Growth performance, Meat quality and biochemical blood parameters of Awassi lamb fed diet supplemented with Rosemary oil

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Abstract

This study's objective was to evaluate whether rosemary oil (RO) (Rosmarinus officinalis) influenced the fattening quality of meat utilizing by determining thirty Awassi lambs at four months of age (with determined weighs 26±3 kg) Lambs were divided into three groups. In the first group, lambs fed diet without rosemary oil (control, RO = 0) while in the second (RO=200) and third (RO=400) groups, lambs fed diet including 200 and 400 mg/kg rosemary oil for 60 days. All lambs were slaughtered in an experimental slaughterhouse after the fattening stage. The results demonstrated that Daily weight gain was higher significantly ($p < 0.05$) of lambs fed RO treatments. The FCR was improved in the group of lambs fed diet with 400 mg/kg rosemary oil. Bigger Rib eye area and low subcutaneous fat ($p < 0.05$) were recorded for lambs fed diet supplemented with 400mg/kg rosemary oil. The conclusion pH differed from 5.76 to 5.55 after 24 h post-mortem which was lower than control group. Rosemary oil had a substantial effect on the lowering of MDA levels in the liver of lambs. Hence, it would be advantageous to attempt rosemary oil in lamb nutrition in order to improve their meat quantity and quality.

Keywords: Awassi lamb, carcass yield, body performance, oxidation stability, Rosmarinus officinalis

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Introduction

The demand for animal products is increasing daily as the world's population rises. [1] Global restrictions promote livestock farming's application of small-scale feeding resources and natural pastures. Animal feeding is subject to limited economic margins, and any nutritional techniques employed to increase meat quality must be compensated by the added value of meat in the market. Animal performance, digestion, and product quality are all impacted by secondary compounds (PSCs), that are included in most low input feed and include phenolic substances (PhCs), saponins, and essential oils (EO).[2]. Awassi sheep breed is an important genetic resource that plays a significant role in sheep industry in more than 30 countries beside the countries of its origin [3]. Despite nearly %60 sixty percent of the total sheep in Iraq constituting Awassi, the breed is the most common and well-known. [4]. It is generally known that the Awassi breed in Iraq is particularly adapted for drier and semi-arid areas, where they are grazed semi-intensively, primarily with the addition of supplementary feed. The utilization of essential oils as a natural substitute feed addition has grown significantly in recent years [5]. assigned the number of animals there are around the world presently. Antioxidant ingredients contained in rosemary oil include methyl carnosate, active carcinol, phenolic diterpenes, polyphenolic extract, rosmanol, isorosmanol, and the acid Rosmarinic along with other phenolic compounds [6]. For the purpose of controlling ruminal fermentation, these active ingredients in rosemary oils may be an extremely beneficial natural dietary supplement. [7]. Modern animal products use rosemary extensively as an antioxidant to improve their period of storage. [8]. It was stated that REO has antibacterial properties in addition to antioxidant ones, and that it has the ability to influence the direction of rumen fermentation and the ruminant's flavor [9]. As a natural antioxidant in animal nutrition, the EOs possess potential to be applied as an additive to feed to promote and enhance animal performance. [10]. Nowadays, preservation of food and alternative therapies both explore significant utilization of RE. Considering rosemary is a readily accessible, non-toxic plant, it has a lot of potential as consumption as a substance in animal feed and food products. [11].

Therefore, throughout the 60-day fattening period, the objective of the present investigation was to determine whether rosemary oil altered the fattening performance, meat quality, and antioxidant status of Awassi lambs.

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Table (1). The components and chemical composition of diet utilized during investigations

Ingredients	Diet (%)
Corn	12.36
Wheat bran	5.63
Barley	57.00
Soybean meal 48%	14.45
Salt	0.97
Limestone	3.28
Vitamin+Mineral Premix	0.25
Chemical composition	100.00
Dry mater DM	94.23
Crude protein	16.80
Energy (K Cal/kg)	2756
Ash	6.40
Crude fat	1.90

Material and methods

Animals, Diet and Experimental proced

The experiment was carried out in 2024 from April to July in a private animal production farm in Bahrka, Erbil Governorate, Iraq. Thirty Awassi lambs, weighing 26±3 kg at 4 months of age, were selected for the current investigation. Prior to the trial, lambs were pasture-bred under standard settings. Lambs were randomly assigned into treatment groups and submitted to the study center one week before the trial began. The lambs were kept in cages with shade and had free consumption of water. concentrated diet formulated for supplying each lamb with the gain 200–250 g/day as recommended by the NRC (Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids; 2007). Alfalfa hay and concentrated diet (based on corn and soybean meal) ratio was around 25:75 %. The experiment proceeded lasting a period of sixty days. Table (1) summarizes the components and chemical composition of the experimental diets.

