EFFECT OF ROSEMARY OR LAUREL LEAVES AS FEED ADDITIVES ON PERFORMANCE OF GROWING LAMBS

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SUMMARY

Thirty males of crossbred Rahmani lambs (Rahmani × Finnish Landrace) were chosen after weaned at 3 months of ages and randomly divided into five similar groups (6 lambs for each) according to their live body weight (20.66 ±0.165 kg) and fed the experimental rations for 20 weeks as an experimental period to investigate the effects of rosemary or laurel herbs as feed additives to lambs rations, on rumen functions, digestibility, some blood parameters and growth performance of growing lambs. Rosemary dry leaves (RDL) or laurel dry leaves (LDL) were added to concentrate feed mixture (CFM) portion of lambs rations at levels of 0, 0.5, 1, 0.5 and 1% as (CFM1, CFM2 CFM3, CFM4 and CFM5, respectively). Each group was assigned randomly to feeding one of experimental rations where R1 (control): received 60% CFM1+40% clover hay (CLH), R2: 60% CFM2+40% CLH, R3: 60% CFM3+ 40% CLH, R4: 60% CFM4 +40% CLH and R5: 60% CFM5 +40% CLH as tested rations. The feed allowances were calculated according to NRC (2007) for sheep. Five digestibility trials were performed to evaluate the nutrients digestibility and feeding values of the experimental rations. Results indicated that the chemical composition of RDL and LDL were contained (6.23, 8.25), (22.72, 23.86), (8.48, 8.41), (53.61, 54.54), (8.96, 4.94) % for CP, CF, EE, NFE and ash, respectively. Essential oil content in LDL was approximately the double of that found in RDL (3.00 vs. 1.6% as fed, respectively). The digestibility of most nutrients and feeding values (DCP) were insignificant improved with increasing the level of RDL and LDL in rations, while TDN value was significantly ($P<0.05$) improved with increasing the level of LDL in ration compared with that of control one. The rumen liquor pH values were somewhat decreased over 3 and 6 sampling times with increasing the level of RDL and LDL up to 1% in the experimental rations. The vice versa trend was found among dietary treatments respecting and NH_3-N and TVFA´s concentrations where its values were increased with increasing the two herbs levels in the tested rations over the three sampling times. No significant differences among treatments in respect of all blood metabolites except for glucose, total lipid, tri-glyceride, total cholesterol and LDL-c which markedly improved with increased the level of RDL or LDL in rations. Concerning blood plasma TAC, its values significantly increased due to the addition of the two levels of both RDL and LDL into the four tested rations compared to the control ration. Total body gain and daily gain were significantly higher with both tested rations that having the high levels of herbs (R3 & R5) than those of control one, while the other tested rations that having the low level of herbs (R2 & R4) were insignificant higher respecting these growth items, than those of control one. Total DMI and TDNI were markedly increased with increasing the levels of the two herbs (RDL & LDL) in the four tested rations, based on control one, being the high level (1%) of herbs appeared to be more affecting than the low one on feed intake. Economic efficiency was tangibly improved by feeding the tested rations that contained the experimental herbs, especially with that having 1% LDL in comparison with control one and the other tested ones. It could be concluded that feeding on rations contained RDL or LDL (i.e. 1% in adding of CFM), could be recommended for growing lambs due to the positive effect on growth performance and health state in addition to increasing profitability.

Keywords: *Lambs, rosemary, laurel, performance, digestibility, ruminal parameters, blood parameters and economic efficiency.*

