EFFECTS OF FEEDING OLIVE LEAVES ON LACTATING PERFORMANCE OF AWASSI EWES

Belal S. Obeidat **Rana Ababneh**
Prof. **Graduate Student**

Depart. Anim. Prod., Fac. Agri., Jordan University Sci. Tech., P.O. Box 3030, Irbid, 22110 Jordan
bobeidat@just.edu.jo

ABSTRACT

The current study aimed to study the effects of feeding olive leaves (OL) on milk yield, milk composition, body weight, and blood parameters of lactating Awassi ewes. Thirty-six newly lambed ewes and their single lambs were distributed at random and assigned to one of three diets: 0% OL (CON), 15% OL (OL15), and 30% OL (OL30) to replace the forage source in sheep's diets. The first seven days of the 56-day experiment were dedicated to adaptation, with the remaining 49 days dedicated to the collection of data. Dry matter (DM) intake was greater (p = 0.014) in the OL15 and OL30 groups compared with the CON group. Crude protein and ether extract intake was also the highest in the OL30 group (p=0.0172) followed by the OL15 group and was lowest for the CON group. The consumption of acid detergent fiber and neutral detergent fiber was higher (p < 0.0001) in CON compared to other groups. A decrease (p = 0.0510) in milk production cost was seen in the group-fed diets containing OL. There were no differences in initial body weight in ewes and lambs, while ewes fed on the CON lost more body weight compared with the OL30, while OL15 was intermediate. The average daily gain in lambs was greater in OL15 and OL30 compared to the CON group. In summary, substituting OL for wheat straw did not impact the lactation performance of ewes whilst it decreased the cost of producing milk and may benefit the livestock farmers.

Keywords: Awassi ewes, olive leaves, milk yield, milk composition.

تأثير التغذية بأوراق الزيتون على الأداء المرضع للنعاج العواسية

بلال عبيدات رنا عبابنة
أستاذ دراسات عليا
قسم الإنتاج الحيواني/كلية الزراعة/ جامعة العلوم والتكنولوجيا الأردنية، إربد، الأردن

المستخلص

هدفت الدراسة الحالية إلى دراسة تأثير تغذية أوراق الزيتون على إنتاج الحليب، وتركيب الحليب، ووزن الجسم، ومؤشرات الدم للنعاج العواسية المرضعة. تم توزيع ستة وثلاثين نعجة حديثة الولادة وحملانها المفردة بشكل عشوائي وتم تخصيصها في واحدة من ثلاث علائق: 0 أوراق زيتون (CON)، 15% (OL15) OL، و 30% (OL30) OL. تم تخصيص الأيام السبعة الأولى من التجربة التي استمرت 56 يومًا للتكيف، بينما تم تخصيص الأيام الـ 49 المتبقية لجمع البيانات. كان تناول المادة الجافة أكبر (p = 0.014) في مجموعتي OL15 وOL30 مقارنة بمجموعة CON. كان تناول البروتين الخام والدهون هو الأعلى أيضًا في مجموعة OL30 (p = 0.0172) تليها مجموعة OL15 وكان الأدنى بالنسبة لمجموعة CON. ان استهلاك ألياف المنظفات الحمضية وألياف المنظفات المحايدة أعلى (p <0.0001) في CON مقارنة بالمجموعات الأخرى. ولوحظ انخفاض في تكلفة إنتاج الحليب في العلائق التي تحتوي على أوراق الزيتون. لم تكن هناك اختلافات في وزن الجسم الأولي في النعاج والحملان، في حين أن النعاج التي تغذت على CON فقدت المزيد من وزن الجسم مقارنة مع OL30، في حين كان OL15 متوسطا. وكان متوسط الربح اليومي في الحملان أكبر في OL15 وOL30 مقارنة بمجموعة CON . في النتيجة، لم يؤثر استبدال OL بقش القمح على أداء الرضاعة لدى النعاج بينما أدى إلى خفض تكلفة إنتاج الحليب وقد يفيد مربي الماشية.

الكلمات المفتاحية: نعاج العواسي، أوراق الزيتون، إنتاج الحليب وتركيبه.