The feed samples were collected and kept for further examination in a freezer at -20 °C. Chemical composition was calculated using the [12] procedure.

Performance Parameters: Each animal's body weight (kg) in the experimental cages was determined at the inception of the trial, and the weight of each animal was subsequently recorded every week.

Feed Intake (g): At the conclusion of the experiment, feed consumption was measured for each experimental treatment. Every day, the records are displayed (g/lamb/day). The difference between the total amount of feed provided (g) and the total amount of feed remaining in the feeders was used to compute the feed intake for every day.

Feed Conversion Ratio: Feed Conversion Ratio (FCR) of lamb was calculated by using the rate of body weight gain to feed intake: FCR = Average feed intake (g) /Average body weight gain (g). All animals were slaughtered at the end of the fattening period in an experimental abattoir by severing the throat and major blood vessels in the neck. Immediately after slaughter and dressing, carcasses were chilled for 24 hours at 4 ^{0}C and then *Longissimus dorsi* muscles (LDM) were dissected from the left and right side of each carcass in order to carcass and meat analysis.

Carcass and Meat Properties Measurement

The thickness of the subcutaneous fat over the *longissimus dorsi* muscle was measured with a caliper. At the same position, a plan meter was used to measure the length of the muscle longissimus dorsi and draw the area on acetate paper. A penetrating electrode connected to a portable pH meter (HI 99163; Hanna Instruments, Cluj-Napoca, Romania) was implemented to assess the pH in *longissimus thoracis* (LDM) muscle 24 hours (ultimate pH) post- mortem, following calibration with two buffers (7.00 and 4.01). A reflectance spectrophotometer (CM-2002; Minolta, Osaka, Japan) was used for determining the colour of the meat directly on its surface after it had been exposed to air for two hours.

Total Phenolic Content (TPC) and Vitamin E Analysis of Meat

The procedure presented by [13]. was followed for vitamin E analysis, using high performance liquid chromatography. With slight modifications. A comprehensive overview of the vitamin E testing in meat samples could be found in [14] With slight modifications, the approach of [15]. The method was used to figure out the meat's total phenolic content (TPC).

The Antioxidant Status in Plasma: At the end of experiment, 10 plasma samples totally 30 plasma samples from experiment collected. Superoxide Dismutase (SOD) activity was measured in accordance with [16]. while spectrophotometers were used to determine Malondialdehyde (MDA) and Oxidative Stress (MDA) using the Thiobarbituric acid (TBA) test procedure of [17].

Statically analysis: Statically analysis: Using SAS's GLM approach, a one-way analysis of variances for the consequences of diet (rosemary oil) on growth performance and biochemical indicators was performed. [18. Then, the Duncan test (19) was used to compare diet mean effects ($p \leq 0.05$)

Result and discussion

1. Growth performance

Effect of rosemary oil on lamb performance presented in Table (1). The detrimental effects of rosemary oil was significant ($p < 0.05$) for lambs fed a diet supplemented with 400 mg/kg of diet. (45.6kg) compared to those not supplemented (42.30kg). Feed intake was similar for all lambs. Significantly higher average daily gain ($p < 0.05$) reported to be higher in lambs administered a diet containing 400 mg/kg of rosemary oil (0.293 g/day). Nevertheless, FCR demonstrated significantly ($p < 0.05$) higher for same group which supplemented with 400mg/kg rosemary oil (5.72). The current study's outcomes corresponded with [14]. and [20]. who's demonstrated that when by-products of aromatic plants were fed to sheep growth performance were enhanced significantly. However, the outcomes of present study were in contrast with those reported by [21] and [22]. who demonstrated that lambs' growth, feed intake, and FCR efficiency were not impacted with supplementation their diets with rosemary diterpenes (0.6 g kg−1 diet) or rosemary essential oils (0.3- or 0.6-mL day−1).

Table 1: Effect of rosemary oil on performance traits of Awassi lambs supplemented with different doses of rosemary oil following 60 days.