INTRODUCTION

Feed additives are non-nutritive substances, but preferably added to animal feeds to improve growth performance, feed intake and the efficiency of feed utilization as well as for good health and other beneficial issues for livestock production. Feed additives have been derived from plants where they called phytogenics or phytobiotics that possibly included in animals' diets to improve their productivity and animal products (Windisch *et al*., 2009). Among these natural additives, aromatic plants, their extracts and essential oils that have been preferred due to their advantages over the antibiotics as growth promoters. Rosemary (*Rosmarinus officinalis* L.) is an evergreen perennial shrub belonging to the *Lamiaceae* family and its leaves are commonly used as a food seasoning. The secondary metabolites in rosemary are well known as major compounds including monoterpenoids, such as α-pinene, β-pinene, camphene, 1-8 cineole, camphor, borneol, bornyl acetate and verbenone and in addition many phenolic diterpenes such as carnosol, carnosic acid, rosmanol, epirosmanol, isorosmanol, methyl carnosate, and rosmarinic acid (Cobellis *et al*., 2015a). The main constituent of the rosemary essential oil was 1,8-cineole (~ 81.47%) which is important for medicinal and pharmaceutical aspects (Türkmen *et al.,* 2014). Previously, Moujahed *et al.* (2011) found that the major compounds identified in rosemary essential oils were 1-8 cineol (44.2%), camphor (12%) and α-pinen (11.6%). Some of these compounds have been working as antimicrobial and antioxidant throughout the bioprocesses in animal's body. Several studies have been evaluated rosemary essential oil as feed additive using in-vitro rumen fermentation trials (Roy *et al*., 2014 and Cobellis *et al*., 2015b) and plant extracts such as essential oils that proved to have positive effects on rumen protein metabolism, volatile fatty acids (VFA), methane and ammonia concentrations (Hart *et al*., 2008 and Cobellis *et al*., 2016a). Rosemary leaves may be used to modulate rumen microbiome and its function that are known to be have a close relationship with degradation of protein and fiber and production of methane and ammonia (Cobellis *et al*., 2016b). Also, laurel or sweet bay (*Laurus nobilis* L.) of the *Lauraceae* family is a native plant in southern Mediterranean region. It is an evergreen plant and grown as high-value spice crop in that region, and as an ornamental plant throughout Europe and America. Phytochemical analysis has shown that such plant containing a lot of valuable compounds such as volatile and non-volatile oils, flavonoids, tannins, sesquiterpenic alcohols, alkaloids, minerals, and vitamins (Kilic *et al*., 2004 and Abu-Dahab *et al.,* 2014). The dried leaves of laurel are used extensively in cooking and its essential oil is generally used as flavoring materials in food industry (Bauer and Garbe, 1985). Also, leaves of this plant could be produce yellow oil that known for being use in many therapeutic indications as well as their essential oil would be increase gastric fluid secretion and work against digestive disorders such as flatulent colic (Matsuda *et al*., 2002). Also it has potential properties for working as antifungal, antibacterial, antiviral insecticidal and antioxidant (Seyed *et al.,* 1991, Qamar and Chaudhary, 1991 and Burt, 2000). The laurel essential oils are a rich source of biologically active compounds and its composition being considerably influenced by various factors such as the environment, harvest season, plant parts, extraction method, and others. The essential oils content of the leaves appeared to be varied widely from 0.5 to 4.3% according to the different estimation conditions (Kilic *et al*., 2004, Amin *et al*., 2007, Bahmanzadegan *et al*., 2015, Caputo *et al*., 2017 and Tanab *et al*., 2018). The leaf essential oil was found to be rich in 1,8-cineole (30-70%), linalool (0.9-26.9%), α-terpinyl acetate (4.50– 25.7%), α-pinene, β-pinene, sabinene, α-terpineol, terpineol-4 (Amin *et al*., 2007, Bahmanzadegan *et al*., 2015, Caputo *et al*., 2017 and Tanab *et al*., 2018). More recently, Fidan *et al.* (2019) estimated the essential oil in the laurel leaves to be reach up 3.25% of its weight and the main constituents in the leaf essential oils were 1,8-cineole (41.0%), α-terpinyl acetate (14.4%), sabinene (8.8%), methyl eugenole (6.0%), β-linalool (4.9%), and α-terpineol (3.1%). The main target of this study was to investigate the effects of adding two levels of either rosemary dry leaves or laurel dry leaves on productive performance, digestibility and some blood parameters of growing lambs.

MATERIALS AND METHODS

The experimental work of this study was carried out during a period of 2019 (lasted 20 weeks) at Sakha Animal Production Research Station, Kafer El-Sheikh Governorate, belonging to Animal Production Research Institute (APRI), Agriculture Research Center (ARC), Ministry of Agriculture, Egypt, and the chemical analysis was carried out at laboratories of APRI, ARC.

Preparation of medicinal plants:

An ample amount of the dry medicinal plants (rosemary or laurel) which included leaves and some small stems (approximately 10% moisture) were purchased from a commercial company at Al-Azhar Street, Cairo Governorate and ground in a hummer mill and stored in bags until use. Samples of the two tested additives were finely ground for the chemical analysis and the percentage of essential oils of both rosemary and laurel dry leaves were determined, using 100g samples. The distillation of the essential oil was conducted as described in the British Pharmacopoeia (1963). The essential oils obtained from, rosemary and laurel dry leaves were analyzed using DsChrom 6200 Gas Chromatograph equipped with a flame ionization detector for separation of volatile oil constituents (Hoftman, 1976). The samples were analyzed in the laboratories of the Medicinal Plants Department, Horticulture Research Institute, ARC.