Received:15 /4/2024, Accepted:22/5/2024

NTRODUCTION

Large sheep and goat populations, along with harsh meteorological circumstances, cause feed shortages, reducing small ruminant production and farm profitability in the Mediterranean basin's arid sections (25). In the Mediterranean region, olive cultivation and the olive oil business are commercially and socially significant (10). With the rising expense of feed, animal nutritionists began to focus on increasing livestock utilization of existing alternative feed sources (9, 19). Olive tree (*Olea europaea* L.) is a long-lived evergreen tree that is planted around the world for its delectable fruits. The olive fruit, oil, and olive tree leaves have been used for centuries for nutritional, medicinal, and ceremonial purposes. Olive leaves (OL) one of livestock alternative feed account for approximately 10% of the total biomass of olives obtained for olive oil extraction (22). Olive leaves are a combination of leaves and branches from both trimming olive trees and harvesting and cleaning olives before oil extraction (15). However, OL contains phenolic chemicals that have various therapeutic qualities, including antioxidant activity (22), and is used as one of the appetizing feed elements for farm animals, particularly sheep. Previous studies have shown that the use of OL reduces production costs and subsequently increases profitability (13,19). Tzamaloukas et al. (23) conducted a study on small ruminants given olive by-products and they concluded that by incorporating these by-products into livestock diets, the environmental impact of their disposal is reduced, and expenses associated with waste management and animal nutrition minimized as animals become less dependent on conventional feeds like human-consumed cereal grains. Furthermore, using them in accordance with the principles of the bioeconomy preserves natural resources reduces the effects of climate change, and permits the sustainable use of high-value ingredients inside the food chain. As a result, a lot of farmers believe that adding OL to animal feeds, such as those for ruminant animals, helps to lessen these risks and challenges (10). In recent years, the successful use of agro-industrial by-products in animal nutrition has helped to lower the expense of feeding and the requirement to recycle waste material, which is costly to dispose of. For instance, the companies that produce olive oil have been effectively included in the diets of ruminants as supplements (25). Therefore, this study was conducted to evaluate whether using OL as a low-cost by-product would affect the performance of lactating Awassi ewes such as feed intake, body weight change, milk production and composition, blood parameters, and pre-weaning growth of their single lambs.

MATERIALS AND METHODS

Study area, ethical consideration, and animals: The Institutional Animal Care and Use Committee at Jordan University of Science and Technology (JUST) approved the techniques utilized in this investigation. The study location, which is situated at 510 meters above sea level and 32.30 degrees north latitude, was described as semi-arid. The nutrition lab in the Department of Animal Production at the Faculty of Agriculture at JUST examined the samples that were collected. The research was carried out in the animal field at JUST Faculty of Agriculture, Research and Training Department. Thirty-six recently lambed ewes were divided into three groups at random and given one of three treatments in place of the wheat straw: 0% (CON; n = 12), 15% OL (OL15; n = 12, and 30% OL (OL30; n = 12). Diets designed for lactating ewes were made to be isonitrogenous and to contain 16% crude protein (CP) to comply with NRC (2007) guidelines (Table 1). Ewes were chosen from the JUST animal field and given ear tags, a health check, and a weight. Ewes were housed in group in shaded pen-sided pens (4 m × 4 m; four pens per diet) and they were fed at eight in the morning every day. The chosen sheep were given a week to get used to their new meals and pens. The allocated diets were fed to the ewes and their lambs for seven weeks after adaption. Throughout the trial, ewes and lambs were weighed separately every two weeks before feeding. Throughout the experiment, ewes had free access to fresh water and were provided their diets ad libitum. Refusals were gathered every day and sampled for chemical analysis in order to calculate nutrient intakes. After being gathered, sun-dried, and exposed to the air, OL was added to a well-balanced diet.

Diets and refusals samples were ground to pass a 1 mm screen (Brabender OHG Duisdurg, Kulturstrase 51-55, type 880845, Nr 958084, Germany) and stored for additional analysis after being dried at 55ºC in a forced-air oven to achieve a constant weight. samples were examined for dry matter (DM; 100ºC in an air-forced oven for 24 hours) and CP (Kjeldahl process), while feeds and refusals were analyzed for neutral detergent fiber (NDF), acid detergent fiber (ADF), and ether extract (EE). The ANKOM2000 fiber analyzer was used to assess NDF and ADF in accordance with the methods outlined by Van Soest et al. (24). Throughout the trial, diets were combined every two weeks, and samples were taken at the time of mixing to guarantee uniformity in the chemical composition. For the duration of the trial, all animals were provided with free access to fresh water and a total mixed ration (110% of the previous day's intake) at their discretion. Throughout the trial, ewes and lambs were weighed separately every two weeks before feeding, and then again before the morning meal, in order to calculate the average daily gain (ADG).