Treatments	IW (Kg)	FW (Kg)	ADWG (Kg)	TWG (Kg)	FCD (g/d)	FCR
R0	27.89	42.30 b	0.240 b	14.41 b	1660.0	6.91a
R200	28.45	44.5 ab	0.267 b	16.05 ab	1650.5	6.17 a
R400	28.0	45.6 a	0.293 a	17.6 a	1680.5	5.72 b
* SEM	0.151	0.35	0.007	0.374	16.52	0.135
P-value	n.s	0.0047	0.0013	0.0069	N.S	0.0103

IW: Initial Weight; FW: final weight, ADWG: Average Daily Weight Gain, TWG: Total weight gain, FCD: Feed Consumption Daily, TFC: Total Feed Consumption, FCR: Feed Conversion Rate, * SEM: Standard Error Mean. .R0: Rosemary oil without additives; R250: added 200 mg/kg DM Rosemary oil; R400: added 400 mg/kg DM Rosemary oil .$^{A-B-C}$ different superscript letters in the same row represent significant difference

2. Carcass measurement

The results of rib eye area and subcutaneous (Table 2). of present study indicated that rosemary oil affected significantly ($p < 0.05$) on rib eye area and subcutaneous fat in muscle *longissimus dorsi* for lamb which rib eye area recorded 12.8 cm2 and 13.7 cm2 for rosemary doses 200 and 400mg/kg respectively in cooperation to control group (11.7 cm2). On other hand subcutaneous fat decreased significantly ($p < 0.05$) by rosemary oil which reported 1.71mm and 1.77mm respectively for 200 and 400 mg/kg rosemary oil compared to control group (2.33mm). This is clear evidence of the antioxidant properties of rosemary oil and the capacity to promote growth. Due to the inverse relationship between the thickness of the fatty layer and the muscle area of the ribcage, this may be the cause of an increase in the ratio of muscle to bone at the expense of fat percentage. Furthermore, the immune system may be stimulated by rosemary oil supplementation, which has a suppressive effect of reducing fat deposition which prevented lipid catabolism and caused energy to be shifted from growth and development. Few research, none of which have been published in the scientific literature, has investigated the effects of

rosemary oil treatments on the subcutaneous fat and rib eye area in Awassi lamb.

Table 2. Effects of Rosemary oil on Rib eye area and Subcutaneous Fat of Awassi lamb.

treatments	Subcutaneous fat (mm)	Rib eye area (cm2)
R0	2.33 a	11.75 b
R200	1.71 b	12.83 ab
R400	1.77 b	13.70 a
* SEM	0.092	0.3105
P-value	0.0002	0.0003

* SEM: Standard Error Mean.R0: Rosemary oil without additives; R200: added 200 mg/kg DM Rosemary oil; R400: added 400 mg/kg DM Rosemary oil. $^{A-B-C,}$ different superscript letters in the same column represent significant difference.

3. Meat properties

The initial pH was significantly greater for the Control group. (6.03) compared to both doses (200mg, 400mg/kg) of rosemary oil supplementation which were 5.76 and 5.55 respectively, nevertheless all value is reasonable. approximately 24 hours after the post-mortem. The ultimate pH ranged from 5.76 to 5.55 (Table 3). The higher ultimate pH of the control may be the consequence of insufficient muscle glycogen stores, altered food energy consumption, or a distinct reaction to the stress of slaughter. [22]. Present outcome is in line with those recorded by [23]. who discovered that The RR intake slightly tended to decrease initial pH (P=0.06) and to increase meat redness (P=0.06). The meat lightness (L*) values presented by both doses of rosemary oil (200,400 mg/kg diet) averaged 40.8 and 40.3 respectively demonstrating that the meat is light in color and is within the range of the average acceptability of meat, as 95% of customers find that meat with a lightness of 34 or higher is acceptable and that it is near to 44. Similar outcomes were observed following dietary consumption of myrtle byproducts, rosemary extracts from plants, by[14]. and [24]. The meat redness is significantly affected by rosemary oil (10.4 and 10.3, respectively) for both doses 200,400 mg/kg diet in compaction with control group (12.5). These results were in contrast with [14]. who demonstrated that redness was unaffected by RR ingestion. Studies have demonstrated that natural antioxidants may improve the redness of meat while minimizing color loss. For instance, supplementing with oregano essential oil improved the meat's redness (a*) and yellowness (b*).[22].

