</sup>	78.92 ± 2.51 <sup>a</sup>	0.03

G1: Control group: water devoid of MSE. G2: drinking water containing 20 ml of MSE.

G3: drinking water containing 40 ml of MSE. G4: drinking water containing 60 ml of MSE.

Different letters a, b, c within the same line indicates significant differences between groups at a level of (P<0.05). ns indicates no significant differences within the same line between the experimental groups (P>0.05).

and 47.04 kg, the average total weight gain was 22.88 and 23.48 kg, and the average daily weight gain was 254.23 and 260.89 g, respectively, compared to group G2, where the final weight of lambs was 44.24 kg, the average total weight gain was 20.6 kg, and the average daily weight gain was 228.89 g/day. The control group G1, where the values were 43.45 kg, 19.39 kg, and 219.22 g, respectively.

The results also showed that there was no significant effect (P>0.05) of the aqueous extract of *Moringa oleifera* seeds on the amount of feed intake, which amounted to 1103, 1113, 1115, and 1122 g/day for groups G1, G2, G3, and G4, respectively. However, the results showed a significant improvement (P<0.05) in the feed conversion ratio in groups G3 and G4, which amounted to 4.38 and 4.30 g/g, respectively, compared to group G2, whose feed conversion ratio amounted to 4.86 g/g, and the control group G1, which averaged 5.03 g/g per day.

### Nutrient Digestibility Coefficient and Nutritional Value of the Feed

The results in Table 3 show a significant improvement (P<0.05) in the digestibility coefficients of nutrients in the treatment groups G2, G3 and G4 compared with the control group G1, as the dry matter digestibility coefficient reached 75.42, 77.99, 80.98 and 81.38% for the groups, respectively, the organic matter digestibility coefficient reached 76.85, 78.85, 82.01 and 82.31%, respectively, the crude protein digestibility coefficient reached 77.50, 79.01, 81.51 and 81.79%, respectively, and the crude fiber digestibility coefficient reached

59.54, 62.30, 64.24 and 64.71%, respectively. The crude fat digestibility coefficient was 78.23, 82.81, 84.69 and 85.06% for the groups, respectively. The results also showed a significant improvement (P<0.05) in the percentage of total digestible nutrients (TDN) for the groups, 74.63, 76.7, 78.69 and 78.92%, respectively.

### Discussion

The results of the study show the important role of the aqueous extract of *Moringa oleifera* seeds in improving the growth rates and daily and total weight gain of Awassi lambs. This may be due to the richness of *Moringa* seeds in proteins rich in sulfur amino acids and their high content of oil and beneficial unsaturated fatty acids [19]. The results are consistent with the findings of [10] when using *Moringa* leaves in lamb rations, and with [11] when feeding lambs *Moringa* roots at rates of 25 and 50 g/kg.

The results also showed no significant effect of *Moringa* seed extract on the amount of feed consumed, which is consistent with the results of [20] when using *Moringa oleifera* seed meal as a protein source in the diets of Rahmani lambs.

The results also show a positive effect of the aqueous extract of *moringa* seeds in improving the feed conversion ratio of lambs in the treatment groups. This may be due to the effect of *moringa* in stimulating rumen fermentation and improving the digestibility of feed nutrients. [21]. This is consistent with the results of [20]

when using Moringa seed meal in feeding Rahmani lambs, and also consistent with the results of [10] when using Moringa leaves in lamb rations.

The results indicate a significant improvement in nutrient digestibility (dry matter, organic matter, crude protein, crude fat, crude fiber, and TDN) in the groups treated with moringa seed extract. This may be attributed to moringa's richness in digestive enzymes, which may help break down complex substances in the feed, facilitating their absorption in the digestive tract. Additionally, moringa may contribute to improving the rumen environment by promoting the growth of beneficial bacteria, which improves digestion and absorption. The study results are consistent with those obtained by [20] when using moringa seed meal in feeding Rahmani lambs. They are also consistent with the findings of [13] when using moringa leaves at a 25% rate in sheep rations. They are also consistent with the findings of [14] when using Moringa oleifera seed extract in Nubian goats.

## Conclusions

The study concluded that the use of aqueous extract of Moringa seeds in the drinking water of Awassi lambs contributed to improving growth rates, weight gain, and feed conversion ratio, in addition to increasing the digestibility of feed nutrients.

## Author Contributions

Researcher dr. Mohamed Alrez wrote the research, conducted the experiments, statistically analyzed the results, tabulated them, reviewed the research, and prepared it for publication.

## Declarations

## Ethics Approval and Consent to Participate

Approval was obtained from the Institutional Animal Care and Use Committee (IACUC) and informed consent was obtained from the animal owner for the experiments and publication of the results, with a commitment to applying the best veterinary practices for animal care

## Consent for Publication

Not applicable.

## Availability of Data and Materials

The datasets analyzed during the current study are available from the corresponding author upon reasonable request due to their sensitivity and are available upon request on the web site. <https://orcid.org/0009-0003-0735-1807>.

## Competing Interests

The authors declare no competing interests.

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