Table 1. Ingredients and chemical composition of diets fed to Awassi ewes

Item	Diet[a]		
	CON	OL15	OL30
Ingredients (% DM)			
Barley grain, whole	50.0	52.0	54.0
Soybean meal, 440 g/kg CP (solvent)	18.0	16.0	14.0
Wheat straw[b]	30.0	15.0	0
Olive leaves[c]	0	15.0	30.0
Salt	1.0	1.0	1.0
Limestone	0.9	0.9	0.9
Vitamin–mineral premix[e]	0.1	0.1	0.1
Feed cost/ton (US$)[f]	405	361	317
Nutrients, %			
Dry matter	90.4	90.3	90.9
Crude protein	16.0	16.1	16.2
Neutral detergent fiber	33.7	29.0	24.4
Acid detergent fiber	14.9	12.6	10.2
Ether extract	1.0	2.1	3.2

[a] Diets were: The control diet (CON), 15% olive leaves (OL15, and 30% OL (OL30) of dietary DM.
[b] Contained 1.6% CP, 68.9% NDF, 38.0% ADF, and 5.0% EE of DM basis.
[c] Contained 8.2% CP, 36.4% NDF, 22.0% ADF, and 7.4% EE of DM basis.
[d] Composition per kg contained: vitamin A, 600,000 IU; vitamin D3, 200,000 IU; vitamin E, 75 mg; vitamin K3, 200 mg; vitamin B1, 100 mg; vitamin B5, 500 mg; lysine, 0.5%; DL-methionine, 0.15%; manganese oxide, 4000 mg; ferrous sulphate, 15,000 mg; zinc oxide, 7000 mg; magnesium oxide, 4000 mg; potassium iodide, 80 mg; sodium selenite, 150 mg; copper sulphate, 100 mg; cobalt phosphate, 50 mg; dicalcium phosphate, 10,000 mg.
[e] Calculated based on the prices of diet ingredients for the year 2023

Milk production and composition

Measurements of milk production have been taken during the second week of lactation and have been done every two weeks after that. To measure milk yield, ewes had an intravenous injection of 0.75 mL of oxytocin, were manually milked at 8:00 by skilled workers, and the lambs were kept apart from their mothers for three hours following the initial milking. After giving the ewes another oxytocin injection, they were milked once more after 3 hours, and the amount of milk produced was measured. Over 24 hours (3 × 8), the milk output was changed. Each ewe provided a 125 ml sample, which was then subjected to analyses for fat (using the Gerber method), total solids (in a forced-air oven at 55°C), and CP (using the Kjeldahl procedure; N × 6.38). According to Baldi et al. (5), the formula for calculating milk energy value (MEV; kilocalories per kilogram) was 203.8 + (8.36 × fat g/100g) + (6.29 × protein g/100g). The formula used to determine energy-corrected milk (ECM) was 0.3246 × milk yield + (12.86 × fat yield) + (7.04 × protein yield).

Digestibility and N balance

At the termination of the study, four sheep were chosen at random from each group and kept separately in 1.0 × 0.8 m metabolism crates to assess N balance and nutrient digestibility. The ewes were given four days to acclimate to their crates. After that, they had four days to record their feed intake, orts, and feces, which were collected, weighed, and documented. 10% of each was saved each day and combined for ewe's later chemical examination. Diets, refusals, and fecal samples were crushed to pass a 1 mm screen in a forced air oven, dried at 55°C, and stored for additional examination. As previously mentioned, feed and excrement were examined for DM, CP, NDF, and ADF. After being collected in plastic containers, urine samples were weighed, and the N balance was calculated by storing 5% at −20 ◦C. To stop ammonia loss, 50 mL of 6N HCL was added to each urine sample container.

Blood parameters

Blood samples were drawn from the jugular vein in plain vacutainers at 8:00 a.m. (before feeding) at the start and end of the trial. After one hour of collection, blood samples were centrifuged at 3000 rpm for 15 minutes. After being separated right away, serum samples were brought to the lab and kept there until the day of analysis at a temperature of -20°C. The following serum concentrations were measured using a spectrophotometer: glucose, urea N, total protein, albumin, aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatase (ALK-P). Commercial kits (JENWAY 6105 UV/Vis, Model 6105, Janeway LTD Felsted, Dunmow ESSEX CM6 3LB, UK) were used for the analysis, and the manufacturer's instructions were followed.

Table 2. Effects of feeding olive leaves (OL) on the nutrient intake of Awassi ewes fed lactation diets

Item	Diet[a]				
	CON (n = 4)	OL15 (n = 4)	OL30 (n = 4)	SEM[b]	p value
Nutrient intake (g/d)					
Dry matter	2397[a]	2450[b]	2476[b]	12.8	0.014
Crude protein	384[a]	391[b]	397[c]	3.1	0.0172
Neutral detergent fiber	808[a]	703[b]	598[c]	5.1	< 0.0001
Acid detergent fiber	357[a]	306[b]	250[c]	2.2	< 0.0001
Ether extract	24[a]	51[b]	78[c]	0.5	< 0.0001

[a] Diets were: The control diet (CON), 15% olive leaves (OL15, and 30% OL (OL30) of dietary DM.

