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Effect of Olive Cake on Growth Performance, Carcass and Hematological Parameters of Local Barbary Lambs

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Abstract:
This study was carried out in early 2025 on a private farm in Bani Walid, Libya, to evaluate the impact of olive cake supplementation on growth performance, carcass characteristics, and hematological parameters of local Barbary lambs. A total of 45 lambs, approximately 3 months old with an average body weight of 25 kg, were randomly allocated into five treatment groups (9 animals per group) based on body weight. The feeding trial lasted for 90 days and followed a completely randomized design.
The dietary treatments included a control group fed a basal diet and four groups receiving increasing levels of olive cake at 10%, 15%, 25%, and 30% inclusion rates. These levels were selected based on the average active components found in olive cake. All lambs were weighed upon arrival and assigned randomly to the respective treatment groups.
Results indicated that increasing the level of olive cake up to 30% led to improvements in growth metrics such as initial and final body weight, total weight gain, daily gain, and overall feed intake. Similarly, enhancements were observed in carcass traits, including fasting live weight, hot and cold carcass weights, non-carcass components, carcass cuts, and fat-tail weight.
In terms of blood parameters, lambs receiving olive cake supplementation showed favorable hematological and biochemical profiles compared to the control. Parameters such as urea nitrogen, glucose, cholesterol, HDL, LDL, AST, ALT, ALP, creatinine, RBC, WBC, hemoglobin, packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were all improved in the olive cake groups. In contrast, the control group consistently showed lower values across growth, carcass, and blood indices.

Keywords: Lamb, Olive Cake, Growth Performance, Hematological and Biochemical Parameters.

تأثير كعكة الزيتون على أداء النمو والذبيحة والمعايير الدموية لحملان البربرية المحلية

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الملخص
أُجريت هذه الدراسة بداية عام 2025 في مزرعة خاصة في بني وليد، ليبيا، لدراسة تأثير كعك الزيتون على أداء النمو والذبيحة والمعايير الدموية لحملان البربري المحلية. قيم خمسة وأربعون حملاً من نوع البربري المحلية، بمتوسط وزن 25 كجم، بعمر ثلاث أشهر، إلى خمس مجموعات (تسع حيوانات من كل مجموعة) حسب الوزن الحي، تجربة تغذية استمرت لمدة 90 يوماً. كانت النسب الغذائية لمجموعات الحيوانات التجريبية كما يلي: 10%، 15٪، 25٪، و30٪، كعك الزيتون (الضابط) المُضاف إلى العليقة الأساسية بالإضافة إلى الكنترول. عند وصول الحملان، وُزنت ووُزّعت عشوائيًا على خمس معاملات، كل منها 9 حملان، بناءً على تصميم عشوائي كامل. تكوّنت المعاملات الغذائية من العليقة الأساسية. اختيرت كميات المكملات الغذائية كعلاجات مع مراعاة متوسط محتوى المادة الفعالة في كعك الزيتون. أظهرت النتائج التي تم الحصول عليها أن زيادة مستوى كعكة الزيتون حتى 30٪ سجلت أعلى أداء للنمو أي الوزن الأولي والوزن النهائي والمكسب الكلي والمكسب اليومي ووزن الجسم وإجمالي تناول العلف، كما تميزت الذبيحة (الوزن الحي الصائم ووزن الذبيحة الساخنة ووزن الذبيحة الباردة والمكونات غير الذبيحة وأوزان قطع الذبيحة والذيل الدهني) والمعايير الدموية أي اليوريا N والجلوكوز والكوليسترول وHDL وLDL وAST وALT وALP والكرياتينين وRBC وWBC وHb وPCV وMCH وMCV وMCHC، مقارنة بمعاملة التحكم التي سجلت أقل قيمة لجميع أداء النمو. أي الوزن الأولي، الوزن

النهائي، المكسب الكلي، المكسب اليومي، وزن الجسم وإجمالي تناول العلف، كما يميز الذبيحة (الوزن الحي الصائم، وزن الذبيحة الساخنة، وزن الذبيحة الباردة، المكونات غير الذبيحة، أوزان قطع الذبيحة والذيل الدهني)، المعايير الدموية والكيميائية الحيوية أي اليوريا N، الجلوكوز، الكوليسترول، HDL، LDL، AST، ALT، ALP، الكرياتينين، RBC، WBC، Hb، PCV، MCH، MCV، MCHC، على التوالي.

الكلمات المفتاحية: حملان، كعكة الزيتون، أداء النمو، والمعايير الدموية، القياسات الحيوية.

Introduction

Since the number of people on the planet has grown along with the amount of food and crop byproducts, it is crucial to implement by-products management programs to get rid of them and use them in ruminant feed. The field of animal nutrition researchers worked hard to come up with various ways to lower feeding costs Ruminants have the ability to utilize by-product feedstuffs—often rich in structural fiber—through their rumen microbial activity, making such feed sources a viable and cost-effective dietary alternative for meeting maintenance and production needs, particularly when these by-products are locally available **(24)**.

