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Essential Oils Blends for Small Ruminants: A Strategy for Enhanced Performance, Rumen Fermentation, Digestibility, and Profitability

Mahmoud Mohamed Abdelfarrag [1*], Hamdy Mohamed Khattab [2], Mahmoud Mohamed Khorshed [2], and Abdalla Mansour Singer [1]

[1] Animal and Poultry Production Department, Faculty of Agriculture and Natural Resources, Aswan University, Egypt.

[2] Department of Animal Production, Faculty of Agriculture, Ain Shams University, Egypt.

Abstract

The study was conducted to determine the influence of dietary supply with two novel blends of essential oils on key performance indicators, including feed intake, rumen parameters, nutrient digestibility, growth performance, and profitability of Saidi lambs. The first supplement incorporated a 1:1:1 Rosemary, Thyme, and Peppermint mixture oils (RTPOM). The second supplement incorporated a 1:1:1 Lemongrass, Marjoram, and Black Seed oils mixture (LMBOM). The 1st group (5 lambs) was administered a control diet devoid of essential oil blends supply (concentrate feed mixture to roughage ratio of 70:30); the 2nd group (5 lambs) was administered a control diet supplemented with 0.03% RTPOM on a DM basis; and the 3rd group administered a control diet supplemented with 0.03% LMBOM on a DM basis. The experiment lasted 180 days. The findings highlight that RTPOM had lowered DMI ($P < 0.0001$), while the LMBOM had higher DMI than the control. The RTPOM or LMBOM dietary supply did not significantly affect ruminal pH, temperature, or ammonia-N. In contrast, total volatile fatty acid and total nitrogen were significantly higher for RTPOM and LMBOM than for the control. Similarly, the crude protein digestibility and digestible crude protein values of the lambs receiving RTPOM or LMBOM were significantly greater ($P < 0.05$) than the control. The average daily gain and feed conversion ratio of the lambs receiving both RTPOM and LMBOM dietary supply were higher than the control diet. Additionally, profitability by economic efficiency was enhanced by the RTPOM supplementation compared to LMBOM and the control diet.

Keywords: Essential oils, rumen parameters, nutrient digestibility, lambs, and profitability.

Introduction

Small ruminants, including sheep and goats, are vital to sustainable livestock production systems, particularly in Upper Egypt, where they are crucial in food security and rural livelihoods. Nevertheless, their productivity often faces challenges such as poor feed quality, suboptimal digestive efficiency, and economic constraints that necessitate innovative nutritional strategies.

Botanical essential oils comprise blends of aromatic molecules derived from various plant components recognized for their unique scents **[1]**. These natural compounds possess antimicrobial, antioxidant, and anti-inflammatory properties **[2, 3, and 4]**. They serve as effective instruments for rumen fermentation, nutrient utilization, and animal performance **[5]**. Their inclusion in small ruminant diets has shown the potential to improve digestion, reduce methane emissions, and support overall animal health **[6]**.

*Corresponding author E-mail: mahmoudfarrag120@gmail.com

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Several studies were conducted on the effects of herbal plants alone, such as Rosemary (*Rosmarinus officinalis*), Thyme (*Thymus vulgaris* L.), Peppermint (*Mentha piperita*), Lemongrass (*Cymbopogon citratus*), Marjoram (*Origanum majorana*), and Black seed (*Nigella sativa*) on animal performance. They enhanced feed efficiency, rumen fermentation, digestibility, and growth performance in lambs **[7, 8, 9, 10, 11, 12, 13, 14, and 15]**.

Recent scientific interest has focused on the amalgamation of many natural additives, which demonstrated superior results compared to individual natural additives, likely due to the synergistic effects among the herbal components that improve the efficacy of their dietary incorporation **[16, 17, and 18]**. Furthermore, feeding a combination of essential oils increases antimicrobial activities, optimizes ruminal fermentation, and enhances animal performance compared to the individual additives **[19, 20, and 21]**.

