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EFFECTS OF SESAME MEAL SUBSTITUTION ON CARCASS PARAMETERS AND MEAT QUALITY OF GROWING MALE LAMBS

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ABSTRACT: This study was established to determine how Awassi male lamb carcass and meat quality features would change if soybean meal were substituted with sesame meal. Twenty-four lambs started with 15.7 ± 0.33 kg BW were chosen and allocated randomly to two dietary treatments; the 0% sesame meal (CON diet) or the 12.5% sesame meal (SM12.5 diet). Lambs were placed in experimental pens separately that equipped with plastic waterers feeders to allow free access to diets and water throughout the experiment. Lambs were slaughtered at day 84 for measuring carcass traits and meat quality. Fasted and carcass weights were measured as dressing percentage was calculated. Non-carcass parts were separated from the carcass and weighed. Carcass features examination included measuring carcass linear dimensions, leg cuts and longissimus dorsi muscle characteristics. Meat quality was evaluated after two weeks for color (L*a*b* co-ordinates), pH, water holding capacity, values of shear force and cooking loss. Lambs consumed SM12.5 had more ($P < 0.05$) fasting live weight (kg), and weights of hot and cold carcasses compared to CON group. Other carcass measurements were not affected by the SM inclusion ($P > 0.05$). Similarly, meat quality parameters did not differ between the two dietary treatments. Therefore, according to these findings, feeding SM to Awassi lambs would not have an adverse impact on the quality of their meat or carcass characteristics. However, performance was enhanced as the fasting weight, as well as hot and cold carcass weight was improved.

Keywords: Awassi lambs, Carcass Characteristics, Dietary treatments, Meat Quality, Sesame meal.

INTRODUCTION

Towards meeting their demands for energy, crude protein, and other nutrients, sheep are fed a variety of conventional feed ingredients. Although the price of these ingredients is significant (about 70% of ruminants' production cost), which is not represented in the sale cost of these sheep, therefore affects the livestock holders' profits (Obeidat and Gharaybeh, 2011). Several studies that have evaluated the use of non-conventional feed in sheep diets found that by-products reduced production costs, which in turn increased productivity and returned on in animal production investments (Ata and Obeidat, 2020; Ominski et al., 2021).

One of the significant byproducts of sesame seed oil production is sesame meal (SM). Sesame by-products which produced annually reached 1 million tons worldwide (Weiss, 2000) and about 3600 tons of SM in Jordan as reported by the Ministry of Agriculture (2017).

Sesame meal is high in crude protein content (approximately 46% CP) as reported by Obeidat et al. (2019); sesame meal (SM), on the other hand, could be attained after the extraction of oil from sesame seed by using compressing techniques. According to other researchers, SM chemical composition is impacted by how it is processed (Sá et al., 2022). Additionally, the sesame seeds' dry matter content increased and their moisture content declined as a result of the roasting techniques utilized during processing (Salamatullah et al., 2021). On the other hand, if a lot of tiny sesame seeds escape when being hulled, it might indicate a higher fat content (Bonos et al. 2017). The plant variety and the method of oil withdrawal are frequently linked to variations in the fat and protein content of oilseed byproducts (Elleuch et al., 2007).

Sesame by-products, as reported by researchers, showed an improvement in small ruminants' performance lacking any negative outcome on carcass and meat composition (Hassan et al., 2013; Ghorbani et al., 2018; El-Tanany et al., 2021). The study hypothesis was that feeding SM by partially replacing soybean meal will improve lamb performance, carcass, and meat characteristics. Since few studies has been conducted regarding the effect of feeding SM on Awassi lambs' carcass and meat quality traits, this current research was carried out to investigate how replacing soybean meal with SM would affect Awassi lamb's carcass traits and quality of meat.

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MATERIALS AND METHODS

Ethical approval

The methodology and guidelines followed in this experiment was authorized by the Animal Care and Use Committee Institution at the Jordan University of Science and Technology in the current search before to its start (Research study number for ethical approval: 16/04/12/39AAB; Deanship of research; Jordan University of Science and Technology, 2025). The committee guidelines were derived from the animal welfare well-established concepts known as the three Rs; Replace, Reduce, Refine; which reflect specify principles and considerations that can be used as tools when balancing between harm and benefit while using experimental animals during the research period (Curzer et al., 2015).