One variety of red meat from domesticated sheep under a year old is lamb. The majority of lamb is sold when it is between six and eight months old. Sheep older than a year are referred to as mutton rather than lamb. The first known domesticated meat species is lamb, which first appeared in the Middle East's cuisine some 9,000 years ago. Meat has a major role in the current human diet due to its nutritional qualities, including its protein, fat, mineral, and vitamin content **(15)**.

Lamb meat's inclusion in diets, especially for young children and the elderly, requires proof of its nutritional worth. Lamb meat production and quality enhancement are both necessary to meet the growing demand for high quality **(27)**.

Livestock productivity and health are largely influenced by nutrition. However, there are a number of difficult challenges that could impact animal nutrition and require livestock management to reconsider their feeding techniques, including rangelands, feed shortages, and growing feed costs. In order to reduce feeding expenses, improve feed efficacy, and guarantee the sustainability of livestock systems, alternative feeds or suitable feed additives are crucial. In an effort to lower diet costs and boost profitability, researchers have begun incorporating alternative feeds to address issues related to the availability and costs of conventional feeds **(36)**.

Food components with nutrients that match animal requirements at reduced costs are becoming more and more sought after due to the demand for highly nutritious and economically viable feed products. Consequently, the development of non-traditional food ingredients for animal nutrition is required. Another way to satisfy animal needs and lower feed costs is to employ agro-industrial by-products **(47)**.

To address the shortage of pasture and rangeland, livestock producers have increasingly relied on various grains and forages as alternative feed sources. While this approach was initially cost-effective, the reliance on imported feed ingredients has led to rising prices, with feed costs now comprising up to 70% of total production expenses **(34)**. Moreover, the quality and availability of these feeds often fluctuate both seasonally and annually, adding further challenges to consistent livestock production **(36)**. Thus, in order to address the scarcity of feeds without compromising the quality of the diets given to the animals, other feed resources or by-products must be found. An excellent option is olive cake **(33)**. Because of its high content of hemicellulose, cellulose, and lignin as well as bioactive substances (phenolic compounds) and bioactive peptides, olive cake (OC) is becoming a desirable resource for the livestock feed industry. Thus, OC reuse improves the supply chain's circular economy as well as that of the producing basins **(32)**. Ruminant diets may use olive cake (OC) as a feed source **(2)**. It is a byproduct of the agro-industrial process of obtaining olive oil. 35% to 40% of the total weight of processed olives is made up of husk, stone wall, pulp, kernel, and leftover oil **(35) (16)**. According to **(8)**, 90% of the world's olive oil is produced in the Mediterranean, where olives are grown. Environmental hazards arise from the huge seasonal volumes of OC produced by olive oil extraction plants in the country. These by-products are difficult to decompose **(20) (21)**.

The chemical composition is characterized by a low protein content (8–11% on DM), a high crude fat content (10–16% on DM), a high proportion of monounsaturated fatty acids (MUFA; oleic acid; 68–70 g/100 g of total fatty acids) and polyunsaturated fatty acids (PUFA; 7–12 g/100 g of total fatty acids), the presence of bioactive compounds (phenols and tannins), and a high neutral detergent fiber (NDF; 60–66% on DM), according to several prior studies conducted by our group **(13) (4)**. The impact of polyphenols on the extracellular enzymes released by the ruminal microflora, the influence on the biohydrogenation of PUFA and ammonia, and the production of volatile fatty acids (VFA) have all led to extensive testing of the OC to assess its possible effects on rumen microbiota and fermentation characteristics. Notably, nevertheless, recent research on dairy cows has shown that adding OC can affect the health of the animal as well as the quality of the finished product **(4)**. According to **(9)**, growing-finishing Limousine bulls with high inclusion levels of OC in the concentrate (15%) had reduced BW gain during the 140-day period of feeding OC and were linked to worsened liver functionality (lower plasma cholesterol and higher bilirubin content).

Thus, the purpose of the current study is to determine how olive cake affects the hematological parameters and growth performance of lambs.

Materials And Methods

This study examined the impact of olive cake on the growth performance, carcass, and hematological parameters of local Barbary lambs on a private farm in Bani Walid, Libya, throughout the 2024 growing season. For a 90-day feeding trial, 45 local Barbary lambs who were 3 months old and had an average body weight of 25 kg were split into 5 groups, with 9 animals in each group. The following were the experimental rations given to the animal groups: The basal diet was supplemented with control olive cake at 10, 15, 25, and 30%. After arriving, the lambs were weighed and assigned, using a perfectly randomized method, to one of five treatments, each consisting of nine lambs. The basal diet was one of the dietary treatments. Given the average amount of active ingredients in olive cake, the dosages of dietary supplements were selected as treatments. They had plastic buckets of clean drinking water. Pens for animals were cleaned once a week. Weekly lamb weights were noted prior to the feeding at 9:00 a.m. Following a 12-hour fast at the conclusion of the 90-day feeding period, all of the lambs were killed. Rations were given to developing lambs (in groups) at 7:00 am and 4:00 pm in the morning and evening, respectively, in enough quantity to produce a daily excess of at least 10%. Before serving the feed for the following day, orts were gathered. Every 15 days, the lambs were weighed before to morning feeding following a 12-hour fast. Once the dry matter (DM) was weighed, it was modified based on variations in body weight.