The application of essential oil blends in small ruminant nutrition remains underexplored. Therefore, this study aims to determine the effects of essential oil blends on key performance indicators of Saidi lambs, including feed intake, rumen parameters, nutrient digestibility, growth performance, feed efficiency, and profitability.

Materials and methods

Lambs, experimental procedures, and diets:

The experiment was conducted for 180 days involving 15 Saidi lambs aged 4–5 months with an average body weight of 18.47 ± 0.45 kg. The lambs were randomly allocated into three experimental groups using a completely randomized design. Before the trial, all animals underwent treatment for internal and external parasites and vaccination against prevalent infectious diseases. According to **NRC [22]**, all groups were fed isonitrogenous and isoenergetic diets daily to meet the needs of both maintenance and production requirements. The daily ration was divided into two equal portions, administered at 8:00 and 16:00, guaranteeing the animals unrestricted access to water. Furthermore, minerals and vitamin blocks were accessible for unrestricted selection. Animals were weighed biweekly prior to the morning feeding to determine individual average daily gain (ADG) and feed conversion ratio (FCR). This approach allowed for accurate growth performance and feed efficiency tracking throughout the experimental period.

Throughout the experiment, the 1st group was the control (received 70% concentrate feed mixture (CFM) with 30% alfalfa hay without any oral administration); the 2nd group received (control plus a 1:1:1 Rosemary, Thyme, and Peppermint essential oil mixture); and the 3rd group received (control plus a 1:1:1 Lemongrass, Marjoram, and Black seed essential oil mixture). The experimental supplements were orally administered in a dose of 0.03% on a dry matter (DM) basis to lambs immediately prior to feeding throughout the entire six-month experimental period. Feed items were evaluated in accordance with **A.O.A.C. [23]**. The chemical composition of the experimental ration is shown in Table 1.

Digestibility trials:

All experimental animals (15 Saidi lambs) were included in the digestibility trials conducted at the end of the six-month experimental period. The digestibility trials consisted of 7-day adaptation and 7-day collection periods. Animals were weighed on the first day of the adaptation period and

again on the last day of the collection period to assess changes in body weight. During the collection period, feces were collected daily over 24-hour intervals using plastic bags, weighed, and sampled. A 5% subsample of the total daily feces for each animal was taken, treated with a solution of 10% formaldehyde and 10% H_2SO_4 to prevent decomposition, than oven-dried at 65°C for 12 hours. The dried samples from the entire collection period were pooled and thoroughly mixed. Composite samples (10% of the total dried feces) were preserved for further analysis. Feed residues (if any) were removed, weighed, and recorded for each animal daily to determine feed consumption. Samples of the diets, feces, and feed residues were analyzed for their crude protein, ether extract, crude fiber, ash, and nitrogen-free extract (NFE) content according to **A.O.A.C. [23]**.

Table 1. Chemical composition (dry matter basis) of the ingredients of the experimental rations.

Item	CFM*	alfalfa hay
Dry matter, %	93.76	94.23
Organic matter, %	83.89	79.14
Crude protein, %	15.06	11.95
Crude fiber, %	16.26	25.18
Ether extract, %	3.06	2.70
Nitrogen Free Extract, %	49.51	39.32
Ash, %	16.11	20.86

*CFM= Concentrate feed mixture; consists of per ton: 500 yellow corn, 200 wheat bran, 150 cotton seed meal, 125 soybean meal, 10 sodium chloride, 10 calcium carbonate, and 5 minerals plus vitamins additives.

Ruminal fermentation:

On the last day of the digestibility trial, rumen fermentation characteristics were assessed at 0, 2, 4, and 6 hours post-morning feeding. A total of 100 mL of rumen liquor was sampled by stomach tube from the ventral blind sac of each animal, and a composite sample was strained through four layers of cheesecloth to remove particulate matter. The pH and temperature of the ruminal fluid were measured immediately after collection using a digital pH meter and a mercury thermometer, respectively. The strained rumen liquor was then stored in 45 mL plastic bottles, with adding a few drops of toluene and a layer of paraffin oil to cover the surface, preventing microbial activity during storage. Samples were stored at -20°C for subsequent laboratory analysis. The stored rumen liquor was analyzed for total nitrogen (TN) and ammonia nitrogen (ammonia-N) using methods described by **A.O.A.C. [23]**; additionally, total volatile fatty acids (TVFA) following the procedures outlined by **Warner [24]**.