Experimental animals and feeding:

Feeding trial was conducted using thirty males crossbred Rahmani lambs (Rahmani × Finnish Landrace) with an average live body weight 20.66 ±0.165 kg and 3 months of age lasted 20 weeks as an experimental period. Lambs were randomly divided into five similar groups (6 lambs for each). Rosemary and laurel dry leaves were added into the concentrate feed mixture (CFM) portion of lambs rations at levels of 0, 0.5, 1, 0.5 and 1% as CFM1, CFM2 CFM3, CFM4 and CFM5, respectively. Each group was assigned randomly to feeding one of the experimental rations where R1: received 60% concentrate feed mixture (CFM) +40% clover hay (CLH), R2: 60% CFM +40% CLH+ 0.5% rosemary dry leaves (RDL), R3: 60% CFM +40% CLH+ 1% RDL and R4: 60% CFM +40% CLH+ 0.5% laurel dry leaves (LDL), R5: 60% CFM +40% CLH+ 1% LDL. The amount of CFM was offered twice daily at 8.00 a.m. and 4.00 p.m. in two equal portions, while the amount of roughage was offered once a day in the morning. Animals were housed in five shaded yards and it were weighed biweekly. The feed allowances were calculated according to NRC (2007) for sheep. Drinking water was available at all times. The experimental animals were in good health condition and free from external and internal parasites and kept in pens under similar conditions. Samples of the feed ingredients were analyzed for crude protein (CP), crude fiber (CF), ether extract (EE) and ash. Proximate analysis was performed according to AOAC (2007). Feed ingredients of the CFM (as fed) are consisted of 38% yellow corn, 39% wheat bran, 17% sunflower meal, 3% molasses, 2% limestone and 1% salt. Chemical analysis of feedstuffs and calculated chemical composition of concentrate feed mixtures and the experimental rations are presented in Table (1). Essential oils and active constituents of the rosemary and laurel dry leaves as fed are illustrated in Table (2).

Digestibility trials and rumen liquor parameters:

At the end of the feeding trial, five digestibility trials were conducted simultaneously on the animals of the feeding trial (3 lambs in each group) to determine the digestion coefficients and feeding values of the experimental rations using acid insoluble ash (AIA) method (Van Keulen and Young, 1977). Feces samples were taken from the rectum twice daily with 12 hours interval for 5 days and composited for each animal and then representative samples were prepared and dried at 60 ^oC for 72 hours. Samples of feed (CFMs, clover hay, rosemary dry leaves and laurel dry leaves) and feces were ground through 1 mm screen on a Wiley mill grinder and then have been analyzed for dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and ash according to AOAC (2007). At the end of the digestibility trials, rumen liquor samples were taken from the three lambs of each group using stomach tube at 0, 3 and 6 hrs. post feeding. The rumen liquor samples were strained through 4 layers of cheese-cloth and immediately pH was determined using digital pH meter (Orian 680). Ammonia nitrogen (NH_3-N) concentration was determined according to Conway and O'Mally (1957). Other rumen liquor samples were kept in the deep freezer until the estimation of TVFA's according to Warner (1964).

Blood parameters:

At the end of collection period of the digestibility trials, blood samples were withdrawn from jugular vein in heparinized tubes and centrifuged for 20 min. at 3000 r.p.m. Plasma was stored at -18°C until the time of analysis. Various chemical parameters were colorimetrically determined using commercial kits; following the same steps as described by manufacture. Total protein was measured as described by the Biuret method according to Henry and Todd (1974) and albumin was assayed according to Doumas *et al.* (1971), while globulin was calculated by subtracting the albumin value from total protein value. Liver functions were assessed by measuring the activities of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) according to Reitman and Frankel (1957). Urea and creatinine were measured according to Berthelot (1959) and Faulkner and King (1976), respectively. Glucose was determined by quantitative enzymatic-colorimetric method that outlined by Trinder (1969). Total lipid, Tri-glycoside, total cholesterol and high density lipoproteins (HDL-c) were estimated according to Zollner and Kirsch (1962), Naito (1989), Tietz (1995) and Nauk *et al.* (1997), respectively. The low density lipoprotein (LDL-c) was calculated: as LDL=TC-HDL-(TG/5) according to Friedewald *et al.* (1972) and total antioxidant capacity (TAC) was measured according to Koracevic *et al*. (2001).

Statistical analyses:

Data were analyzed using the general linear models procedure of SAS (2004). The difference between means was tested by Duncan's Multiple Range Test (Duncan, 1955). The used model was: Yij+ μ+ Ti+ eij where: Yij= the observation of ij, μ= overall mean of Yij. Ti= effect of i (treatments). eij = the experimental random error.