Data Recorded

- **Growth Performance**

The body weight of each lamb was recorded biweekly prior to the morning feeding in order to assess average daily weight gain throughout the trial period.

- **Carcass Characteristics**

After being fed for nine weeks, the lambs were killed. After eighteen hours of shrinkage without nourishment, slaughter was performed. At the moment of slaughter, the weights of the lambs' live bodies and heated carcasses were recorded. following a 48-hour chilling period for the carcasses.

Red blood cell (RBC) counts ($\times 10^6/\mu L$) were determined following the method described by Feldman et al. (2000). Hemoglobin concentration (g/dL) and packed cell volume (PCV, %) were assessed according to the procedures outlined by Drew et al. (2004). The mean corpuscular volume (MCV, μm^3) was calculated using the formula: MCV=(Hematocrit/RBCcount) ×10MCV = (Hematocrit / RBC count) × 10MCV=(Hematocrit/RBCcount) ×10. Mean corpuscular hemoglobin (MCH, pg) was calculated as: MCH=(Hemoglobin/RBCcount) ×10MCH = (Hemoglobin / RBC count) × 10MCH=(Hemoglobin/RBCcount) ×10, and mean corpuscular hemoglobin concentration (MCHC, %) was determined using: MCHC=(Hemoglobin/Hematocrit) ×100MCHC = (Hemoglobin / Hematocrit) × 100MCHC=(Hemoglobin/Hematocrit) ×100.

For microscopic examination, a thin blood smear was prepared using a small drop of blood. The smear was air-dried completely and then stained with Giemsa stain to evaluate cellular morphology.

For microscopic examination, a thin blood smear was prepared using a small drop of blood. The smear was air-dried completely and then stained with Giemsa stain to evaluate cellular morphology.

- **Blood Biochemical Parameters**

Blood samples were collected at the end of the experimental period using plain vacutainer tubes, with sampling performed from the jugular vein prior to the morning feeding (around 8:00 a.m.). The collected blood was allowed to sit for one hour before being centrifuged at 1734 × g for 15 minutes. The resulting serum was carefully separated and stored at –20°C until further analysis.

Serum biochemical parameters were assessed using a UV/Vis spectrophotometer (JANEWAY 6105, Model 6105, Janeway Ltd., Felsted, Dunmow, Essex CM6 3LB, UK). The analyses included blood glucose, blood urea nitrogen (BUN), alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total cholesterol, triglycerides, high-density lipoprotein (HDL), low-density lipoprotein (LDL), and creatinine. All biochemical measurements were performed using commercial diagnostic kits (BioSystems S.A., Costa Brava, Barcelona, Spain) according to the manufacturers' protocols.

Total plasma cholesterol (mg/dL) was determined individually using specific assay kits, as described by **(10)**. The concentration of alkaline phosphatase (U/L) was measured based on the colorimetric method reported by **(6)**.

Statistical Analysis:

The collected data were analyzed using the PROC MIXED procedure in **(42)**, based on a completely randomized design. The dietary treatment was considered the sole fixed effect in the model. When significant

differences were detected ($P < 0.05$), least square means were separated using appropriate post hoc comparisons to determine the effect of treatment levels.

Results And Discussion

A) Growth performance

Table (1) and Fig. (1) present the findings on the impact of feeding varying amounts of olive cake (OC) (10, 15, 25, 30%, and control) on growth performance. But the findings indicated that up to 30% more olive cake (OC) resulted in higher initial weight (29.27 kg), final weight (41.69 kg), total gain (73.97 kg), daily gain (91.37 kg), body weight (1.49%), and total feed intake (69.75 kg/lamb). This was followed by 25% of initial weight (28.13 kg), final weight (36.99 kg), total gain (50.38 kg), daily gain (55.42 kg), body weight (1.44%), and total feed intake (67.50 kg/lamb), in contrast to the control treatment, which showed lower values for body weight (1.33%), total feed intake (54.50 kg/lamb), daily gain (26.44 kg), total gain (24.03 kg), beginning weight (19.62 kg), and final weight (22.89 kg). Compared to lambs fed 15% olive cake, the control group's final body weight was somewhat greater, though not statistically significant. The method used to extract the oil, the extent of the extraction, the year, and the olives' place of origin can all affect the chemical makeup.