Economical evaluation:

The economic evaluation was conducted to assess the cost-effectiveness of the experimental diets across the three groups. The analysis included calculating the total feed cost for each group, considering the costs of concentrate feed mixture, alfalfa hay, and essential oil supplements. The ADG and FCR were used as performance indicators to estimate production efficiency.

The total revenue generated was calculated based on the market value of the weight gain achieved by each group. Net income was determined by subtracting the total feed cost from the total revenue. Economic efficiency was then calculated using the following formula:

$$Economic\ Efficiency\ = \frac{Net\ Income}{Total\ feed\ cost}$$

Analytical statistics:

An analysis of variance (ANOVA) was employed to examine the collected data using the standard linear modeling approach **[26]**. Statistical significance was determined using **Duncan [27]** multiple comparison tests with a significance level of P<0.05.

Results and discussion

Feed intake:

Results indicated that the LMBOM diet significantly increased DM and TDN, SV, and DCP intake (P < 0.0001). Conversely, the RTPOM diet reduced DM and TDN intake compared to the control (Table 2) with non-significant decrease in SV and CP intake.

Table 2. Effect of essential oils blends on feed intake of growing sheep.

Item	Experimental rations			SEM	*p value*
	Control	RTPOM	LMBOM		
Feed intake /h/d					
DMI, kg	1.29^{b}	1.19^{c}	1.49^{a}	0.01	<0.0001
TDN intake, g	908.63^{b}	863.24^{c}	1101.07^{a}	10.37	<0.0001
SV intake, g	825.02^{b}	833.01^{b}	1030.50^{a}	10.54	<0.0001
CPI, g	181.94^{b}	168.33^{b}	210.61^{a}	2.82	<0.0001

$^{a,\ and\ b}$ …. Values within the same row followed by different superscript letters indicate statistically significant differences (p < 0.05).

These results highlight that the composition of essential oils can have varying impacts on feed intake, depending on the specific blend and its influence on diet appeal to lambs. In particular, the essential oils of Rosemary, Thyme, and Peppermint, which are very fragrant herbs, may have contributed to reduced feed intake due to their strong aromatic properties. On the other hand, the essential oils of Lemongrass, Marjoram, and Black Seed, included in the LMBOM diet, are milder in their aromatic profile and likely enhance the palatability of the feed. These oils are known for their pleasant and subtle fragrances, which can make the diet more appealing and encourage higher consumption by lambs.

These results align with previous findings incorporating a mixture of dried Rosemary, Thyme, and Peppermint plants into the diets of Saidi lambs reduced feed intake **[17]**. In contrast, Various studies have shown that feed intake for lambs was increased when using Marjoram and Black seed alone **[15 and 27]**. Meanwhile, other studies have found that including Lemongrass did not significantly influence feed intake **[13 and 28]**.

Ruminal fermentation:

The ruminal fermentation profile across treatments is shown in Table 3. The findings reveal that the inclusion of RTPOM and LMBOM in the diets had no significant effect (P>0.05) on rumen temperature, ruminal pH, and ammonia nitrogen (ammonia-N) levels. Results showed lambs fed diets supplemented with RTPOM and LMBOM exhibited a significant increase in total volatile fatty acid (TVFA) concentrations (P=0.0343) and total nitrogen levels (P=0.025) compared to the control group.

Table 3. Effects of RTPOM and LMBOM inclusion on ruminal fermentation of Saidi lambs.