RESULTS AND DISCUSSION

Chemical composition:

Chemical analysis of feedstuffs and calculated chemical composition of the CFM´s and experimental rations are presented in Table (1). The chemical composition of CFM1, CFM2, CFM3, CFM4 and CFM5 were closely comparable to those using commonly in practical field of lambs feeding. Also, the values of chemical composition of clover hay are within the normal range that widely recorded in the literature. While the compositional values of rosemary dry leaves (RDL) were found as 6.23, 22.72, 8.48, 53.61 and 8.96% (on DM basis) for CP, CF, EE, NFE and ash, respectively. The values of chemical analysis of the RDL were closely comparable to which recorded by many authors who reported that the analysis could be influenced by various factors, such as the prevailing environmental conditions, harvest season, plant parts and others. The estimation of Gasmi-Boubaker *et al.* (2009) had presented that the chemical composition of *Rosmarinus officinalis* that growing in the pastures of central Tunisia was contained 8.36, 34.5, 45.9 and 7.75% for CP, ADF, NDF and ash, respectively. Also, Moujahed *et al.*(2011), El-Wardany *et al.*(2015), Badawi *et al*. (2016) and Bakr *et al.*(2016) found that the chemical composition of *Rosmarinus officinalis* was within the following ranges 4.10- 5.80% for CP, 13.37- 21.71% CF, 9.23- 16.32% EE and 5.23- 6.20% for ash (on DM basis). The chemical composition of LDL that used in the present study was contained 8.25, 23.86, 8.41, 54.54 and 4.94% (on DM basis) for CP, CF, EE, NFE and ash, respectively. While, Al-Hashimi and Mahmood (2016) reported that the chemical composition of bay leaves (*Laurus nobilis* L.) as protein, oil, ash and carbohydrate were 7.62, 8.5, 3.63, 50.83%, respectively. Generally, RDL and LDL are rich in most nutrients and some bio-compounds which could be used as excellent feed additives in sheep rations.

Table (1): Chemical analysis of feedstuffs and calculated chemical composition of the concentrate feed mixtures and the experimental rations (% on DM basis).

Item	DM	OM	CP	CF	EE	NFE	Ash
Feedstuffs:							
Rosemary dry leaves (RDL)	92.82	91.04	6.23	22.72	8.48	53.61	8.96
Laurel dry leaves (LDL)	95.26	95.06	8.25	23.86	8.41	54.54	4.94
Clover hay (CLH)	89.66	87.20	13.20	26.08	2.12	45.80	12.80
Concentrate feed mixtures (CFM´s):							
CFM_1	88.72	95.81	15.01	7.20	3.35	70.25	4.19
CFM_2	89.16	95.77	15.04	7.31	3.38	70.04	4.23
CFM_3	89.63	95.73	15.07	7.39	3.43	69.84	4.27
CFM_4	89.19	95.79	15.05	7.32	3.39	70.03	4.21
CFM_5	89.83	95.77	15.09	7.43	3.43	69.82	4.23
Experimental rations:							
R1	89.10	92.32	14.27	14.85	2.85	60.35	7.68
R2	89.66	92.30	14.30	14.92	2.90	60.18	7.70
R3	90.23	92.28	14.33	14.96	2.96	60.03	7.72
R4	89.70	92.33	14.34	14.93	2.91	60.15	7.67
R5	90.40	92.34	14.40	14.98	2.97	59.99	7.66

R1: CFM1+clover hay (control ration), R2: CFM2 contain 0.50% of rosemary dry leaves+ clover hay, R3: CFM3 contain 1% of rosemary dry leaves+ clover hay, R4: CFM4 contain 0.50% of laurel dry leave+ clover hay and R5: CFM5 contain 1% of laurel dry leave+ clover hay.

Essential oil and active constituents:

Essential oils and active constituents of the rosemary dry leaves and laurel dry leaves are presented in Table (2). The essential oil content in LDL was approximatively the double of that found in RDL (3.00 and 1.60%, respectively) and within the normal range that widely recorded in the literature. The biggest constituent in the leaf essential oils was 1,8-cineole which reaching up to 29.52% in RDL and 38.92% in LDL. The concentrations of essential oils and active constituents of the RDL and LDL are closely comparable to which suggest by other authors. Mulas *et al.* (1998) found that the essential oil content of rosemary leaves ranged between 0.8 to 2.6 % of the dry weight. While, Wolski *et al.* (2000) reported that the content of essential oil of rosemary leaves was ranged from 1.5 to 2.0%, which being that the essential oil and its constituents may differ from place to another due to variations in species, soil, weather, agronomical treatments and processing. On other estimations, Touafek *et al.* (2004) identified 1,8-cineole

(29.5%),2-ethyl-4,5-dimethylphenol (12.0%) and camphor (11.5%) as the major components of *Rosmarinus officinalis* essential oil. The content of essential oils of the LDL has been varied widely from 0.5 to 4.3% as recovered by many researchers (Kilic *et al*., 2004, Amin *et al*., 2007, Bahmanzadegan *et al*., 2015, Caputo *et al*., 2017 and Tanab *et al*., 2018). Further evaluations appeared that the LDL essential oil being rich in 1,8-cineole (30-70%), linalool (0.9-26.9%), α-terpinyl acetate (4.50-25.7%), α-pinene, β-pinene, sabinene, α-terpineol, terpineol-4 (Amin *et al*., 2007, Bahmanzadegan *et al*., 2015, Caputo *et al*., 2017 and Tanab *et al*., 2018). Moreover, Fidan *et al*. (2019) found that the oil yield was representing 3.25% of the laurel leaves and the main constituents in the leaf essential oils were 1,8-cineole (41.0%), α-terpinyl acetate (14.4%), sabinene (8.8%), methyl eugenole (6.0%), β-linalool (4.9%), and α-terpineol (3.1%). Lastly the concentrations of essential oil and active constituents having little variations than those recorded in the literature, because of the insignificant differences of varieties, types, species, growing environmental conditions and post harvest factors.