One of the main limiting factors for the use of olive cake in the feed of domestic animals is its variable chemical composition **(30).**

According to the aforementioned authors, lambs could consume 20–25% olive cake per day without experiencing adverse impacts on their body weight or daily growth. In contrast to our findings, **(14)** discovered that lambs fed 30% of the concentrate's olive cake had greater daily growth than lambs fed a smaller percentage or no dietary olive cake. According to **(22),** olive cake that is eaten as silage with ground maize grain and poultry litter produces better results in the fattening process of lambs. When PSP was introduced into the lambs' diet, their performance improved. Improving the nutritional intake of the lambs during the experimental period may be linked to the improvement in weight increase and ADG in this study. In support of this finding, **(17)** found that lamb's daily gain rose in proportion to the amount of pomegranate by-products supplied to the experimental diets. According to **(41),** the growth performances of the feeding treatments were quite comparable to the control. There were no statistically significant changes between treatments in terms of feed intake, feed conversion index, or final body weight attained. In contrast to lambs fed a control diet alone, **(7)** found no appreciable effects on the final BW and TWG of Awassi lambs fed a diet containing 200g/kg OC combined with concentrate. Similarly, in a study by **(3),** when OC was given at 250g/kg, no changes were seen in the final BW, total gains, and ADG of either ewes or lambs. However, as compared to groups that consumed either a 150 g/kg OC diet or the control diet, a study by **(29)** found that giving Pramenka lambs a 300 g/kg OC diet led to a lower final BW and an ADG. In addition, compared to Awassi lambs fed the commercial diet, those fed diets containing OC showed faster growth rates, higher final BW, and greater TWG **(5). (37)** noted no variations in carcass weight or yield between lambs fed diets containing 125 and 250 g/kg OC, and the carcass characteristics results from this study are in line with their findings. Additionally, **(29)** found no effect on carcass weight or dressing percentage when 150 g/kg OC was fed. However, carcass weight and dressing percentage decreased when OC inclusion was increased to 300 g/kg. Consistent with our results, **(45)** demonstrated that when sheep were fed OC at 100 or 250 g/kg, their feed intake was unaltered. **(11)** observed a decrease in feed consumption when nursing cows were fed OC. Nonetheless, the OC150 diet had the highest EE intake, which was followed by the OC 75 and CON diets. Consuming fodder high in crude fiber, such as olive cake, causes the rumen and other parts of the digestive tract to swell because it stays in the tract longer. The percentage of stomach and intestines (24.71%) in Pramenka breed lambs, as reported by **(28),** is comparable to our findings for the control group of lambs. Similarly, **(45)** found that ewes fed diets containing olive cake at 9.8 and 24.4% of dietary DM had similar DM consumption, as did developing lambs fed diets comprising 10 and 20% olive cake **(44).** The same outcomes were also observed in male lambs fed concentrate that contained 20% de-stoned olive cake. In comparison to the control ration, Awassi sheep fed olive cake at 49% of their DM intake showed a decrease in DM intake (**1) (41) (18)** confirmed this result for the entire period by finding no OC dietary treatment effect in BW compared to ADG at 20% inclusion level during the first fattening phase (from 100 to 250 kg of BW). According to Molina **(31),** the reduced organic matter digestibility (OMD) linked to pelleting can be explained by the decreased retention time in the rumen caused by the reduction in particle size, which in turn results in a lower gain in lambs given the pelleted OC diets. The reduced organic matter digestibility (OMD) linked to pelleting, which results in a decrease in retention time in the rumen due to the reduction in particle size, can be the reason for the decreased growth in lambs given the pelleted OC diets **(31).**

Table (1): Impact of feeding varying amounts of olive cake (OC) on growth performance of local Barbary lambs.

Treatments	Initial weight (kg)	Final weight (kg)	Total gain (kg)	Daily gain (kg)	Body weight (%)	Total feed intake (kg/lamb)
Control	19.62	22.89	24.03	26.44	1.33	54.50
10 % OC	21.80	26.45	28.73	32.3	1.36	57.80
15 % OC	29.07	33.92	35.61	39.17	1.40	61.45
25 % OC	28.13	36.99	50.38	55.42	1.44	67.50
30 % OC	29.27	41.69	73.97	91.37	1.49	69.75