Study procedures and sample analysis

The current study all set of methods were described by Obeidat et al. (2022). Briefly, twenty-four Awassi male lambs body weight (BW) equivalent to 15.7 ± 0.33 kg were divided evenly between the two treatments in random order (12 animal per treatment; N=12). Both the control diet (CON), which consisted of 0% sesame meal, and the diet (SM12.5), which contains 12.5% sesame meal, were used as treatments. Diets were combined to ensure that lambs received their required nutrients as they were formulated to be isonitrogenous (crude protein (CP) content was designed to be 15.6% of dietary DM) (Table 1).

The lambs were weighed, their ears were marked with plastic tags, and a veterinarian checked them to verify they were healthy and clear of diseases before the trial began. Separate cement pens measuring 1.5 by 0.75 meters were used for the lambs to be housed in as each pen provided with plastic feeders (10 L) and waterers (7 L). Lambs had free access throughout the experiment to water and diets.

Every two weeks during the trial, the feed was mixed, and samples were collected to determine its chemical composition. The trial was conducted for 84 days, of which the first week was spent to get lambs acquainted to their pens and feed while the other 77 days were used for data assortment.

Table 1 - Ingredients and chemical composition of diets-containing sesame meal (SM) fed to Awassi lambs.

Item / Diets [1]	CON	SM12.5	SM
Ingredients (% DM)			
Barley grain, whole	47	45.5	-
Soybean meal, 440 g/kg CP (solvent)	21	10	
Sesame meal	0	12.5	-
Wheat straw	30	30	
Salt	1	1	-
Limestone	0.9	0.9	-
Vitamin-mineral premix [2]	0.1	0.1	
Feed cost/ton (US$) [3]	418	375	
Nutrients (% DM)			
Dry matter	90.3	90.5	93.9
Crude protein	15.6	15.6	41.5
Neutral detergent fiber	30.0	30.5	12.6
Acid detergent fiber	20.3	19.88	5.3
Ether extract	1.7	3.45	14.5
Metabolizable energy, Mcal/kg [4]	2.28	2.37	3.53

[1] Diets were: the control diet (CON) or 12.5% SM (SM12.5) of dietary dry matter (DM). [2] 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; 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. [3] Calculated based on the prices of diet ingredients of the year 2022. [4] Estimated based on tabular values of NRC (2007).

Slaughtering procedures, carcass, and meat quality evaluation

All lambs at day 84 were slaughtered for carcass and meat characteristics measurements at the Agriculture and Production facilities Center at the university. Slaughtering procedure followed in this study are documented by Abdullah and Musallam (2007); whereas lambs were handled and slaughtered by trained personnel approximately after 18 hours of fasting. Live weight was recorded before starting the procedures followed by recording hot carcass weight directly after slaughtering while after a full day of chilling carcass at 4◦C the weight was documented. Calculating the dressing percentage of all carcasses performed through dividing the carcass weight (cold) by animal live weight (fasted). Immediately after slaughtering, non-edible parts were separated from the carcass and weighed. Subsequently 24 hours later, linear dimensions were recorded following the slaughtering procedure using the chilled carcass parts. Carcasses were dissected to four parts (loin, rack, shoulder, and leg cutes) to be examined. Two weeks before starting the meat quality evaluation, the loins' cut longissimus dorsi muscle was separated and kept in vacuum-packed at 20 ◦C.

Cooking loss, shear force, water holding capacity (WHC), color values (CIE L*a*b* coordinates), and pH values were all measured as indicators of meat quality. All meat quality parameters were measured following the procedures of Abdullah and Musallam (2007). In a fridge set at 4°C, frozen longissimus dorsi muscles were allowed to defrost overnight whereas still in their plastic bags. The pH was measured after thawing and muscles were divided into slices of particular thickness to be used for meat quality measurement. Allowing all slices to be oxygenated for 2 h at 4 ◦C, slices were spread on a tray and coated with a porous cloth. Slices color was measured (slices thickness were 15-mm). For Cooking loss (CL) measurements, slices with 25-mm thick were used, which were evaluated before being cooked, sealed in bags made of plastic, and cooked for 1 hour and 30 min in a 75 ◦C water bath to be re-weighed for determine the amount of water lost. To determine shear force values, cooked slices were split into 6 smaller samples (cores) with size of 1 cm3 and left at 4 °C overnight. With Warner-Bratzler (WB) shear blade (Model 235), cooked meat cores were sheared using the triangular cutting slot placed on the Salter, parallel to the muscle fiber direction for calculating the force (kg) needed to shear the cores. Evaluating the WHC performed with the technique outlined by Grau and Hamm (1953) and it was described as follow: WHC % = (initial weight − final weight) × 100/initial weight.