Table (2): Essential oils and active constituents of the rosemary and laurel dry leaves (as fed).

Item	Rosemary dry leaves	Laurel dry leaves	
Essential oils, %	1.60	3.00	
Constituents of essential oils, %			
α- pinene	7.0242	α- Thujene	6.3146
Comphene	4.9640	α- pinene	17.0270
B-pinene	7.0141	1.8 cineole	38.9179
Limonene	1.5365	Ɣ-terpinene	1.7864
1.8 cineole	29.5228	Linalool	1.3320
Ɣ-terpinene	4.1863	Myrcenol	2.0539
Linalool	0.8650	Menthone	5.1337
Comphor	15.5710	Terpinene-4-ol	15.0547
α- terpineol	4.8347	Santalone	1.5484
Borneol	12.8017	Carveol	1.5163
Eugenol	0.9540	Cuminaldehyde	1.0591
B-caryophyllene	0.8012	Total	91.744
Total	90.0755		

Nutrients digestibilities and feeding values:

Digestion coefficients and feeding values of the experimental rations are presented in Table (3). Results revealed that the digestibility of all nutrients and feeding values as DCP did not significantly affected by increasing the level of RDL and LDL up to 1% in rations, while TDN values were significant ($P \leq 0.05$) higher with only the two tested rations that having either RDL or LDL at 1% level. The addition of both RDL and LDL by the two levels led to an insignificant improvement in the digestibility of all nutrients in comparison with those of the control one (R1). The digestibility of CP, CF, EE and NFE as well as the DCP value were insignificant higher with LDL-ration (1%) compared with those of RDL ones. This might be due to some variations in essential oils concentrations between RDL and LDL and also owing to its different contents of active substances that can improve the digestibility, metabolic processes and immune stimulant action of animals (Sabra and Metha, 1990). Likewise, El-Bordeny (2011) reported that diet contained 1,8-cineole; α-pinene and β-myrcene could be working as micro factors to stimulate rumen microflora to be in more efficient for producing vitamins and enzymes which are required to optimizing the digestibility, absorption and the whole metabolic processes. Otherwise, Sahraei *et al.* (2014) revealed that nutrients digestibilities of DM, NDF, ADF and CP did not affect by rations contained different levels (0, 100, 200 and 400 mg $d^{-1}$of rosemary essential oils using male sheep. Differences between the results may be due to the difference in blend of oils and dosages those used in different studies. The obtained results are in agreement with those recorded by Tekippe *et al.* (2013) and Lin *et al.* (2013) who reported that the digestibility of feeds was not affected by essential oils in most of nutrients in several studies. Generally, Bakr *et al.* (2016) reported that rosemary (*Rosmarinus officinalis*), Marjoram (*Origanum majorana*), Ginger root (*Zingiber officinale*) and their mixture could be added to NZW rabbit diets to improve digestibility of nutrients under arid conditions. Similarly with sheep Allam and El-Elaime (2020) reported that the rosemary leaves could be improved all nutrients digestibility (DM, OM, CP, CF, EE and NFE) and feeding values as TDN, DCP compared with those of control ration.

Table (3): Digestion coefficients and feeding values of the experimental rations.

Item	R1	R2	R3	R4	R5	±SE
Digestibility coefficients, %						
DM	63.06	64.02	64.26	64.36	64.40	±0.402
OM	66.68	66.81	67.16	66.96	67.22	±0.481
CP	62.73	62.95	63.68	63.29	64.00	±0.615
CF	53.52	53.75	54.74	54.13	54.98	±0.573
EE	69.13	69.54	70.16	69.69	71.57	±0.926
NFE	72.61	74.37	74.88	74.57	75.05	±0.942
Feeding values, %						
TDN	65.16^{b}	66.54^{ab}	67.39^{a}	66.82^{ab}	67.75^{a}	±0.609
DCP	8.95	9.00	9.12	9.07	9.22	±0.088

a and b mean in the same row with different superscripts are significantly (P≤0.05) different.
SE=standard error.