Statistical analysis

The data was analyzed using SAS's MIXED technique (Version 8.1, 2000, SAS Inst. Inc., Cary, NC). Except for milk yield and composition, the only effect included in the fixed effects for all data was treatment. The variation of repeated assessments in milk production and composition was examined using a model that included treatment, week, and the interaction between treatment and week. The discussion is limited to the main effects because there was no treatment × week interaction found. When the fixed effects were statistically significant ($p < 0.05$), the least-square means were divided using the relevant pair-wise t-tests.

RESULTS AND DISCUSSION

Table 1 displayed the diets' costs in $US/ton. In comparison to the CON diet, the OL15 and OL30 diets showed diet cost reductions of 11 and 22%, respectively. As a result, the overall cost of the diet declined when the OL was included. The effects on nutrient intake are in Table 2. The DM intake was greater ($p = 0.014$) in ewes fed the OL15 and OL30 diets than the CON diet. However, CP and EE intakes were the highest ($p \leq 0.0172$) for the OL30 diet followed by the OL15 and CON diets. On the other hand, intake of NDF and ADF were lowest ($p < 0.0001$) for ewes fed the OL30 followed by OL15 and CON diets. Table 3 shows the effect of feeding OL on the body weight of ewes and the growth rate of lambs. At the termination of the study, ewes fed the CON diet lost more weight ($p=0.0540$) compared with the ewes fed the OL30 and OL15 diets. Regarding lambs, final body weight, total gain, and average daily gain were greater ($p \leq 0.0530$) for the OL30 and OL15 groups compared to the CON group. When the ewes were fed the three diet treatments milk yield tended to be higher ($p = 0.0721$) in OL15and OL30 compared to the CON diet (Table 4). However, there were no differences ($p \geq 0.1027$) in the milk composition (g/kg or g/d), MEV, or ECM. The cost of milk was lower in the diet containing OL versus the CON diet ($p \leq 0.0510$). The in vivo digestibility and N balance trial is recorded in Table 5. The digestibility coefficients and N balances of the three diets showed no significant differences except N retention was significant in OL30 and OL15 than CON ($p = 0.0094$). Finally, serum urea nitrogen, glucose, LDL, Triglycerides, creatinine, AST, ALT, and ALP did not differ among the treatment diets (Table 6). However, the serum content of cholesterol and HDL was higher ($p < 0.0173$) in OL30 and, OL15 than in CON diets. Our investigation indicates a favorable relationship between feed cost and OL inclusion rate in Awassi ewes' diets (Table 1). This outcome is consistent with earlier research studies that examined alternative feeds as a means of lowering the expense of traditional animal diets (18). Additionally, the cost of the diet was reduced as a result of the addition of OL as an alternative feed, presumably having no adverse impacts on the animal's health and performance as we reported in the current study. This had a beneficial effect on production costs. Consequently, using such a byproduct. In this study, when compared to the findings of Abbeddou et al. (1), a slight decrease in the OL DM, NDF, and ADF values and an increase in the CP and EE values were observed (Table 1); this variation may be caused by the differences in the OL nutritional contents between different olive tree cultivars (13). Also, DM, CP, and EE intakes were higher in diets incorporated with the OL (OL15 and OL30) (Table 2). However, the NDF and ADF intakes decreased in the OL15 and OL30 diets. This is mostly because, as noted by Ismail and Obeidat (13), OL are low in tannins (i.e., at a level that does not affect nutrient intake). Intake of NDF and ADF were lower in the OL15 and OL30 diets. This result may be explained by the OL's decreased NDF and ADF levels when compared to wheat straw. On another hand, a study conducted by Aloueedat et al. (3) showed that no effect on DM, CP, or ADF consumption was discovered in the diet that contained alternative feeds. The CON diet contains more NDF than the alternative feeds at 20% (AF20) and 40% (AF40) diets due to greater levels of NDF from wheat straw. The addition of the OL at 15 and 30% of dietary DM did not negatively impact the nutrient intake in general, according to the intake data. In agreement with our study, Ismail and Obeidat (13) showed that the diet cost decreased in Awassi lambs that were fed with an OL50 and OL100, 381(US$/1000 kg) and 359 (US$/1000 kg) respectively containing diet had a lower production cost compared with lambs that fed a commercial diet 405 (US$/1000 kg). Also, Aloueedat et al. (3) found that the diet cost of using alternative feed for lactating Awassi ewes and lambs lowered the diet cost by about $72/1000 kg between alternative feeds AF40% and CON. Similarly, Obeidat and Thomas (20) observed that OC added to growing Awassi lambs' diets somewhat decreased costs. likewise, production costs were decreased when carob pods were partially substituted for barley grains by Obeidat et al. (17). Also, Aljamal et al. (2) when OC was used as an alternative feed instead of the barely component, feed costs decreased while the lambs' growth parameters were maintained. in agreement with our study, there were no differences in the digestibility and N balance parameters except N retention when Awassi lambs were fed diets containing olive leaves (13). Also, in agreement with our study Obeidat (16) noted that N retention increased in growing Awassi lambs supplemented with black cumin meal (BCM) as an alternative feed due to, the higher CP digestibility in the BCM group as compared to the CON group. Fegeros et al. (8) fed concentrate, alfalfa hay, and OL treated with ammonia to lactating ewes observed that the apparent digestibility of the EE, CP, and NDF increases when fresh OL are treated with an ammonia solution. Also, Ismail and Obeidat (13). explained the increase in EE digestibility due to the increased inclusion rate of OL, which is a result of the olives found in the OL after they are gathered from an oil pressing mill. The fiber content and preservation methods of OL have an impact on its apparent digestibility in vivo. When it comes to growth performance, prior research on lambs raised with olive by-products like olive cake (OC; 2), OL (10,11,13) results showed that no significant difference in initial weights and the final BW of their results that use olive by-product; and there was no significant difference in total weight gain, average daily gain and feed conversion ratio. Obeidat et al. (17) conducted a study on nursing Awassi ewes fed different levels of bread by-products and showed that ewes' initial and final body weights were similar across all diets. Similarly, lambs' performance (i.e., initial and weaning body weight and average daily gain) was not impacted by the addition of BB. The results were predicted given that all groups had similar levels of nutrient intake and digestibility. In contrast, Obeidat (16) showed that the final BW and ADG in the BCM150 diet were higher than in the CON diet, suggesting that the lambs given the BCM150 diet were more effective in utilizing resources for growth. Also, our results showed that there was a significant difference between groups in body weight change in ewes and final weight, total gain, and average daily gain in their lambs as shown in Table (3).