Table 3: Effect of Rosemary oil on colour parameters and postmortem pH in *longissimus dorsi* (LD) Muscle of Awassi lamb

	Treatments	pH	L*	a*	b*	H*
*	R0	6.03 a	43.2 a	8.11 a	12.5 a	57.4
	R200	5.78 ab	40.8 ab	7.76 ab	10.3 b	54.4
	R400	5.53 b	40.3 b	6.15 b	10.4 b	53.6
	* SEM	1.541	2.411	3.601	3.211	3.410
	P-value	0.0005	0.0004	0.0009	0.0003	0.0007

SEM: Standard Error Mean. R0: Rosemary oil without additives; R200: added 200mg/kg DM Rosemary oil; R400: added 400 mg/kg DM Rosemary oil. $^{A-B,}$ different superscript letters in the same column represent significant difference.

4. The Evolution of Antioxidant and Lipid Oxidation (TBARS)

Because lipid oxidation provides meats an unexpected flavor and bitterness during their aging, it is undesirable. Carnatic acid and carnosol are the two phenolic diterpenes in rosemary oil that predominantly have an antioxidant effect [23] Results of rosemary oil supplementation on oxidation MDA marker and serum antioxidant enzymes were presented in Table (5). According to the present investigation, rosemary oil had a major effect on the Awassi lambs' liver's reduced MDA concentrations. Our results are in contrast with [25]. who demonstrated that rosemary residues did not affect the lipid oxidation (MDA level in muscle) of Barbarian lamb meat and they reported the lack effect of rosemary residues were unexpected considering meat is protected from lipid oxidation by the effective antioxidant activity of polyphenols. the results of current study are in contrast with [23]. who illustrated that rosemary had no effect on lipid oxidation of Rasa Aragonesa male lambs during the 14 days of storage under retail conditions. Glutathione peroxidase enzyme (GPX) significantly ($P \leq 0.05$) increased by rosemary oil which recorded 13.6, and 11.8 U/L for both doses of rosemary oil (RO 400 and 200 mg/kg) respectively. On other hands rosemary oil second dose (400mg/kg) improved significantly ($P \leq 0.05$) antioxidant enzymes superoxide dismutase (SOD) which raised to 80.3 U/ML compared to first dose (73.3 U/ML) and control group was (75.0 U/ML).

Lambs supplemented with rosemary oil (200 and 400 mg/kg) resulted in a significant decrease in serum ALT activity ($p < 0.05$) which were 10.6 and 9.4 U/L in comparison to control group (13.9 U/L). Furthermore, AST level reduced by same treatments (200 and 400 mg/kg) to 53.3 and 47.1U/L respectively compared to control one (58.4U/L). The results of the present investigation indicate that the liver functions adequately on account of the reduced ALT levels in the Awassi lamb supplemented with rosemary oil. It was discovered that dosages of 200 and 400 mg/kg of rosemary oil have an advantageous effect on liver function. The serum's total protein level was unaffected by the rosemary oil treatments; nevertheless, the blood sugar level dropped to 63.1g/dl after 400mg/kg of rosemary oil was administered in combination with the control group, which reported 71.3g/dl.

Table 4: Effects of rosemary oil on serum antioxidant enzyme (GPX, SOD) status and liver MDA (mg/1000g) level of Awassi lamb.

treatments	GPX U/L	SOD U/ML	MDA (mg/1000g	AST (U/L)	ALT (U/L)	Glucose g/dl	Total Protein g/dl
R0	9.4 b	75.0 b	0.89 a	58.4 a	13.9 a	71.3 a	6.46
R200	11.8 a	73.3 b	0.56 ab	53.3 b	10.6 b	67.6 ab	6.58
R400	13.6 a	80.3 a	0.44 b	47.1 b	9.4 b	63.1 b	6.84
* SEM	0.669	2.47	2.686	1.51	0.579	0.996	0.102
P-value	0.0023	0.0010	0.0006	0.0226	0.0064	0.0003	N.S

* SEM: Standard Error Mean. R0: Rosemary oil without additives; R200: added 200 mg/kg DM Rosemary oil; R400: added 400 mg/kg DM Rosemary oil. $^{A-B,}$ different superscript letters in the same Colum represent significant difference

5. Vitamin E and total phenolic in meat.

Table (5). illustrated whether rosemary oil influenced the vitamin E and total phenolic content of the meat. (5). The α-Tocopherol and phenolic contents were recorded significantly higher ($p < 0.05$) in meat from both experimental groups' (200 and 400mg/kg rosemary oil) which achieved 6.45,6.68 mg/g respectively than the control one which was 3.45mg/g. Present results in line with those reported by [21]. who demonstrated that the α-Tocopherol and phenolic contents were higher ($p < 0.05$) for the meat of the fat-tailed lambs supplemented with rosemary residual than the control one.