Rumen fermentation parameters:

Data of ruminal fermentation activities parameters of animals fed the experimental rations are presented in Table (4). Results revealed that overall rumen liquor pH values did not affected significantly by the different tested rations in comparison with control one respecting all sampling times, with the exception of 1% LDL-ration (R5) that significant lower in pH value than that of control one (R1). In fact, the main source of essential oils and its type and content can affect markedly on fermentative microbial activities and consequently on rumen pH. Also, the variations in pH values would be generally due to the production of TVFA´s (Odetokun, 2000) that largely depending on protein-based fermentation (Adenike *et al.*, 2007). These results are in harmony with those obtained by Khayyal (2006) who observed that no clear effect on cecum pH value when adding thyme and sage leaves in diets of growing rabbits in comparison with control one. The present results are in agreement with the finding that obtained by Castillejos *et al.* (2008) who showed that rosemary essential oil at 5 and 50 mg L–1 had no effect on ruminal pH values. Likewise ruminal pH of the sheep was not affected by rosemary leaves, rosemary leaves pellet and rosemary essential oil (Cobellis *et al*., 2015a). The concentrations of ruminal NH3-N at all sampling times didn’t significant affected by the dietary treatments of the experiment and just there were insignificant increases with the two higher levels of additives in rations (R3 and R5) regarding 3 and 6 hrs. of sampling times compared with the other treatments. These results are comparable with those obtained by Sahraei *et al.* (2014) who showed that the concentration of ammonia-N across sampling times was lower (P<0.05) at low rosemary essential oil (REO) dosage (100 mg d^{-1} to diet) compared with that of control diet. The production of ammonia and amines is quite common end products that released during ruminal fermentation processes as a result of protein hydrolysis. Greatly, the interaction of feed ingredients in ruminant rations can affect positively or negatively on the whole fermentative processes in the rumen and its end products, as well as effect on feed intake or synergistic as antagonistic interactions among diet ingredients (Thomas, 1990). Rosemary and laurel additives might be working as buffers for regulating absorbing and releasing NH3-N in the rumen. Related to this point, Huhtanen (1991) added that the utilization of dietary energy depends not only on the profile of nutrients made available from a particular feed, but also from nutrients made available from other feeds that incorporated in a rations. Regarding the TVFA´s production in the rumen at zero sampling time, there were no significant differences among the dietary treatments respecting its value. Increases in concentration of ruminal TVFA´s with increasing RDL and LDL levels may be due to the positive effects of additional essential oils. Respecting the TVFA´s concentration, there were non-significant differences among different dietary treatments were observed over the three sampling times, except for R5 that being significant (P<0.05) higher than that of R1, R2 and R3 at 3 hrs. sampling times, and was significant higher than R1 at 6 hrs. Such slightly increases of TVFA´s concentration may be due the effects of DM digestibility, rate of absorption, rumen pH and changes in microbial population in the rumen and their activities (Allam *et al.*, 1984). The obtained results are in agreement with those recorded by Cobellis *et al*. (2015a) who showed that rumen TVFA´s was not affected by rosemary leaves; pelleted rosemary leaves, or rosemary essential oil when added to the diets of sheep. Otherwise the study that conducted by Sahraei *et al.* (2014) showed that the TVFA´s concentration at 4 hrs. after morning feeding of sheep at low rosemary essential oil dosage (100 mg d^{-1} to diet) was reduced (P<0.05) compared with control, whereas medium dose (200 mg d^{-1} to diet) increased (P<0.05) TVFA´s concentration at the same sampling time compared with control ration, hence the concentration of TVFA´s much dependent on the dose of such additive and ruminal fermentation of sheep. Such significant increases of TVFA´s concentrations with the addition of rosemary additive into the ration of ruminant animals might be due to the increase in OM digestibility of the supplemented ration.

Table (4): Ruminal parameters of lambs fed the experimental rations.

Item	pH			NH3-N (mg/100 ml RL)			TVFA´s (meq/ 100 ml RL)		
	0 hrs	3 hrs	6 hrs	0 hrs	3 hrs	6 hrs	0 hrs	3 hrs	6 hrs
R1	6.73	5.92[a]	6.24	16.61	27.17	24.49	8.00	10.69[b]	9.07[b]
R2	7.05	5.61[ab]	6.10	16.85	27.95	24.34	8.09	11.01[b]	9.66[ab]
R3	6.71	5.46[ab]	6.04	16.82	30.32	28.85	8.41	11.36[b]	10.22[ab]
R4	6.67	5.47[ab]	6.08	16.58	27.86	24.03	8.19	11.59[ab]	9.81[ab]
R5	6.77	5.37[b]	5.86	16.93	30.15	28.93	9.00	12.78[a]	11.53[a]
±SE	±0.173	±0.157	±0.201	±0.329	±1.23	±2.05	±0.418	±0.379	±0.697

a and b mean in the same column with different superscripts are significantly (P≤0.05) different. SE=standard error.