Statistical analysis

Data was examined using SAS PROC MIXED methods for analysis, with considering diet as the fixed effect (SAS version 8.1, 2000, SAS Institute Inc., Cary, NC) and individual lambs were the random variable. The probability of rejecting a false null hypothesis, was calculated as 1-β (1 - Type II error probability) as α level is 0.05. Least square means separation was performed by using Tukey test and significance level was determined at p<0.05.

RESULTS

Sesame meal, as well as, the experimental diets were chemically analyzed as presented in Table 1. Sesame meal shown to be rich in CP content. The ME energy and EE content were high in the SM (3.53 Mcal/kg, 14.5%; respectively). The proximate analysis for the experimental diets showed similar DM, CP, and neutral detergent fiber (NDF) content, while diet containing sesame meal (SM12.5) had greater EE and ME content compared to the control diet (CON). Feed cost (US$/ton) was calculated based on the ingredients prices and was less for diet containing SM compared to CON (375 US$/ton, and 418 US$/ton; respectively).

The effect of SM on lambs' carcass traits were summarized in Table 2. live weight, carcass weight (hot and cold) was greater (P < 0.05) for lambs consumed SM12.5 compared to CON group. Dressing percentage, non-carcass parts, cut weight, tail fat, as well as, dissected leg features did not change (P > 0.05) by the presence of SM to the diet. Carcass leaner dimensions were not affected (P > 0.05) also by sesame meal addition as illustrated in Table 3.

Meat quality characteristics were slightly changed with SM inclusion as presented in Table 4. Meat pH was similar (P > 0.05) between the two diets. Meat color coordinates were similar (P > 0.05) regarding the whiteness, redness, and yellowness.

Table 2 - Effects of sesame meal (SM) on carcass, non-carcass components, dissected leg carcass cut weights and percentages of Awassi lambs.

Item / Diet [1]	CON (n = 12)	SM12.5 (n = 12)	SEM[4]	*P* value
Fasting live weight (kg)	31.11 [b]	33.18 [a]	0.700	0.0397
Hot carcass weight (kg)	14.63 [b]	15.84 [a]	0.377	0.0359
Cold carcass weight (kg)	13.93 [b]	15.05 [a]	0.231	0.0442
Dressing percentage	44.68	45.30	0.870	0.6167
Non-carcass components (kg)[2]	1.39	1.45	0.038	0.3366
Carcass cut weights (kg)[3]	12.33	13.06	0.303	0.1205
Fat tail (kg)	1.67	1.73	0.129	0.7205
Leg weight (g)	2220	2297	73.4	0.4346
Subcutaneous fat (g /100 g)	12.2	11.4	0.70	0.4466
Intermuscular fat (g /100 g)	1.9	2.1	0.10	0.2570
Total fat (g /100 g)	14.1	13.5	0.71	0.5595
Total meat (g/ 100 g)	55.8	55.8	1.14	0.9931
Total bone (g /100 g)	22.3	22.4	0.62	0.8456
Meat to bone ratio	2.51	2.52	0.080	0.8800
Meat to fat ratio	4.15	4.21	0.241	0.8707

[1] Diets were: the control diet (CON) or 12.5% SM (SM12.5) of dietary dry matter (DM). [2] Non-carcass components (Heart, liver, spleen, kidney, and lungs and trachea). [3] Carcass cut (shoulder, racks, loins, and legs). [4] SEM = Standard error of the mean; [a,b] within a row means without a common superscript difference (P < 0.05).

Table 3 - Effects of feeding sesame meal (SM) on carcass leaner dimensions of Awassi lambs.

Item \ Diet [1]	CON (n = 12)	SM12.5 (n = 12)	SEM[4]	*P* value
Leg fat depth (*L3*) (mm)	2.35	2.50	0.241	0.6434
Tissue depth (*GR*) (mm)	8.67	8.50	0.438	0.7884
Rib fat depth (*J*) (mm)	1.75	1.90	0.141	0.4684
Eye muscle width (*A*) (mm)	49.36	49.24	0.729	0.9083
Eye muscle depth (*B*) (mm)	19.76	20.02	0.317	0.5745
Eye muscle area (cm2)	8.84	9.03	0.325	0.6618
Fat depth (*C*) (mm)	1.50	1.50	0.143	1.000
Shoulder fat depth (*S2*) (mm)	1.30	1.40	0.158	0.6643

[1] Diets were: the control diet (CON) or 12.5% SM (SM12.5) of dietary dry matter (DM). [2] SEM = Standard error of the mean

Table 4 - Effects of feeding sesame meal (SM) on meat quality characteristics of Awassi lambs.