Item	Time (hrs.)	Experimental rations			SEM	*p value*
		Control	RTPOM	LMBOM		
Ruminal Temperature °C	0	38.98[a]	38.90[b]	38.88[b]		
	2	38.98	38.96	38.96		
	4	39.14	39.12	39.12		
	6	39.10	39.00	39.02		
	Mean	39.05	39.00	39.00	0.02	0.53
Ruminal pH	0	6.74	6.65	6.67		
	2	6.63	6.67	6.53		
	4	6.59[b]	6.71[a]	6.72[a]		
	6	6.91[a]	6.73[b]	6.80[b]		
	Mean	6.72	6.69	6.68	0.03	0.20
Total nitrogen (mg/dL)	0	119.10[b]	150.50[a]	142.50[a]		
	2	136.00	158.40	153.00		
	4	118.50[b]	132.50[a]	126.00[ab]		
	6	114.50	123.00	121.00		
	Mean	122.03[b]	141.10[a]	135.63[a]	9.04	0.02
Ammonia-N (mg/dL)	0	38.25	43.05	42.75		
	2	39.75	45.15	45.00		
	4	40.25	47.05	47.75		
	6	37.75	44.75	40.75		
	Mean	39.00	45.00	44.06	1.99	0.36
TVFA (meq/dL)	0	8.20[b]	11.44[a]	9.40[ab]		
	2	9.40[b]	12.04[a]	12.76[a]		
	4	8.80	9.68	10.26		
	6	11.72	11.92	12.76		
	Mean	9.53[b]	11.27[a]	11.30[a]	0.76	0.03

a, and b .... Values within the same row followed by different superscript letters indicate statistically significant differences ($p < 0.05$).

Ruminal ammonia-N concentration was increased at 4 hours post-feeding but subsequently decreased at 6 hours post-feeding across all treatments. Similarly, total nitrogen levels were increased 2 hours post-feeding and reduced to a minimum at 6 hours post-feeding .

Despite stabilizing ruminal pH, rumen temperature, and ammonia nitrogen levels following the inclusion of RTPOM and LMBOM, the essential oil blends positively impacted ruminal fermentation. Specifically, they enhanced TVFA production and increased total nitrogen availability. These improvements indicate that essential oils selectively modulate microbial populations and metabolic pathways, thereby promoting more efficient nutrient utilization and energy production. Furthermore, the high solubility of crude protein in RTPOM and LMBOM diets likely facilitated the rapid release of ammonia and amino acids in the rumen . In line with the current study, these results are consistent with previous studies indicating that there is no effect of essential oils of Rosemary, Thyme, Peppermint, Lemongrass, Marjoram, and Black seed on ruminal pH and ammonia-N concentrate in sheep **[29, 30, 31, 32, 33, 34, 35, and 36].**

Furthermore, the inclusion of RTPOM and LMBOM significantly increased ruminal TVFA concentrations (from 9.53 to 11.30 meq/dL). This may be related to active substances of RTPOM and LMBOM, such as thymol, carvacrol, eugenol, and eucalyptol, which may enhance microbial efficiency by stabilizing ruminal fermentation. These compounds optimize energy production pathways by reducing wasteful fermentation processes, such as excessive ammonia production, and redirecting nitrogen toward microbial protein synthesis **[29, 32, and 37]**. These results are consistent with previous findings feeding Peppermint, Rosemary, and Lemongrass into the diets of sheep increased TVFA **[38]**. Moreover, ruminal TVFA was increased with feeding Marjoram leaves powder as an additive in lambs **[15]**.

Including RTPOM and LMBOM increased ruminal total nitrogen (TN) concentrations (from 122.03 to 141.10 mg/dL). This increase may be attributed to the high solubility of crude protein in RTPOM and LMBOM, which likely facilitated the rapid release of ammonia and amino acids in the rumen. Rumen microbes break down soluble proteins efficiently, providing readily available nitrogen sources for microbial protein synthesis. These results agree with findings that essential oils improve nitrogen utilization in ruminant diets [**39**].