Table 3. Effect of feeding olive leaves (OL) on the body weight of ewes and the growth rate of lambs

Item	Diets[a] CON (n = 12)	OL15 (n = 12)	OL30 (n = 12)	SEM	p value
Ewes					
Initial body weight (kg)	52.8	52.7	52.9	2.39	0.9240
Final body weight (kg)	49.2	50.2	50.8	2.37	0.8155
Body weight change (kg)	- 3.67[a]	- 2.58[ab]	- 1.08[b]	0.726	0.0540
Lambs					
Initial body weight (kg)	5.5	5.8	5.3	0.33	0.5236
Final body weight (kg)	18.4[a]	20.4[b]	19.5[b]	0.54	0.0477
Total gain (kg)	12.8[a]	14.7[b]	14.2[b]	0.62	0.0560
Average daily gain (g)	230[a]	262[b]	252[b]	9.9	0.0482

[a] Diets were: The control diet (CON), 15% olive leaves (OL15, and 30% OL (OL30) of dietary DM.

Table 4. Effect of feeding olive leaves (OL) on milk yield and composition of Awassi ewes fed lactation diets

Item	Diets[a] CON (n = 12)	OL15 (n = 12)	OL30 (n = 12)	SEM	p value
Milk yield (g/d)	1909[a]	2356[b]	2367[b]	164	0.0491
Milk composition (g/kg)					
Total Solids	200	203	197	0.58	0.7919
Protein	45	43	44	0.15	0.4923
Fat	76	75	74	0.24	0.8130
Lactose	65	62	63	1.17	0.1263
Milk yield (g/d)					
Total Solids	387	474	461	36.0	0.1960
Protein	86	102	102	8.0	0.2974
Fat	154	200	188	15.3	0.1027
Lactose	126	146	146	11.3	0.3635
MEV[b]	299	303	299	3.8	0.6055
ECM[c]	3.22	4.06	3.89	0.29	0.1145
Cost/kg milk production (US$)	0.53[a]	0.39[b]	0.34[b]	0.049	0.0410

[a] Diets were: The control diet (CON), 15% olive leaves (OL15, and 30% OL (OL30) of dietary DM.
[b] MEV: milk energy value
[c] ECM: energy corrected milk

Moreover, Table (4) summarizes the results of this study on milk yield and composition of Awassi ewes fed lactation diets there was a significant difference between diet groups in milk yield nevertheless did not significantly affect milk total solid, protein, fat, and lactose. So, according to our data, olive leaves do not have a significant influence on milk composition. Similarly, Cabiddu et al. (6) found that feeding olive cake silage to Sarda ewes (250, 500 g DM/head/day) did not affect milk fat or protein content. Although, Abbeddou et al. (1) consistent a study on Awassi ewes, as the replacement of barley with 30% OC revealed that the milk yield does not impact, but it may cause a drop in milk protein compared to the control diet. This could be explained by Aljamal et al. (2), the high milk production in the OC group leads to a decrease in the content of these nutrients at a larger volume of milk. Also, a previous study conducted by Chiofalo et al. (7) noticed that using 20% OC in Comisana lactating ewes feed increased milk yield compared with the control group.