Blood parameters:

Results of blood parameters of lambs fed the experimental rations are presented in Table (5). Data revealed that the two levels of each RDL and LDL had no significant effects on the concentrations of total protein, albumin, globulin, ALT, AST, urea, creatinine and HDL-c based on control that free from such supplements. The blood parameters are intimately related to the metabolic processes and influenced by the external environment including feeding, climate and management factors. The concentration of total protein was slightly increased with increasing the level of RDL and LDL in rations and these slightly increases might be due to indirect response to protein quality, protein intake of RDL, LDL and essential oils which contain deferent levels of constituents specially 1,8 cineol vital compound. Also, the AST, ALT, urea and creatinine values were insignificantly improved with increasing the level of RDL and LDL in the tested rations based on control one, being insignificant differences among them. The obtained results are in agreement with those recorded recently by Sahraei *et al.* (2014) who showed that the supplementation with rosemary essential oil had no significant effect on plasma concentrations of total protein and albumin. The glucose, total lipids, tri-glyceride, total cholesterol and LDL-c values were almostly significant (P≤0.05) decreased with increasing the level of RDL and LDL up to 1% in the tested rations. The obtained results are in agreement with those recorded by Abdel-Azeem *et al.* (2018) who reported that the supplemented bay laurel leaves into rabbits diets showed a significant decrease in blood plasma glucose, cholesterol, triglycerides, total lipids, low-density lipoproteins, AST and ALT as compared to those of control one. While, Sahraei *et al.* (2014) showed that the supplementation of sheep rations with rosemary essential oil had no effect on plasma concentrations of glucose.

Table (5): Blood parameters of lambs fed the experimental rations.

Item	R1	R2	R3	R4	R5	±SE
Total protein, g/dl	6.52	6.53	6.56	6.55	6.59	±0.028
Albumin, g/dl	3.52	3.33	3.27	3.30	3.31	±0.137
Globulin, g/dl	3.00	3.20	3.29	3.25	3.28	±0.142
ALT, IU/L	22.28	20.84	20.69	20.23	20.18	±0.831
AST, IU/L	34.61	32.95	35.49	34.66	32.94	±0.964
Urea, mg/dl	33.66	33.61	33.56	33.59	33.55	±0.410
Creatinine, mg/dl	1.18	1.13	1.04	1.16	1.09	±0.058
Glucose, mg/dl	60.61[a]	60.02[a]	57.26[ab]	58.13[a]	54.11[b]	±1.16
Total lipid, mg/dl	373.17[a]	342.83[b]	333.33[b]	330.50[b]	327.50[b]	±8.94
Tri-glyceride, mg/dl	68.25[a]	66.21[ab]	64.58[b]	64.90[ab]	62.81[b]	±1.15
Total cholesterol, mg/dl	133.65[a]	123.36[ab]	118.12[b]	124.29[ab]	119.51[b]	±3.57
HDL-c, mg/dl	72.51	72.65	73.18	72.97	75.33	±1.55
LDL-c, mg/dl	47.49[a]	37.46[ab]	32.03[b]	38.34[ab]	31.62[b]	±4.41
TAC, mmol	0.665[c]	0.810[b]	0.883[b]	1.08[a]	1.17[a]	±0.046

a, b and c mean in the same row with different superscripts are significantly (P≤0.05) different. SE=standard error.

The content of TAC was significantly increased with increasing the level of each RDL and LDL in the tested rations in comparison with that of control one. The obtained results are in agreement with those recorded by Basyony and Azoz (2017) who reported that dietary supplementation of bay laurel leaves improved significantly the antioxidant status of doe rabbits during the pregnancy and lactation periods as well as their offspring's. Similarly, Abdel-Azeem *et al.* (2018) showed that bay laurel leaves markedly increased seminal plasma total antioxidant capacity (TAC) for New Zealand White rabbit's bucks.

Likewise, plasma total antioxidant capacity was substantially higher in the rabbits receiving bay leaves in their diets compared with those have no receive it (Casamassima *et al.*, 2016).

Growth performance and economic efficiency:

