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Research Article

The Supplementary Effect of Some Medicinal Plant Mixtures on the Productive Performance of Saidi Lambs

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Abstract

The present study was aimed to compare the effect of two mixtures of medicinal plants as feed additives on the lamb's performance. The first additive consisted of a 1:1:1 Rosemary, Thyme, and Peppermint mixture (RTPM). While, the second additive consisted of a 1:1:1 Lemongrass, Parsley, and Coriander mixture (LPCM). Twelve male Saidi lambs of 20.49 ± 0.76 kg body weight (BW) were randomly allocated into three groups. The first group received a control diet (concentrate-to-forage ratio: 70:30) without additives, the second group received a control diet supplemented with 1.5% RTPM on a dry matter (DM) basis, and the third group received control diet supplemented with 1.5% LPCM on a DM basis. The experiment lasted for 150 days. The results showed that RTPM had lowered DMI ($P = 0.0692$) while the LPCM had higher DMI as compared the to control. The supplementation of RTPM or LPCM did not have a significant effect on nutrients digestibility and their nutritive value. Similarly, ruminal pH, ruminal temperature and total volatile fatty acid (TVFA) were not affected ($P > 0.05$) by RTPM or LPCM, while ammonia-N ($P = 0.0043$), and total nitrogen ($P < 0.0001$) were higher for RTPM and LPCM than Control. The average daily gain (ADG), total weight gains (TWG), and feed conversion ratio (FCR) of the lambs receiving RTPM or LPCM rations were greater ($P \leq 0.0057$) than the control diet. The economic efficiency was improved by the RTPM addition ($P < 0.0001$) while the LPCM diet decreased economic efficiency compared to the control.

Keywords: Medicinal Plants; Growth Performance; Lamb; Economic Efficiency

Introduction

Due to the limitation on the use of some antibiotics and dangerous residual effects, herbal feed additives are becoming more popular in animal production. Plant extracts, essential oils, leaves, seeds, and herbal plants possess antimicrobial and antioxidant activities [1]. In addition, they regulate gastrointestinal nutrient transport and improve animal performance [2]. Studies on single components of herbal plants, spices, special extracts, or essential oils had reported several positive effects on animal health [2], feed utilization, ruminal fermentation [3], and performance of animals [4]. Therefore, combining herbal plants (phytogenic additives mixture) has attracted increased attention due to its notable antibacterial, anti-oxidative, and anti-fungal activities and ability to enhance feed utilization, ruminal fermentation, intake, and performance in ruminants [5-6].

Rosemary (*Rosmarinus officinalis L.*), Thyme (*Thymus vulgaris L.*), and Peppermint (*Mentha piperita*) were medicinal herbs belonging to the *Lamiaceae* family. The secondary metabolites in Rosemary are well known, with major compounds including monoterpenoids, like α-pinene, β-pinene, camphene, 1–8 cineole, camphor, borneol, bornyl acetate and verbenone, and phenolic diterpenes, such as carnosic acid, carnosol, rosmanol, isorosmanol, methyl carnosate, epirosmanol, and rosmarinic acid [7]. Moreover, the compounds which comprise the essential oil of Thyme have been identified as phenoylic compounds such as thymol, carvacrol, and γ- terpipene [8]. In addition, the oil of Peppermint contains 1, 8-cineole, dihydrocavone, limonene, phytol, linalool, thymol, carveol, piperitenone, and eugenol as the primary components [9-10].

Many researchers have shown that the Rosemary compounds have antioxidant [11] and antimicrobial effects in ruminants [12-13]. Also, the Thyme has strong antiseptic, antimicrobial, and antioxidant effects and are also found in the extracted water-soluble fraction of Thyme [8]. The peppermint compounds are used to treat respiratory disorders [14], antimicrobial [15], and antioxidants [16].