Digestibility and nutrients values:

The addition of RTPOM and LMBOM diets led to a significant increase ($P < 0.05$) in crude protein (CP) digestibility compared to the control (Table 4). At the same time, digestibility coefficients for dry matter (DM), organic matter (OM), crude fiber (CF), ether extract (EE), and nitrogen-free extract (NFE) showed a non-significant increase (except EE digestibility of LMBOM showed non-significant decrease) compared to the control. The higher digestible crude protein (DCP) values observed ($P < 0.05$) in the diets supplemented with RTPOM and LMBOM, indicating improved protein utilization and digestion with these treatments. Also, nutrients values expressed with TDN and SV were non-significant higher in the treated groups than control. However, DCP values were significant higher in the treated groups than control.

Table 4. Effect of RTPOM and LMBOM supplementation on digestibility and nutrient values coefficients of lambs.

Item	Experimental rations			SEM	*p value*
	Control	RTPOM	LMBOM		
Digestibility, %					
Dry matter (DM)	63.17	68.97	66.00	1.73	0.4241
Organic matter (OM)	64.93	68.89	65.14	1.45	0.4869
Crude protein (CP)	68.64[b]	76.72[a]	74.81[a]	1.23	0.0125
Crude fiber (CF)	51.79	53.88	52.18	1.41	0.8353
Ether extract (EE)	62.51	63.69	62.47	1.49	0.939
Nitrogen free extract (NFE)	76.84	79.44	78.91	1.06	0.6053
Nutritive value, %					
Total digestible nutrients (TDN)	70.53	73.81	72.42	0.94	0.3904
Starch values (SV)	64.04	69.88	69.08	1.23	0.1054
Digestible crude protein (DCP)	9.69[b]	10.84[a]	10.28[a]	0.17	0.0126

[a, and b] .... Values within the same row followed by different superscript letters indicate statistically significant differences ($p < 0.05$).

This improvement in CP digestibility may be attributed to the antimicrobial properties of the essential oils, which potentially reduced the number and activity of antagonistic organisms. Moreover, this enhancement in DCP values aligns with the significant increase in crude protein digestibility, further emphasizing the role of essential oils blends in optimizing protein metabolism in the rumen (Table 3). These findings are consistent with previous studies **[9, 12, 15, 31, 39, and 40]** when using Rosemary, Thyme, Peppermint, Lemongrass, Marjoram; and Black seeds alone for enhance CP digestibility and DCP values.

Growth performance:

The effect of RTPOM and LMBOM dietary supply on lamb growth performance is represented in Table (5). The initial weight was not significantly different (P = 0.9974), but the final weight was significantly different (P = 0.0076) among the supplemented groups. Both total weight and average daily gain were significantly higher (P <0.05) for RTPOM and LMBOM supply than control. Notably, the RTPOM diet yielded the highest feed conversion ratio (P < 0.05) among the treatments, outperforming both the LMBOM and control diets.

The observed increases in total weight gain and average daily gain (P < 0.05) further highlight the nutritional benefits of these supplements (Table. 4), suggesting that the active substances in the supplements provided the lambs with additional nutrients or improved digestion and nutrient absorption compared to the control diet. Additionally, the feed conversion ratio, a key indicator of feed utilization efficiency, was highest for the RTPOM diet (P < 0.05). This suggests that lambs on this diet could convert feed into body weight more efficiently, demonstrating improved metabolic utilization than the LMBOM and control.

These results agree with previous findings incorporating a mixture of dried Rosemary, Thyme, and Peppermint plants into the diets of Saidi lambs enhanced growth performance and feed utilization efficiently. Moreover, these results are consistent with previous studies **[32, 41, 42, and 43]** which reported that essential oils such as Rosemary, Thyme, Black seeds, and Peppermint, when used individually, effectively improved growth performance and feed conversion ratios in lambs. These results further support the potential of essential oil blends as natural growth promoters in sheep nutrition.

Table 5. Effect of essential oils blends on growth performance and feed conversion ratio.