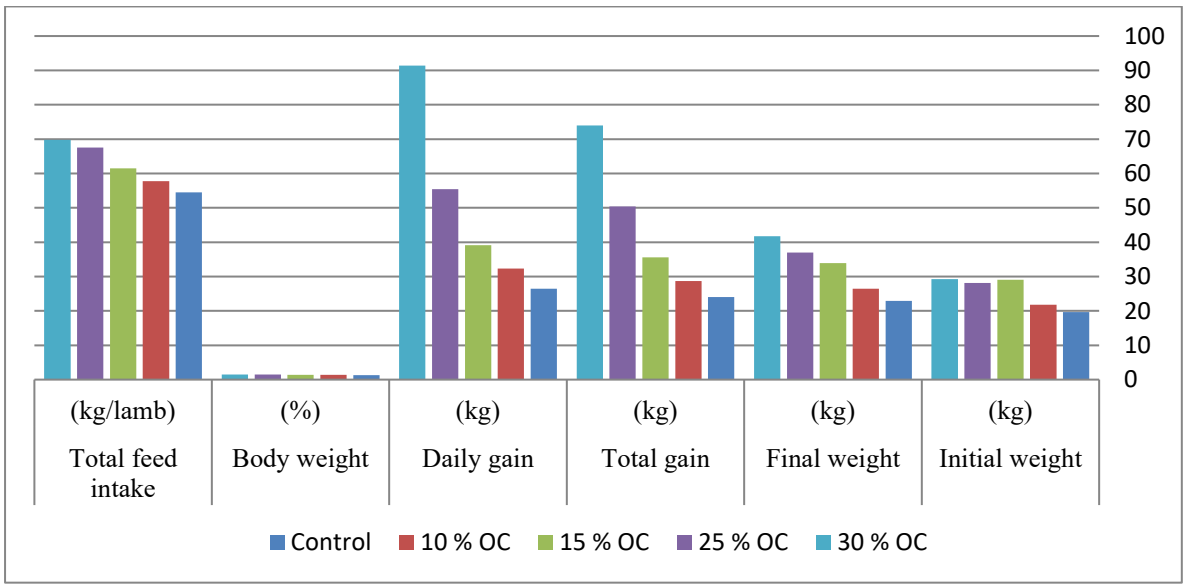

Fig. (1): Impact of feeding varying amounts of olive cake (OC) on growth performance of local Barbary lambs.

B) Carcass characteristics

Table 2 and Figure 2 summarize the impact of varying olive cake (OC) inclusion levels (10%, 15%, 25%, and 30%) in the diet on carcass traits of Barbary lambs. The results demonstrated that increasing the proportion of olive cake up to 30% led to notable improvements in carcass-related parameters. Lambs in the 30% OC group recorded higher values for hot carcass weight (15.33 kg), cold carcass weight (14.68 kg), non-carcass components (1.39 kg), carcass cuts (12.50 kg), and fat-tail weight (1.68 kg), compared to the control group, which showed lower values across all carcass metrics—such as fasting live weight (19.91 kg), hot carcass weight (11.35 kg), cold carcass weight (11.55 kg), non-carcass components (1.11 kg), and fat-tail weight (1.23 kg). A 25% OC inclusion also resulted in significant improvements: fasting live weight (26.80 kg), hot carcass weight (13.75 kg), and cold carcass weight (13.11 kg), among others.

Diet composition can significantly influence carcass quality and palatability. For instance, **(25)** reported carcass yields exceeding 50% in Barbaresca lambs of similar age, comparable to results from other breeds like Rambouillet **(43)** and Awassi **(26)**. However, **(38)** noted that Pramenka lambs had lower dressing percentages (~45%).

Contradictory findings exist regarding olive cake's effect on carcass characteristics. Some studies, such as **(23)**, found no significant impact on carcass or meat quality in Barbary lambs fed 280 g/day of OC. Similarly, **(46)** and **(33)** reported no effects on chilled carcass weight or dressing percentage. However, other studies showed variable responses depending on dosage. For example, **(29)** observed no effect at 15% OC but noted a reduction in carcass weight at 30%. In contrast, **(13)** reported improvements in carcass traits and intramuscular fat in beef cattle fed 7.5–15% OC.

In the present study, non-carcass component weights were generally consistent across treatments, aligning with findings from **(34) (33)** and **(37)**, who found minimal variation with by-product supplementation. These results suggest that moderate levels of OC can enhance carcass quality without adversely affecting non-carcass yields.

Table (2): Impact of feeding varying amounts of olive cake (OC) on carcass characters of local Barbary lambs.

Treatments	Fasting live weight (kg)	Hot carcass weight (kg)	Dressing (%)	Cold carcass weight (kg)	Non-carcass components (kg)	Carcass cut weights (kg)	Fat-tail (kg)
Control	19.91	11.35	38.45	11.55	1.11	10.75	1.23
10 % OC	22.95	12.25	41.36	12.16	1.15	11.09	1.29
15 % OC	25.37	13.00	43.89	12.88	1.29	11.25	1.35
25 % OC	26.80	13.75	45.54	13.11	1.34	11.54	1.41
30 % OC	27.66	15.33	47.08	14.68	1.39	12.50	1.68