Lemongrass (*Cymbopogon citratus*) is a medicinal herb belonging to the *Poaceae* family. While, the medicinal herb Parsley (*Petroselinum crispum*) was a member of the Umbelliferae family. In addition, Coriander (*Coriandrum sativum*) is a medicinal, glabrous aromatic plant belonging to the family *Apiaceae.* The Lemongrass oil contains citral as the main component. Moreover, the other major component is myrcene and the minor components include linalool, aterpineol, geraniol, nerol, methyl heptanol, methyl pentanone, citronellol, citronellal, and volatile acids [17-18]. The Parsley oil contains myristicin, apiole, copaene, β-pinene, camphene, and carotol [19]. In addition the Coriander essential oil contains decanal, E-2-dodecanol, E-2-decenol, nonane, undecanal, phytol, tetradecanal, E-2-tridedecenal and linalool [20-21]. Lemongrass herb has been reported to have antibacterial, antioxidant, and anti-hyper ammonia-producing ruminal bacterial activities [18]. Also, Parsley has been reported to have a number of possible medicinal attributes including, antioxidant, antifungal, and antiaflatoxigenic activity [19]. In addition Coriander oil is used as an antioxidant, antifungal activity, and antimicrobial agent as it possesses broad-spectrum antimicrobial activity [22-23]. Therefore, the objective of this study was to compare the effect of two mixtures of medicinal plants as feed additives. The first additive consisted of Rosemary, Thyme, and Peppermint mixture (RTPM). While, the second additive consisted of Lemongrass, Parsley, and Coriander mixture (LPCM) on the rumen fermentation, feed intake, digestibility, growth performance, and economic efficiency of Saidi lambs.

Materials and Methods

Animals care

This study was conducted at in El-Eyman farm and the Animal and Poultry Production Department, Faculty of Agriculture and Natural Resources, Aswan University, Aswan, Egypt, during the months of December, 2020 through May, 2021 Care and handling of the animals and samples collection were approved by Aswan University Animal Care and Use Committee.

Animals, diets, and experimental design

This experiment was carried out for 150 days with twelve young male Saidi lambs of about 5-6 months age and an average initial body weight (Bw) of 20.49 ± 0.76 kg that were randomly assigned to three experimental groups, in a completely randomized design. All animals were treated for internal and external parasites and vaccinated for common infection diseases before the experiment started. Daily rations were introduced to cover maintenance and production requirements according to Tommi [24] allowances to earn 200 daily. The daily ration was divided into two equal meals at 8.00 AM and 4.00 PM with the provision of drinking water all the time. Animals were weighed every two weeks before the morning feed to calculate individual average daily gain (ADG) and feed conversion ratio (FCR).

The control diet (T1) consisted of 70% Concentrate feed mixture (CFM) with 30% alfalfa hay without any feed additives. The second diet (T2) was the control diet with leaves mixture of the Rosemary, Thyme and Peppermint mixture (RTPM). The third diet (T3) was the control diet with leaves mixture of the Lemongrass, Parsley and Coriander mixture (LPCM). Where each component is ground separately and a mixture is made in a ratio of 1: 1: 1 and each mixture was added in a ratio of 1.5% on a dry matter basis. The chemical composition of ingredients and diet used in the experiment are represented in table 1.

Item	DM%	OM%	CP%	CF%	EE%	NFE%	Ash%
Concentrate feed mixture[1)]	92.99	90.28	14.32	17.27	2.89	55.80	9.72
Alfalfa hay	85.32	83.03	12.68	23.16	2.64	44.55	16.97
Basal Diet	90.69	88.11	13.83	19.03	2.82	52.43	11.89

Table 1: The chemical composition of ingredients and diet used in the experiment (on DM basis, %).

DM: Dry Matter; OM: Organic Matter; CP: Crude Protein; EE: Ether Extract; CF: Crude Fiber; NFE: Nitrogen Free Extract

[1)]Concentrate feed mixture contains: 50.0% yellow corn, 20.0% wheat bran, 15.0% cottonseed meal, 12.5% soybean meal, 1.0% calcium carbonate, 1.0% sodium chloride, and 0.5% mineral plus vitamins additives.