Item	Experimental rations			SEM	*P value*
	Control	RTPOM	LMBOM		
Initial weight (kg)	18.45	18.45	18.53	0.49	0.9974
Final weight (kg)	51.98^{b}	59.37^{a}	58.78^{a}	1.20	0.0076
Total weight gain (TWG, kg)	33.54^{b}	40.93^{a}	40.26^{a}	1.05	0.0005
Average daily gain (ADG, kg)	0.186^{b}	0.228^{a}	0.222^{a}	0.01	0.0006
Feed conversion ratio (FCR)	6.92^{a}	5.26^{b}	6.70^{a}	0.21	<0.0001

a, and b, ... values within the same row followed by different superscript letters indicate statistically significant differences (p < 0.05).

Profitability:

Table (6) presents the economic efficiency of lamb diets supplemented with RTPOM and LMBOM. The results demonstrated the highest improvement in the economic performance of lambs in the RTPOM-supplemented than the LMBOM and control treatments.

Table 6. Effect of essential oils blends on economic efficiency of Saidi lambs.

Item	Experimental rations		
	Control	RTPOM	LMBOM
Final Average Weight (kg)	51.98	59.37	58.78
Total Weight Gain (kg)	33.54	40.93	40.26
Feed Consumed (kg)	232.20	214.20	268.20
Feed Conversion Ratio	6.92	5.26	6.70
Feed Cost (LE/head)	3018.60	2945.25	3620.78
Total Revenue (LE/head) *	5701.80	6958.10	6844.20
Net Profit (LE/head) **	2683.20	4012.85	3223.42
Economic Efficiency (%) ***	0.89	1.36	0.89
Relative Economic efficiency****	100.00	152.80	100.00

*** Total revenue** = Total weight gain × Price of kg live weight gain (170 LE)

**** Net Profit** = Total revenue – Feed cost.

The recorded market prices were: CFM was 16000 LE / Ton, alfalfa hay was 7000 LE /Ton, Rosemary essential oil was 3500 LE /liter, Thyme essential oil was 2500 LE /liter, Peppermint essential oil was 1500 LE /liter, lemongrass essential oil was 2300 LE /liter, Marjoram essential oil was 2000 LE /liter and Black seed essential oil was 700 LE /liter.

$$*** \boldsymbol{Economic\ efficiency} = \frac{Net\ Profit}{Feed\ cost}$$

$$**** \boldsymbol{Relative\ Economic\ efficiency} = \frac{Economic\ efficiency\ of\ treatment}{Economic\ efficiency\ of\ control} \times 100$$

The feed cost per head was higher for the LMBOM-supplemented diets due to the high feed intake and the price of essential oils. However, RTPOM was compensated by a significant increase in total revenue resulting from higher final weights. Consequently, the net profit per head was notably highest for the RTPOM followed by LMBOM groups than the control.

The economic efficiency was higher in the RTPOM, indicating that this diet provided the most cost-effective solution for improving lamb growth performance. These findings underscore the potential of using essential oil-based supplements, such as RTPOM and LMBOM, to enhance animal performance and financial returns.

These results agree with previous findings incorporating a mixture of dried Rosemary, Thyme, and Peppermint plants into the diets of Saidi lambs enhanced profitability **[17]**. In the same way, oral supplementation of a 1:1 Thyme and Garlic oil blend enhanced the net farm income compared to the control group of Damascus goats **[45]**.

Conclusion

Collectively, current results indicate the potential of essential oil blends (RTPOM and LMBOM) as natural dietary additives for effectively enhancing ruminal fermentation, digestibility, growth performance, feed efficiency, and profitability of Saidi lambs.

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مخاليط الزيوت العطرية لصغار المجترات: استراتيجية لتحسين الأداء، تخمير الكرش، الهضم، والربحية

محمود محمد عبدالفراج[1]، حمدي محمد خطاب[2]، محمود محمد خورشيد[2]، عبد الله منصور سنجر[1]

[1] قسم الإنتاج الحيواني والداجني - كلية الزراعة والموارد الطبيعية- جامعة أسوان - أسوان - مصر.