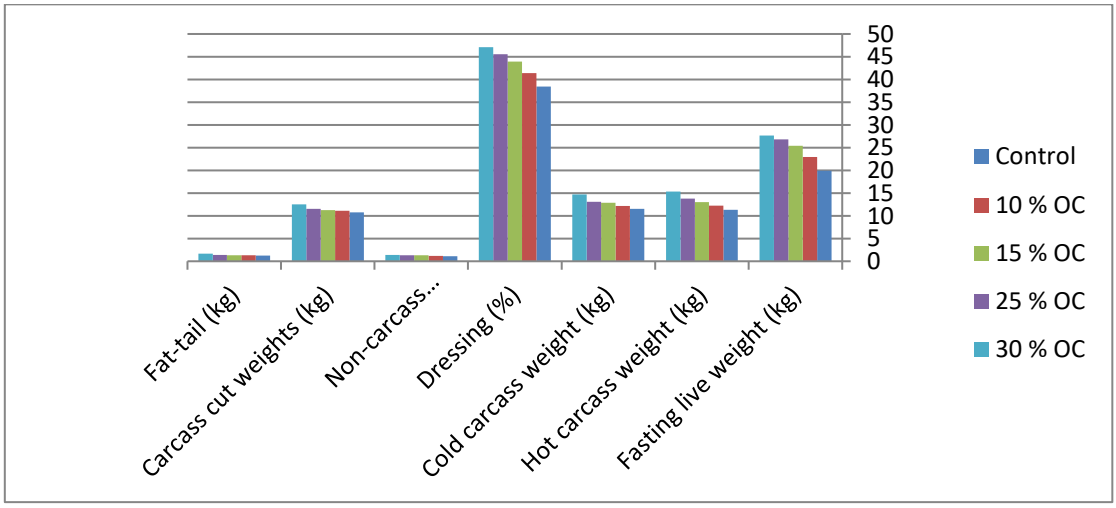

Fig. (2): Impact of feeding varying amounts of olive cake (OC) on carcass characters of local Barbary lambs.

C) Blood Metabolites

Table (3) and Fig. (3) present the findings regarding the impact of feeding varying amounts of olive cake (OC) (10, 15, 25, 30%, and control) on blood metabolites. Nevertheless, the findings indicated that a higher level of olive cake (OC) was associated with higher levels of urea N (19.50 mg/dl), glucose (56.2 mg/dl), cholesterol (48.0 mg/dl), HDL (32.8 mg/dl), LDL (10.9 mg/dl), AST (60.30 IU/L), ALT (11.00 IU/L), ALP (85.65 IU/L), and creatinine (0.70 mg/dl). This was followed by urea N (17.71 mg/dl), glucose (55.11 mg/dl), cholesterol (46.30 mg/dl), HDL (28.20 mg/dl), LDL (9.70 mg/dl), AST (57.44 IU/L), ALT (9.98 IU/L), ALP (83.50 IU/L), and Creatinine (0.67 mg/dl). ALP (75.25 IU/L), ALT (7.25 IU/L), urea N (12.45 mg/dl), glucose (49.45 mg/dl), cholesterol (39.25 mg/dl), HDL (23.25 mg/dl), LDL (7.33 mg/dl), AST (50.88 IU/L), and creatinine (0.68 mg/dl) were all lower in the control treatment. To highlight the advantages of utilizing alternative diets like SM, animal scientists are evaluating the health state of animals by analyzing blood metabolites **(19).** In relation to blood metabolites, the EOC group exhibited higher concentrations of GGT and ALP and lower levels of plasma albumin than the CTR group. ALP levels in the blood of goats given OC showed a contrary effect, but no prior research found a similar effect on beef **(35).** Nonetheless, a prior study on dairy cows **(4)** produced comparable results, with the exception of ALP, which validates the findings presented here. Together with total protein, albumin, and GOT, ALP and GGT's levels indicate the liver's capacity for metabolism, making them crucial markers of liver function **(48).** Due to the high amount of oxidizable unsaturated fatty acids in olive cake, variations in GGT and ALP readings may therefore be caused by the presence of peroxides. Ca uptake, which was actually lower in the treated group in this study, may have been changed by lipid peroxidation, which may have changed mitochondrial activities by oxidizing pyridine nucleotides **(39).**

According to **(40),** the EOC group also had decreased albumin, which indicates less liver protein synthesis. Fructosamine's plasma concentration was lower in the EOC group. Fructosamine is a measure of the amount of glucose present in the preceding weeks or months **(12).** Even though the pro fraction of propionic acid and gluconeogenic precursors increased in this study, fructosamine did not rise in proportion. The hypothesis that olive cake could reduce feed efficiency was strengthened by a similar reaction to fructosamine in our earlier work with dairy cows **(4).** Low fructosamine levels were known to indicate nutritional difficulties (e.g., reduced dietary energy absorption or likely reduced feed efficiency). EOC's inclusion in the concentrate (higher content of ADF, NDF, and ADL, and lower content of starch) may have resulted in a slight decrease in rumen energy utilization, even though glucose **(34)** was not impacted by either treatment or the interaction treatment x time. Additionally, higher urea levels in the EOC bulls may support this latter hypothesis.

Table (3): Impact of feeding varying amounts of olive cake (OC) on blood metabolites of local Barbary lambs.