Table 5. Effect of feeding olive leaves (OL) on blood metabolites of Awassi ewes fed lactation diets.

Item	Diet[a]				
	CON (n = 12)	OL15 (n = 12)	OL30 (n =12)	SEM	p value
Blood urea nitrogen, mg/dL	19.92	16.35	19.54	1.544	0.1635
Glucose, mg/dL	43.75	46.25	43.91	1.490	0.7323
Cholesterol, mg/dL	73.83[a]	78.17[a]	85.73[b]	3.392	0.0173
HDL, mg/Dl[b]	56.42[a]	61.00[a]	70.37[b]	2.845	0.0058
LDL, mg/dL	11.97	11.07	10.13	1.764	0.7376
Triglycerides, mg/dL	27.25	30.50	26.18	2.964	0.5066
Creatinine, mg/dL	0.67	0.59	0.70	0.047	0.2620
AST, U/L	25.67	31.33	28.46	2.576	0.3174
ALT, UL	12.75	8.83	8.63	2.389	0.4043
ALP, UL	58.83	63.75	56.46	8.192	0.8153

[a] Diets were: The control diet (CON), 15% olive leaves (OL15, and 30% OL (OL30) of dietary DM.
[b] HDL: high-density lipoprotein, LDL: low-density lipoprotein, AST: aspartate aminotransferase, ALT: alanine aminotransferase, ALP: alkaline phosphatase.

Table 6. Effect of feeding olive leaves (OL) on nutrient digestibility and N balance of Awassi ewes fed lactation diets.

Item	Diets[a]				
	CON (n=4)	OL15 (n=4)	OL30 (n=4)	SEM	p value
Nutrient intake, g/d					
Digestibility, %					
Dry matter	79.8	79.0	77.6	2.06	0.7629
Crude protein	74.1	76.8	77.3	1.32	0.2505
Neutral detergent fiber	61.5	65.8	64.7	2.38	0.4651
Acid detergent fiber	58.7	58.5	56.4	2.08	0.7467
Ether extract	81.0	83.7	85.9	1.51	0.1536
Nitrogen Balance					
N intake, g/d	21.4	21.9	21.8	0.64	0.7849
N feces, g/d	4.7	5.0	4.9	0.43	0.5300
N urine, g/d	5.7	4.6	4.7	0.33	0.1177
N retained, g/d	11.0	12.3	12.2	0.43	0.1094
N retention, g/100g	51.6[a]	56.4[b]	55.8[b]	1.02	0.0094

[a] Diets were: The control diet (CON), 15% olive leaves (OL15, and 30% OL (OL30) of dietary DM.