[2] قسم الإنتاج الحيواني - كلية الزراعة – جامعة عين شمس – مصر.

الملخص

أُجريت الدراسة لتحديد تأثير الإمداد الغذائي بمزيجين جديدين من الزيوت العطرية على مؤشرات الأداء الرئيسية، بما في ذلك تناول العلف، معاملات الكرش، هضم العناصر الغذائية، أداء النمو، والربحية لدى الحملان الصعيدي. تم استخدام 15 حملاً ذكر من الأغنام الصعيدي في عمر 4-5 أشهر بمتوسط وزن 18.47 كجم. تتمثل المكمل الأول خليطًا بنسبة 1:1:1 من زيوت الروزماري، الزعتر، والنعناع. أما المكمل الثاني خليطًا بنسبة 1:1:1 من زيوت حشيش الليمون، البردقوش، وحبة البركة. تم إعطاء المكملين عن طريق الفم باستخدام محقنة. تضمنت المجموعة الأولى نظامًا غذائيًا ضابطًا خاليًا من خليط الزيوت العطرية (نسبة خليط العلف المركز إلى دريس البرسيم الحجازي 30:70 على الترتيب). تضمنت المجموعة الثانية النظام الغذائي الضابط مدعمًا بـ 0.03% من مخلوط زيوت الروزماري، الزعتر، والنعناع على أساس المادة الجافة. أما المجموعة الثالثة فتضمنت النظام الغذائي الضابط مدعمًا بـ 0.03% من مخلوط زيوت حشيشة الليمون، البردقوش، وحبة البركة على أساس المادة الجافة. استمرت التجربة لمدة 180 يومًا. أظهرت النتائج أن مخلوط زيوت الروزماري، الزعتر، والنعناع أدى إلى تقليل تناول المادة الجافة($P < 0.0001$) ، في حين أن مخلوط زيوت حشيشة الليمون، البردقوش، وحبة البركة أدى إلى زيادة تناول المادة الجافة مقارنة بعليقه المقارنة. لم يؤثر الإمداد الغذائي بمخلوط (زيوت الروزماري، الزعتر، والنعناع) أو بمخلوط (زيوت حشيشة الليمون، البردقوش، وحبة البركة) معنويا على درجة الحموضة في الكرش أو درجة الحرارة أو تركيز الأمونيا. في المقابل، كانت الأحماض الدهنية الطيارة الكلية وإجمالي النيتروجين أعلى معنويا في مجموعتي (زيوت الروزماري، الزعتر، والنعناع) و(زيوت حشيش الليمون، البردقوش، وحبة البركة) مقارنة بالمجموعة الضابطة. وبالمثل، كانت قابلية هضم البروتين الخام وقيم البروتين الخام المهضوم في حملان المجموعتين (زيوت الروزماري، الزعتر، والنعناع) و(زيوت حشيشة الليمون، البردقوش، وحبة البركة) أعلى بشكل معنويا ($P < 0.05$) مقارنة بالمجموعة الضابطة. ومع ذلك، لم تتأثر قابلية هضم العناصر الغذائية الأخرى وقيمتها الغذائية بالمعالجات. كان معدل الزيادة اليومية ومعامل التحويل الغذائي في حملان مجموعتي (زيوت الروزماري، الزعتر، والنعناع) و(زيوت حشيشة الليمون، البردقوش، وحبة البركة) أعلى معنويا من الحملان المغذاة على عليقة المقارنة. بالإضافة إلى ذلك، أوصت النتائج أن اعلي ربحية وكفاءة الاقتصادية كانت نتيجة إضافة مخلوط (زيوت الروزماري، الزعتر، والنعناع) تليها مخلوط (زيوت حشيشة الليمون، البردقوش، وحبة البركة) ثم النظام الغذائي الضابط.