Table 5: Effects of Rosemary oil on meat Vitamin E (α-tocopherol (mg/g DM)) and Total phenolic of Awassi lamb.

Treatments	α-tocopherol (mg/g DM)	Total phenolic content
R0	3.45 b	41.22 b
R200	6.44 a	59.33 a
R400	6.68 a	61.39 a
* SEM	0.120	2.11
P-value	0.001	0.008

* SEM: Standard Error Mean. R0: Rosemary oil without additives; R200: added 200 mg/kg DM Rosemary oil; R400: added 400 mg/kg DM Rosemary oil$^{A-B,}$ different superscript letters in the same Colum represent significant difference.

Conclusion

The results of this study demonstrate that feeding Awassi lambs a concentrate diet supplemented with 400 mg/kg of rosemary oil for 60 days enhanced the meat's oxidative and color stabilities overall. However, feeding sheep with 400 mg/kg of rosemary oil did influence the animals' performance. Both doses of rosemary oil enhanced meat quality by increasing meat α-tocopherol and total phenolic. From present investigation it could be concluded that daily doses of rosemary oil 200 and 400 mg/kg had a beneficial effect on the liver function by decreasing liver level of ATL, AST and improving antioxidant (GPX, SOD) capacity in serum of Awassi lambs.

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داء النمو ونوعية اللحوم ومؤشرات الدم البيوكيميائية في عليقة الحملان العواسية المغذاة على زيت اكليل الجبل

أداء النمو وجودة اللحوم وصفات الدم البيوكيميائية للحملان العواسية المغذية على المكملات الغذائية بزيت إكليل الجبل

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- تاريخ استلام البحث 22 /10/ 2024 تاريخ المراجعه 12/7 / 2024 و تاريخ قبوله 2/ 1/ 2025

الخلاصة

هدفت هذه الدراسة إلى تحديد تأثير زيت إكليل الجبل (Rosmarinus officinalis) كان الغرض من هذه الدراسة هو تقييم تأثير زيت إكليل الجبل (Rosmarinus officinalis) (RO) على التسمين وجودة اللحوم باستخدام ثلاثين حملان عواسية في عمر أربعة أشهر (بمعدل وزن 26±3 كغم) تم تقسيم الحملان إلى ثلاث مجموعات. في المجموعة الأولى، تغذت الحملان على غذاء بدون زيت إكليل الجبل (السيطرة، RO = 0) بينما في المجموعة الثانية (RO = 200) والثالثة (RO = 400)، تغذت الحملان على نظام غذائي تضمنت 200 و 400 ملغم/كغم من زيت إكليل الجبل لمدة 60 يوما. تم ذبح جميع الحملان في المذبحة بعد مرحلة التسمين. أظهرت النتائج أن انتاج اللحوم في الحملان التي غذيت على زيت إكليل الجبل (200,400 مجم / كجم) كانت تحتوي على بفيتامين E ومحتويات البوليفينول اكثر، مقارنة مع الحملان مجموعة السيطرة ($p < 0.05$) ، مما قد يزيد من قدرتها على مضادات الأكسدة. كانت زيادة الوزن اليومية أعلى بشكل ملحوظ ($p < 0.05$) من الحملان التي تغذت على عليقة RO. كانت FCR في مجموعة الحملان التي تغذت على النظام الغذائي ب 400 ملغم / كغم من زيت إكليل الجبل افضل. كانت العضلة العينية أكبر ودهون تحت الجلد اقل ($p < 0.05$) للحملان التي تغذت على عليقة 400 ملغم / كغم من زيت إكليل الجبل. تكان الرقم الهيدروجيني النهائي من 5.76 إلى 5.55 بعد 24 ساعة بعد ذبح الحملان وهو أقل من المجموعة السيطرة. كان لزيت إكليل الجبل تأثير كبير على خفض مستويات MDA في كبد الحملان. وبالتالي ، يمكن استخدام زيت إكليل الجبل في تغذية حملان التسمين من أجل تحسين كمية اللحوم وجودتها.

كلمات مفتاحية: الحملان العواسيه ،المضادات الاكسده،الصيفات الوزنيه، إنتاجية الذبيحة. اكليل الجب