Economically speaking, results herein showed that using OL decreased the cost of diets by 14 and 19% OL15 and OL30 diets respectively, when compared to the CON diet. This is because non-traditional feeds are far less expensive than conventional feeding as reported by Aljamal et al. (2). Similarly, Obeidat et al. (17) found that the manufacturing cost decreased when carob pods were partially substituted for barley grains. Also, Aloueedat et al. (3) found that the AF40 diet had the lowest milk costs followed by the AF20 and control diets. In agreement, Obeidat et al. (17) conducted a study on nursing Awassi ewes fed different levels of bread by-products (BB) and showed that reduced milk production costs are linked to diet costs. Incorporating BB lowered diet costs compared to a free BB diet. There were no significant variations in blood urea nitrogen, glucose, triglyceride, or creatinine levels, however, OL30 treatment appears to have been beneficial in increasing blood cholesterol. In a previous study, Issa (14) discovered that developing lambs fed acacia and olive pulp throughout the hot summer months had a greater increase in the concentration of minerals and hormones in their plasma than lambs fed rice straw, indicating that acacia and olive pulp have a protective effect against heat stress. This might be explained by the role minerals play in vitamins, hormones, and the control of enzyme activity, all of which are required for the creation of flesh, bones, and other common biological functions. Otherwise, no apparent differences were found in the calculations of the various cell types, and the administration of OL appears to have been effective in decreasing blood cholesterol (12). Although it is not feasible to compare this instance to previous trials, Olmez et al. (21) accomplished a study that investigated the effect of an olive leaf extract in rats fed a cholesterol-rich diet. It has been established that giving the extract successfully decreases blood cholesterol and LDL-cholesterol levels, which is associated with a reduced susceptibility to the formation and progression of atherosclerosis. Rats on a high-cholesterol diet also experienced hypocholesterolemic effects from a phenolic extract derived from olive mill effluent. In this case, the results were likewise consistent with tests conducted across a broader range to assess antioxidant enzyme activity and lipid peroxidation in the heart, liver, kidney, and aorta. Alkhtib et al. (4) conducted a study that showed all treatments (e control group was fed a conventional ration (75% commercial concentrate mixture and 25% wheat straw), OTU (62.3% concentrate mixture + 37.3% air-dried olive twigs and leaves treated with 4% urea for 14 days) and OTUM (51.5% concentrate mixture + 48.5% air-dried olive twigs and leaves treated with 4% urea for 14 days then sprayed with 10% molasses) have equivalent amounts of albumin, total protein, urea, packed cell volume, hemoglobin, alanine transferase, aspartate transferase, glucose, cholesterol, and creatinine, indicating normal liver and kidney function. The inclusion of OL at either 15 or 30% of dietary dry matter showed that using diets containing OL as a primary source of fiber would improve or at least not impact the performance of Awassi ewes compared with the conventional Therefore, these findings suggest that Using alternative feeds like OL in ruminant feeding is important to reduce dependence on traditional feeds, reduce the cost of production so, increase profitability.

Acknowledgments: Authors wish to thank Deanship of Research at JUST for funding this research (Grand #: 110/2021)

REFERENCES

1. Abbeddou, S., S. Rihawi, H. D. Hess, L. Iniguez, A. C. Mayer, and M. Kreuzer, 2011. Nutritional composition of lentil straw, vetch hay, olive leaves, and saltbush leaves and their digestibility as measured in fat-tailed sheep. Small Rumin. Res., 96, 126-135. https://doi.org/10.1016/j.smallrumres.2010.11.017

2. Aljamal, A.E., B.S. Obeidat, and M. D. Obeidat, 2021. Lactation performance of Awassi ewes fed diets containing either *Atriplex halimus* L. or olive cake. Ital. J. Anim. Sci., 20(1), 426–432. https://doi.org/10.1080/1828051X.2021.1886002

3. Aloueedat, M. K., B.S. Obeidat, and M.S. Awawdeh, 2019. Effects of partial replacement of conventional with alternative feeds on nutrient intake, digestibility, milk yield and composition of Awassi ewes and lambs. Animals, 9, 684. https://doi.org/10.3390/ani9090684

4. Alkhtib A., M. Muna, E. Burton, J. Wamatu, M. Darag, E. Alkhaled, Z. Al-Asa'ad, H. Almoufachi, and R. Zaeowd 2021. Effect of olive tree leaves and twigs on intake, digestibility, growth performance and blood variables of Shami goats. Vet. Med. Sci., 7(3), 908-914. doi: 10.1002/vms3.419

5. Baldi, A., F. Cheli, C. Corino, V. Dell'Orto, and F. Polidroi, 1992. Effects of

feeding calcium salts on long chain fatty acids on milk yield, milk composition and plasma parameters of lactating goats. Small Rumin. Res., 6, 303–310.

6. Cabiddu A., M. Canu, M. Decandia, G. Molle, and R.Pompel 2004. The intake and performance of dairy ewes fed with different levels of olive cake silage in late pregnancy and suckling periods. Nutrition and Feeding Strategies of sheep and goats under harsh climates. Centre International de Hautes Études Agronomiques Méditerranéennes-Instituto Agronómico Mediterráneo de Zaragoza (CIHEAMIAMZ), Zaragoza, Spain, pp.197-202.

7. Chiofalo, B., L. Liotta, A. Zumbo, and V. Chiofalo, 2004. Administration of olive cake for ewe feeding: effect on milk yield and composition. Small Rumin. Res., 55(1-3), 169-176. https://doi.org/10.1016/j.smallrumres.2003.12.011

8. Fegeros, K., G. Zervas, F. Apsokardos, J. Vastardis and E. Apostolaki, 1995. Nutritive evaluation of ammonia treated olive tree leaves for lactating sheep. Small Rumin. Res., 17(1), 9–15. http://doi:10.1016/0921-4488(95)00657-7

9. Hatamleh, S. M. and B. S. Obeidat, 2019. Growth performance and carcass traits responses to dried distillers' grain with solubles feeding of growing Awassi ram lambs. Animals. 12, 9(11):954. http://doi: 10.3390/ani9110954