Digestibility trials

All the experimental animals (12 animals) were used for the digestibility trails (after 5 month of the experiment). The digestibility trails consisted of 7days as primary period followed by collection period of 7 days. Animals were weighed at the first day of the primary period and the last day of the collection period. Faeces were collected daily every 24 hrs. in plastic bags and weighed. A 5% of the total daily faeces of each animal was taken as a sample and sprayed with solution of 10% formaldehyde and 10% H_2SO_4 and dried in the oven at 65°C for 12 hrs.

Dried samples of the collection period were mixed and composite samples were kept for analysis (10% of the total quantity). Feed residues (if any) were removed and weighed for each animal every morning for feed consumption. Moreover, the sample of diets, faeces and feed residues were analyzed for crude protein, ether extract, crude fiber, ash, and NFE was calculated by difference according to the methods of the AOAC [25].

Ruminal fermentation

On the last day of the digestibility trial, fermentation characteristics were determined at 0, 2, 4, 6, and 8 hrs post morning feeding. Rumen liquers (100 mL) were sampled in the area of the ventral blind sac with a composite sample strained through 4 layers of cheesecloth. The pH and temperature of ruminal fluid was immediately determined using a digital pH meter (model PH-222, Lutron, Taiwan) and a mercury thermometer, respectively. Strained rumen liquor was stored in 45 mL plastic bottles, with adding a few drops of toluene and paraffin oil just to cover the surface and stored at -20º C for analysis of total nitrogen (TN), and ammonia-N were analyzed as described by AOAC [25], and total volatile fatty acid (TVFA) according to Warner [26].

Economical evaluation

The economic gain was calculated as the market values of the total income from total weight gain (TWG) after subtracting feed cost, and the cost of medicinal plants during the experimental period. The following criteria were calculated in Egyptian pounds (LE): Feed cost, Net revenue, and Total revenue per TWG. The value of economic efficiency was calculated as the net revenue per unit of total costs, through the following equation:

Economic efficiency = (Net revenue)/(Total feed cost).

Statistical analysis

All data were analyzed as a complete randomized design using the PROC MIXED procedure of [27]. The statistical model was: $Y_{ij} = \mu + T_i + C_j + E_{ij}$, in which Y_{ij} is observed measurement, μ is the overall mean, T_i is the fixed effect of treatments (i = 1, 2, and 3), C_j is the random effect of lamb within treatment, and E_{ij} is the residual error. Significant differences between means were separated by Duncan's [28] multiple range tests.

Results

Ruminal fermentation

Feeding RTPM and LPCM diets did not affect ruminal pH, rumen temperature, and TVFA ($P > 0.05$) (Table 2). While, adding RTPM and LPCM led to a significant increase of ruminal ammonia-N ($P = 0.0043$) and TN ($P < 0.0001$).

Regarding the effect of sampling time on ammonia-N concentration, it may be noticed that the ruminal ammonia-N concentration was increased at 4hrs post-feeding, but it decreased at 8 hrs. feeding for all treatments. As for TN, is gradually increased at 2hrs