Treatments	Urea N (mg/dl)	Glucose (mg/dl)	Cholesterol (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	AST (IU/L)	ALT (IU/L)	ALP (IU/L)	Creatinine (mg/dl)
Control	12.45	49.45	39.25	23.25	7.33	50.88	7.25	75.25	0.68
10 % OC	14.22	51.55	41.88	25.11	8.49	52.11	7.36	78.78	0.71
15 % OC	15.30	53.28	44.59	26.55	9.22	54.39	8.66	81.88	0.74
25 % OC	17.71	55.11	46.30	28.20	9.70	57.44	9.98	83.50	0.67
30 % OC	19.50	56.22	48.02	32.80	10.9	60.30	11.00	85.65	0.70

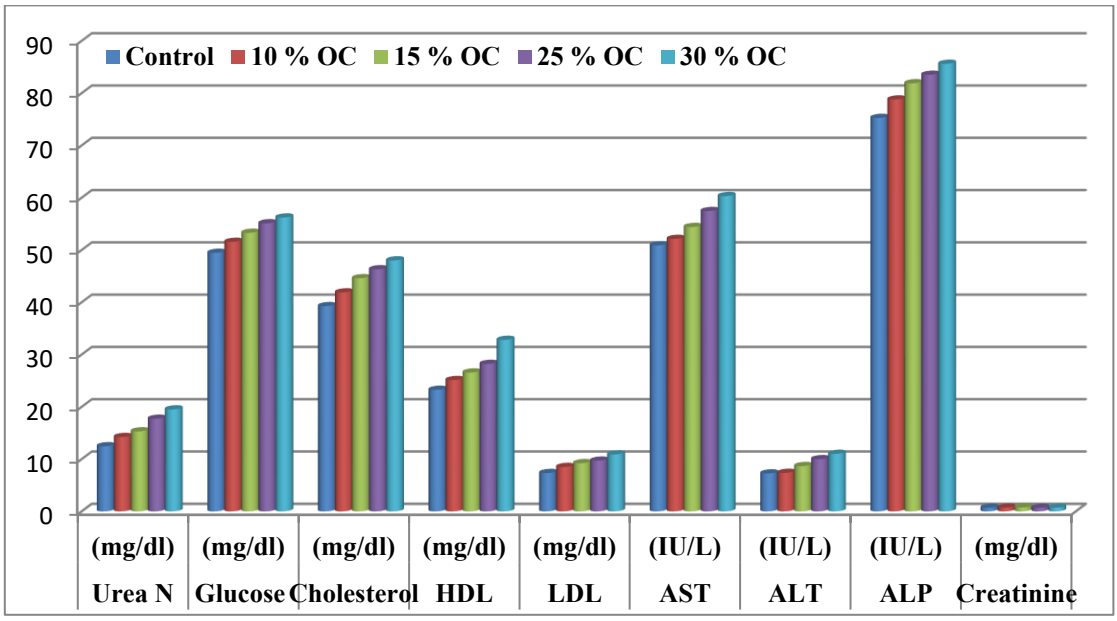

Fig. (3): Impact of feeding varying amounts of olive cake (OC) on blood metabolites of local Barbary lambs.

D) Hematological constituents of blood

The findings of feeding varying amounts of olive cake (OC) (10, 15, 25, 30%, and control) on blood metabolites are displayed in Table (4) and Fig. (4), according to the analysis of those two figures. Results, however, indicated that RBC (12.55 mil/mm3), WBC (12.94 thous/mm3), Hb (13.78 g/dL), PCV (36.45%), MCH (10.96 pg), MCV (30.80 μm^3), and MCHC (38.10 %) increased with increasing levels of olive cake (OC) up to 30%. This was followed by 25% of olive cake (OC), which recorded RBC (12.33mil/mm^3), WBC (12.72 thous/mm^3), Hb (12.65 g/dL), PCV (34.69 %), MCH (10.66 pg), MCV (29.18 μm^3), and MCHC (36.65%). In contrast to the control therapy, which showed lower values for Hb (11.66 g/dL), PCV (31.30 %), MCH (9.11 pg), MCV (23.88 μm^3), RBC (11.20 mil/mm^3), WBC (11.88 thous/mm^3), and MCHC (31.55 %), respectively.

Table (4): Impact of feeding varying amounts of olive cake (OC) on hematological constituents of blood values of local Barbary lambs.

Treatments	RBC (mil/ mm^3)	WBC (thous/ mm^3)	Hb (g/ dL)	PCV (%)	MCH (pg)	MCV (μm^3)	MCHC (%)
Control	11.20	11.88	11.66	31.30	9.11	23.88	31.55
10 % OC	11.90	12.12	11.85	33.55	9.70	25.93	33.30
15 % OC	12.00	12.58	12.22	33.89	10.40	27.60	34.44
25 % OC	12.33	12.72	12.65	34.69	10.66	29.18	36.65
30 % OC	12.55	12.94	13.78	36.45	10.96	30.80	38.10