10. Hukerdi, J. Y., F.M.H. Nasri, L. Rashidi, M. Ganjkhanlou, and A. Emami, 2019. Effects of dietary olive leaves on performance, carcass traits, meat stability and antioxidant status of fattening Mahabadi male kids. Meat Sci., 153, 2-8. http://doi: 10.1016/j.meatsci.2019.03.002

11. Hukerdi, J.Y., F.M.H. Nasri, L. Rashidi, M. Ganjkhanlou, and A. Emami, 2020. Supplementing kids diet with olive leaves: Effect on meat quality. Small Rumin. Res., 106258. http://doi:10.1016/j.smallrumres

12. Ianni, A., F. Bennato, C. Martino, M. Colapietro, and G. Martino, Whole Blood transcriptome profiling reveals positive effects of olive leaves supplemented diet on cholesterol in goats. Animals. 17, 11(4):1150. http://doi: 10.3390/ani11041150

13. Ismail, N. and B.S. Obeidat, 2023. Olive leaves as alternative feed for finishing lambs: evaluation of feed intake, nutrients digestibility, growth performance, and carcass quality. Ital. J. Anim. Sci., 22, 214-221. https://doi.org/10.1080/1828051X.2023.2179429

14. Issa, H.H. 2012. Effect of acacia and dry olive pulp on alleviation heat stress in Awassi female lamb in Iraq. Iraqi J. Agric. Res., 17(1), 164–173.

15. Molina-Alcaide, E. and D.R. Yanez-Ruiz, 2008. Potential use of olive by-products in ruminant feeding: A review. Anim. Feed Sci. Technol., 147(1-3), 247–264. doi:10.1016/j.anifeedsci.2007.09.021

16. Obeidat, B.S. 2020. The inclusion of black cumin meal improves growth performance of growing Awassi lambs. Vet. Sci., 9, 7(2):40. doi: 10.3390/vetsci7020040.

17. Obeidat, B.S., M.A. Alrababah, M.N. Alhamad, M.A. Gharaibeh, and M.A. Abu Ishmais, 2012. Effects of feeding carob pods (*Ceratonia siliqua* L.) on nursing performance of Awassi ewes and their lambs. Small Rumin. Res., 105, 9-15. https://doi.org/10.1016/j.smallrumres.2012.01.001

18. Obeidat, B. and M.M. Alwaked, 2024 The role of olive leaves and *saccharomyces cerevisiae* supplementation in enhancing the performance and economic feasibility of fattening lambs. Trop. Anim. Health Prod., Accepted.

19. Obeidat, B.S. and M.G. Thomas, 2023. Assessing the influence of feeding olive leaves on the productivity and economic viability of growing Awassi lambs. Cogent Food Agri., 9, 2277518. https://doi.org/10.1080/23311932.2023.2277518

20. Obeidat, B.S. and M.G. Thomas, 2024. Growth performance, blood metabolites and carcass characteristics of Black goat kids fed diets containing olive cake. Animals, 14(2), 272. https://doi.org/10.3390/ani14020272

21. Olmez, E.. K. Vural, S. Gok, Z. Ozturk, H. Kayalar, S. Ayhan, and A.Var, 2015. Olive leaf extract improves the atherogenic lipid profile in rats fed a high cholesterol diet. Phytother. Res., 29(10), 1652-7. doi: 10.1002/ptr.5445

22. Quirantes-Piné, R., J. Lozano-Sánchez, M. Herrero, E. Ibáñez, A. Segura-Carretero, and A. Fernández-Gutiérrez, 2013. HPLC-ESI-QTOF-MS as a powerful analytical tool for characterizing phenolic compounds in olive-leaf extracts. Phytochem. Anal., 24(3), 213-23. doi: 10.1002/pca.2401

23. Tzamaloukas, O., M. C. Neofytou, and P.E. Simitzis, 2021. Application of olive by-products in livestock with emphasis on small ruminants: implications on rumen function, growth performance, milk and meat quality. Animals, 11(2), 531. https://doi.org/10.3390/ani11020531

24. Van Soest, P.J., J.B. Robertson, and B.A. Lewis, 1991. Methods of dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. J. Dairy Sci., 74, 3583-3597. http://dx.doi.org/10.3168/jds.S0022-0302(91)78551-2

25. Vasta, V., A.Nudda, A. Cannas, M. Lanza, and A. Priolo, 2008. Alternative feed resources and their effects on the quality of meat and milk from small ruminants. Anim. Feed Sci. Technol., 147, 223– 246. https://doi.org/10.1016/j.anifeedsci.2007.09.020