Item	Time (hrs.)	Diets[1)]			SEM	P value
		Control	RTPM	LPCM		
Ruminal Ph	0	7.63	7.76	7.74		
	2	6.65	6.60	6.56		
	4	6.71	6.64	6.39		
	6	6.84^{a}	6.76^{ab}	6.62^{b}		
	8	6.76	6.72	6.67		
	Mean	6.92	6.90	6.80	0.07	0.7493
Ruminal Temperature °C	0	37.50	37.50	37.33		
	2	37.83	37.50	37.83		
	4	37.17^{b}	39.00^{a}	39.00^{a}		
	6	37.66	37.22	37.63		
	8	36.66	36.87	36.00		
	Mean	37.37	37.62	37.15	0.14	0.8312
Ammonia-N (mg/dL)	0	28.00^{b}	36.40^{a}	33.60^{ab}		
	2	33.60^{b}	42.93^{a}	36.40^{ab}		
	4	36.40^{b}	44.80^{a}	44.80^{a}		
	6	35.47	39.20	37.33		
	8	30.80^{b}	36.40^{a}	33.60^{ab}		
	Mean	32.85^{b}	39.95^{a}	37.15^{a}	0.92	0.0043
TVFA (meq/dL)	0	6.33	6.67	6.33		
	2	6.33	5.67	6.00		
	4	6.00	5.67	6.33		
	6	6.00	6.33	7.00		
	8	5.67^{b}	7.00^{ab}	7.67^{a}		
	Mean	6.07	6.27	6.80	0.13	0.1462
Total nitrogen (mg/dL)	0	87.50^{b}	151.67^{a}	122.50^{a}		
	2	105.00^{b}	151.67^{a}	134.16^{a}		
	4	87.50^{b}	122.50^{a}	122.50^{a}		
	6	93.33^{b}	116.67^{a}	122.50^{a}		
	8	122.50	128.33	140.00		
	Mean	99.17^{b}	134.17^{a}	128.33^{a}	0.35	< 0.0001

Table 2: Effect of mixtures of medicinal plants on ruminal fermentation parameters.

SEM, standard error of the mean; means with different superscripts in the same row differ ($p < 0.05$). VFA, volatile fatty acid.

[1)]Diets: CON, control diet; RTPM, CON plus 1.5% of Rosemary, Thyme, and Peppermint mixture/DM basis; LPCM, CON plus 1.5% of Lemongrass, Parsley, and Coriander mixture/DM basis.

post-feeding then decreased and rose again to its maximum at 8hrs post-feeding.

Feed intake and nutrient digestibility

The LPCM diet increased (P = 0.0692) DMI while the RTPM diet decreased DMI compared to the control (Table 3). The addition of the RTPM diet resulted in a non-significant increase (P > 0.05) in DM, OM, CP, CF, EE, and NFE digestibility, while LPCM non-significant decreased DM, OM, CP, CF, EE, and NFE digestibility compared to the control (Table 3). The highest TDN, SV and DCP values were recorded for RTPM treatment (Table 3), whereas LPCM recorded the lowest values of TDN and SV.

Item	Diets[1)]			SEM	P value
	CON	RTPM	LPCM		
Feed intake/head/day					
Dry matter intake, kg	1.36[a]	1.26[b]	1.40[ab]	0.014	0.0692
Total digestible nutrients, kg	0.91	0.85	0.90		
Crude protein intake, g	188.18	174.56	193.23		
Nutrient digestibilities, %					
Dry matter	62.82	63.40	62.36	1.25	0.9523
Organic matter	70.41	71.01	68.27	0.69	0.25
Crude protein	67.43	71.47	69.19	1.65	0.6509
Crude fiber	59.79	59.83	57.17	1.95	0.8435
Ether extract	61.99	63.84	62.91	1.95	0.9399
Nitrogen free extract	77.19	77.21	74.26	1.09	0.4858
Nutritive value, %					
Total digestible nutrients (TDN)	66.62	67.08	64.7	0.64	0.3008
Starch values (SV)	65.07	65.49	63.14	0.62	0.2816
Digestible crude protein (DP)	9.29	9.85	9.54	0.23	0.6509

Table 3: Effect of mixtures of medicinal plants on dry matter intake, nutrient digestibilities, and nutritive values.

SEM: Standard Error of the Mean

[1)]Diets: CON, control diet; RTPM, CON plus 1.5% of Rosemary, Thyme, and Peppermint mixture/DM basis; LPCM, CON plus 1.5% of Lemongrass, Parsley, and Coriander mixture/DM basis.

Growth performance

The initial BW was not significantly (P = 0.8201; Table 4) differed between treatments. While the TWG and ADG were significantly higher (P = 0.0034) for both RTPM and LPCM rations than in control. The RTPM diet showed the highest ADG and significant (P = 0.0057) the best FCR in lambs compared with the LPCM and control.