Item \ Diet [1]	CON (n = 12)	SM12.5 (n = 12)	SEM[4]	*P* value
pH[2]	5.73	5.75	0.007	0.0619
Cooking loss (g /100 g)	39.1	50.7	4.61	0.1058
Water holding capacity (g/ 100 g)	26.7	28.2	0.88	0.2467
Shear force (kg/cm^2)	8.0	7.8	0.39	0.7269
Color coordinates				
L* (whiteness)	37.18	36.51	0.585	0.4293
a* (redness)	3.41	2.11	0.502	0.0757
b* (yellowness)	18.19	1.71	0.400	0.2185

[1] Diets were: the control diet (CON) or 12.5% SM (SM12.5) of dietary dry matter (DM). [2] pH measured after thawing. [3] SEM = Standard error of the mean

DISCUSSION

Sesame meal and formulated diets chemical composition values, in this current trial, were slightly within the range values of what previously reported by other researchers (Awawdeh et al., 2019; Obeidat et al., 2022). The greater diets' EE and ME content reported in this study might referred to the process of SM preparation and kinds of seeds which harvested from various plants (Elleuch et al., 2007). Feed cost, on the other hand, was reduced by 10 % compared to CON when SM was included. This result is comparable to which reported by Obeidat et al. (2022); authors noticed that the inclusion of sesame meal to the lambs' formulated diet decreased feed cost per ton (US$) by 10%.

Omer et al. (2019) noticed a reduction of feed cost ranged from 27 to 38% by increasing the quantity of SM added to the formulated diets compared to the CON. Our findings may contribute to the enhancement of economic effectiveness attained via utilizing alternative feeds by Awassi lambs.

An improvement in fasting live weight and carcass weights with lambs consumed SM included diet was noticed in this current study. In agreement with our results, other researchers reported increasing final weight and carcass weight with lambs fed sesame by-products containing diets (Fitwi and Tadesse, 2013; Bonos et al., 2017). Those previous studies attributed the improvement of final and carcass weight to the increase of feed intake and utilization of diets containing sesame by-products. In this current study, greater fasting and carcass weight revealed from improved SM diet intake and digestibility which was reported in previous study (Obeidat et al., 2022).

Other carcass characteristics (dressing percentage, cuts weight, non-carcass components, dissected leg, fat tail and leaner dimensions) where not differ with the group consumed SM diet from the CON group which reflects that the addition of SM had no adverse effect on Awassi lambs' carcass traits. Fitwi and Tadesse (2013) reported opposite results to our study; they noticed an increase in dressing percentage, rib-eye area, and non-carcass component weight with the addition of sesame seed cake to sheep diet.

Meat quality was not affected with sesame by-products addition to diets as reported previously (Bölükbaş and Kaya, 2022; Kaya et al., 2022). Minor changes on meat quality were noticed by the addition of SM, in this current study, through a slightly increase in meat pH with the SM group. It was expected that including sesame by-products in sheep diets could alter rumen function as changing the pH and subsequently the composition of the meat, despite the fact that considerable amounts of sesame oil are rich in PUFA and may improve rumen microbial population (Bauman and Griinari et al., 2003; Aldai et al., 2012).

Regarding meat color, redness slightly increased with SM group. Awawdeh et al. (2019) noticed changing in meat color with addition of alternative feed to lambs' diets. The researchers referred variations in redness as being caused by altered mechanisms for pigment synthesis rather than a direct result of hemoglobin or myoglobin concentration in meat (Priolo et al., 1998).

The goal of incorporating alternative feeds into livestock diets is to lower costs without affecting the quality of the meat or the carcass traits. According to the current findings, adding SM up to 12.5% of diets had no effect on the carcass and meat characteristics. Both preceding and this current study have demonstrated that SM might be included in animal diets without negatively affecting the meat quality and carcass traits.

CONCLUSION

The current results verified that adding sesame meal to lambs' fattening rations had no negative impact on the meat's quality or the carcass's features. Additionally, the cost of feed was decreased by 10% for the SM-based diet during the time and settings of this study which led to increase the economic efficiency.

DECLARATIONS

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Authors' contributions

Mysaa Ata: Writing, reviewing, and editing; Belal Obeidat: Writing & editing, data curation; formal analysis, methodology, supervision.

Data availability

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

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Consent to publish

All authors agree to the publication of this manuscript.

Competing interests

The authors have not declared any conflict of interest.

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