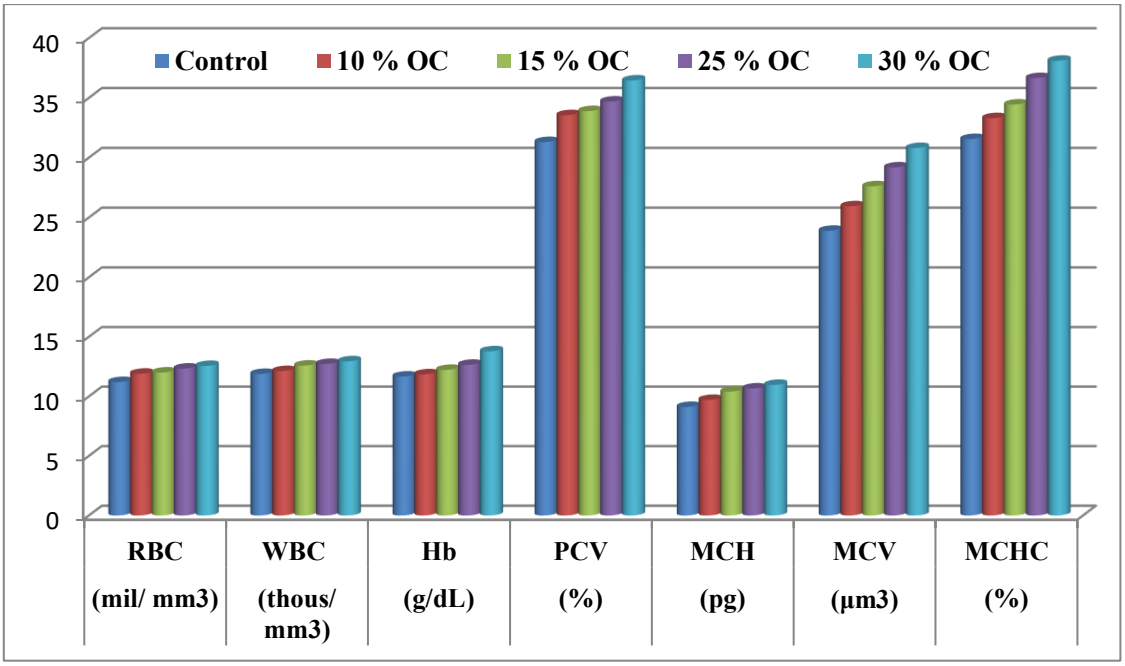

Fig. (4): Impact of feeding varying amounts of olive cake (OC) on hematological constituents of blood values of local Barbary lambs.

Discussion

The inclusion of olive cake (OC) in the diets of local Barbary lambs yielded significant improvements in growth performance, carcass characteristics, and hematological parameters, particularly at inclusion levels up to 30%. The enhanced growth metrics, including higher final weight, daily gain, and feed intake, are likely attributed to the nutritional contributions of OC, such as its fiber content and bioactive compounds like polyphenols and unsaturated fatty acids. These findings are consistent with previous reports indicating that olive cake, when incorporated moderately, does not compromise growth and may even support enhanced feed utilization and body weight gain **(30); (14)**.

Improved carcass traits—including higher hot and cold carcass weights, greater dressing percentage, and increased fat-tail weight—were observed in lambs receiving 30% OC. These outcomes align with **(13)**, who noted similar carcass improvements in ruminants fed OC-based diets. In contrast, the control group showed the lowest performance across all carcass parameters. The observed improvements suggest that OC can enhance energy intake and nutrient availability, likely due to its high content of digestible fiber and residual fat.

Hematologically, OC supplementation resulted in higher red and white blood cell counts, hemoglobin levels, and improved indices such as MCH, MCV, and MCHC. These values reflect improved physiological status and oxygen transport efficiency in the lambs. Biochemically, the elevated levels of glucose, cholesterol, HDL, and liver enzymes (AST, ALT, ALP) further suggest enhanced metabolic activity and possibly improved liver function under OC supplementation. These trends are supported by findings in similar ruminant studies **(4; 48)**.

Despite some literature suggesting that high levels of OC can reduce feed intake and nutrient digestibility **(29)**, no such adverse effects were noted at the 30% inclusion level in this study. The observed improvements

reinforce the potential of OC as a sustainable and economically viable feed ingredient in small ruminant production systems.

Conclusion

The results of this study demonstrate that dietary inclusion of olive cake up to 30% in the ration of Barbary lambs positively affects growth performance, carcass yield, and hematological and biochemical parameters. These enhancements support the use of OC as a valuable agro-industrial by-product for ruminant nutrition, offering both economic and environmental benefits. The lambs showed no signs of compromised health or productivity, indicating that OC is both a safe and effective feed alternative.

Recommendations

1. **Optimal Inclusion Level:** Based on this study, an olive cake inclusion level of up to 30% is recommended for local Barbary lambs without adverse effects on growth or health.
2. **Further Research:** Future studies should investigate the long-term effects of olive cake feeding under different climatic and management conditions, as well as its impact on meat quality traits and consumer acceptability.
3. **In Vivo Digestibility Trials:** Additional in vivo trials focusing on digestibility and rumen fermentation patterns are needed to better understand the metabolic pathways involved in nutrient utilization from olive cake.
4. **Economic Analysis:** It is advisable to conduct a cost-benefit analysis comparing olive cake-based diets with conventional rations to quantify the economic advantage at the farm level.
5. **Wider Applications:** The use of olive cake should be explored in other livestock species such as goats and cattle to assess its broader applicability in Mediterranean and arid agricultural systems.

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