Economical evaluation

Economic efficiency was estimated as the price of gained weight divided by the cost of feed consumed for the gain. The highest daily feed cost was shown for the LPCM diet followed by RTPM (Table 5). The economic efficiency and relative economic efficiency were the highest for the RTPM diet (P < 0.0001), while the lowest values were recorded for the LPCM diet compared to the control.

Discussion

Ruminal fermentation

Ruminal pH and ruminal temperature were not affected with feeding RTPM and LPCM treatments. These results are consistent with the literature indicating that there is no effect of Rosemary, Thyme, Peppermint, Lemongrass, or Coriander on ruminal pH and ruminal temperature in small ruminants [7,18,29-32]. While

Item	Diets[1)]			SEM	p value
	CON	RTPM	LPCM		
Initial weight (kg)	21.22	20.27	20.00	0.76	0.8201
Final weight (kg)	49.75	52.59	50.99	0.83	0.4116
TWG (kg)	28.54^{b}	32.32^{a}	30.99^{ab}	0.01	0.0034
ADG (kg)	0.190^{b}	0.216^{a}	0.207^{ab}	0.56	0.0034
FCR	7.17^{a}	5.86^{b}	6.78^{ab}	0.22	0.0057

Table 4: Effect of mixtures of medicinal plants on growth performance.

TWG: Average Weight Gain; ADG: Average Daily Gain; FCR: Feed Conversion Ratio; SEM: Standard Error of the Mean

[1)]Diets: CON, control diet; RTPM, CON plus 1.5% of Rosemary, Thyme, and Peppermint mixture/DM basis; LPCM, CON plus 1.5% of Lemongrass, Parsley, and Coriander mixture/DM basis.

Item	Diet[5)]		
	Control	RTPM	LPCM
Total weight gain obtained (kg)	28.54	32.32	30.99
Consumed DM (kg) to produce	204.15	189.30	209.70
Feed cost (LE[*]) for Total weight gain	928.88	968.86	1048.64
Total revenue (LE)[1)]	1997.80	2262.40	2169.30
Net revenue (LE)[2)]	1068.92	1293.54	1120.66
Economic efficiency[3)]	1.15	1.34	1.07
Relative Economic efficiency[4)]	100.00	116.02	93.04

Table 5: Economical evaluation of the experimental ration.

[*](LE) = Egyptian pound is equivalent to 0.064 US dollars

[1)]Total revenue = Total weight gain * price of kg live weight gain (70 LE))

[2)]Net revenue = Total revenue - Feed cost for total weight gain.

Market prices were as follow: concentrate was 5000 LE/Ton, alfalfa hay was 3500 LE/Ton, Rosemary, Thyme and peppermint 40 LE/kg, lemon grass, Parsley and Coriander 30 LE/kg

[3)]Economic efficiency = Net revenue/Total feed cost

[4)]Relative Economic efficiency = (Economic efficiency of treatment/ Economic efficiency of control) × 100

[5)]Diets: CON, control diet; RTPM, CON plus 1.5% of Rosemary, Thyme, and Peppermint mixture/DM basis; LPCM, CON plus 1.5% of Lemongrass, Parsley, and Coriander mixture/DM basis.

[33] reported that the ruminal pH was decreased in the *in vitro* by adding Parsley. The RTPM and LPCM inclusion increased ruminal ammonia-N values in the present study (form 32.85 to 39.95 mg/dL). This may be due to the antioxidant and antimicrobial activities of some medicinal plants that provide a suitable environment for the growth of beneficial microflora in the rumen and let for more feed nutrients fermentation and subsequently more NH3-N. [34] Reported that the inclusion of Rosemary essential oil at 200 mg daily in the diets of sheep increased ruminal ammonia-N. Similarly, [33] reported that ruminal ammonia-N was increased with feeding Parsley. Moreover, [35] found that the inclusion of Thyme essential oil in the diets of lambs increased ruminal ammonia-N. While

[18] reported that supplementation with Lemongrass in the diets of cows decreased ruminal ammonia-N concentration. Similarly, [36] found that the inclusion of Thyme essential oil in the diets of Holstein dairy cows decreased ruminal ammonia-N.

Ruminal TVFA was no affected with feeding RTPM and LPCM treatments. These results are consistent with the literature indicating that there was no effect of Rosemary, Thyme, Lemongrass, or Coriander on ruminal TVFA in small ruminants [7,18,31,35,36]. While [33] reported that the ruminal TVFA was increased in the *in vitro* by adding Parsley. Similarly, [37] found that the ruminal TVFA was increased with feeding Peppermint, Rosemary, and Lemongrass treatments in lambs. The RTPM and LPCM inclusion increased ruminal total nitrogen (from 99.17 to 134.17 mg/dL). This may be due to the high solubility of crude protein of RTPM and LPCM likely released more ammonia and amino acids in the rumen.

Feed intake and nutrient digestibility

Including RTPM in the diet of lambs reduced the feed intake of lambs. Rosemary, Thyme, and Peppermint are very fragrant herbs. Therefore, mixing it reduces the sheep's feed intake. These findings are in conflict with the literature data [35,37-39] about no effect on feed intake of sheep when these medicinal plants are used alone. Whereas [30,40-42] found an increase in feed intake for sheep when using these herbs alone.

Including LPCM in the diet of lambs increased the feed intake of lambs. Greater feed intake due to the Coriander in the mixture may be a result of its pleasant odour and flavor. Coriander oil's flavor is one of the functions of its main ingredient, linalool, which has an appetizing effect on diets. These results are in agreement with these of [43-44]. While [17,29,34,45] indicated that using Lemongrass or Parsley did not significantly affect the feed intake. The addition of RTPM and LPCM supplementation did not affect significantly the nutrient digestibilities and nutritive value. These results are consistent with [7,33,35,36,46,47,48] when each herb is used alone. While [2,41,42] indicated a significant improvement in the nutrient digestibility and nutritive value when using some medicinal plants alone.

Growth performance

The TWG and ADG of the RTPM and LPCM diets were significantly higher than the control. The RTPM diet recorded the highest the TWG and ADG whereas the control diet showed the lowest values. The feed conversion ratio was improved significantly in the RTPM diet however, FCR of the LPCM diet did not differ significant compared to the control. This may be due to increasing protein anabolism as a result of higher ruminal total nitrogen (Table 2), so an increase in protein biosynthesis, and a decrease in protein catabolism. Moreover, medicinal plant mixtures supplementations might have a stimulating effect on rumen functions and digestion. Similar results were observed by [30] who reported that the ADG was increased with feeding Peppermint and Thyme treatments to Sanjabi lambs. In addition, [37] found that the ADG and FCR were increased with feeding Peppermint, Rosemary, and Lemongrass treatments in Barki lambs.

Economical evaluation

Including RTPM in the diet of lambs increased the economic efficiency and relative economic efficiency while LPCM diet recorded the lowest values. Moreover, the feed cost for total weight gain was increased in the RTPM and LPCM diets compared to the control but was compensated for by the increase in total weight gain obtained in both diets. Similar results were observed by [37] who recorded that using some medicinal herbs (Peppermint, Rosemary, and Lemongrass) as feed additives in lambs ration increased the economic efficiency and relative economic efficiency compared to the control.

Conclusion

Under the conditions of the present study, using RTPM or LPCM (natural feed additives) in the diet of growing Saidi lambs appeared to show a better performance than lambs in the control diet. The addition of the RTPM or LPCM trended improved dry matter intake, rumen fermentation, growth performance, feed conversion ratio, and economic efficiency.

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Conflict of Interest

The authors confirm that this article content has no conflict of interest.

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