The measurements of growth performance including daily feed intake, total body weight gain, daily gain, feed conversion and economic efficiency are presented in Table (6). Final live body weight, total body weight gain and daily body weight gain were significantly ($P \leq 0.05$) increased only with the higher level (1%) of RDL and LDL in tested rations (R3 and R5) in comparison with control one (R1), while the other tested rations (R2 and R4) whose have the low level of either RDL or LDL did not differ significantly with control one (R1) respecting to the mentioned growth performance items. The improvements of growth performance for lambs fed the higher level of RDL and LDL in ration (R3 and R5) might be indicated that such level (1%) could be considerably compatible with the metabolic process needs for animals. The insignificant highest relative daily body weight gain were resulted by feed additives (RDL and LDL) at its high level (1%) compared with the control one and low level (0.5%) rations. The results of the current study are in harmony with those obtained by Biricik *et al.* (2012) who found that a significant increase in live body weight by supplementing essential oils to quail diets, and with the results of Ozek *et al*. (2000) who fed a broiler diet supplemented with essential oils of bay laurel (*Laurus nobilis L.*) that contained linalool, cineole, methyl eugenol in its leaf powder. Also, Badawi *et al.* (2016) and several previous studies showed that adding medicinal plants and herbs to the diets of rabbits, chicks, sheep, cows and buffaloes could be improved their feed intake and nutrients digestibilities (Mir *et al.*, 1998, Aboul-fotouh *et al.*, 1999 and EL-Ayek, 1999), feed conversion (Allam *et al.*, 1999, Aboul-fotouh *et al.*, 1999 and Salem and El-Mahdy, 2001), growth performance and mortality rate (Ibrahim *et al.*, 2004, Ibrahim, 2005, Tipu *et al.*, 2006 and Bakr *et al*., 2016). Concerning feed intake, the quantity of TDMI and TDNI were markedly insignificantly higher in all tested rations (R2 up to R5) than those of control one (R1), where R3 and R5 rations that had 1% RDL or LDL, respectively were represent the best ones among all the experimental rations. Considerably, this trend of feed intake among the dietary treatments might be attributed to the clear differentiation in palatability between RDL and LDL supplements. Concerning feed conversion measurements, its values were slightly affected by the dietary treatments, being an insignificant improvement (DM: gain or TDN: gain) respecting all tested rations compared with those of control one. Likewise, results obtained by Çabuk *et al.* (2006) indicated that the supplementation of a mixture of herbal essential oils to the diet of broilers could be improved feed conversion ratio. Much longer, the herbal essential oil mixture might be considering as a potential growth promoter for innovative nutritional management. These could be interpreted that essential oil and their mixture could positively affect the intestinal microflora and thus digestibility state accordingly. Abdel-Azeem *et al.* (2018) reported that the supplemented diet of bucks with bay laurel leaves could be caused an insignificant positive effect on body weight bucks; however, feed intake was significantly ($P \leq 0.05$) increased compared with the group of bucks that given the control diet. The increase in feed intake of group fed diet including bay laurel leaves compared to the control one may be due to the stimulating effect of bay laurel leaves on the gastrointestinal system by enhancing diet palatability and appetite. Data of economic efficiency that presented in Table (6) showed that daily feed cost (L.E.) was somewhat increased with increasing the level of both RDL and LDL in tested rations compared with that of control one. While, feed cost per kg gain and the price of daily weight gain were considerably the best with ration (R3 and R5) that have 1% of RDL or LDL, respectively compared with those of R2, R4 and R1 rations. The favorable economic values were occurred with R5, followed by R3 in comparison with the lowest one (R1). Ultimately the whole outcomes were obviously reflected on economic efficiency, where the highest profitability being associated with R3 and R5 and the moderate ones are placed with the R2 and R4-ration, while the lowest values were outputted by R1 ration. The highest economical return and relative economical return (LE) were resulted by feed additives (RDL and LDL) that supplemented at 1% level, compared with the control one. The present results are in harmony with those recorded by Fayed and Azoz (2018) who showed that the bay laurel leaves (*Laurus nobilis* L.) supplemented into the diets of rabbits at different levels had the best economic return over the control diet that free from such supplement. Likewise, Allam and El-Elaime (2020) reported that the supplementing rosemary leaves into the diet of growing lambs had increased the economic efficiency based on the control ration.

Table (6): Growth performance, daily feed intake, feed conversion and economic efficiency of lambs fed the experimental rations.

Item	R1	R2	R3	R4	R5	±SE
Growth performance:						
Initial body weight, kg	20.83	20.50	20.83	20.67	20.50	±0.542
Final live body weight, kg	41.67^{b}	43.67^{ab}	45.83^{a}	44.67^{ab}	46.50^{a}	±1.18
Total body weight gain, kg	20.84^{b}	23.17^{ab}	25.00^{a}	24.00^{ab}	26.00^{a}	±1.09
Daily body weight gain, kg	0.149^{b}	0.166^{ab}	0.179^{a}	0.171^{ab}	0.186^{a}	±0.008
Relative daily body weight gain, %	100	111.41	120.13	114.77	124.83	
Daily feed intake (as fed):						
Av. CFMI, kg	0.641	0.670	0.701	0.690	0.722	
Av. CLH, kg	0.427	0.445	0.463	0.458	0.477	
TDMI, kg	1.068	1.115	1.164	1.148	1.199	
TDNI, kg	0.696	0.742	0.784	0.767	0.812	
TDCPI	0.096	0.100	0.106	0.104	0.111	
Feed conversion:						
DM, kg/ gain, kg	7.17	6.72	6.50	6.71	6.45	
TDN, kg/ gain, kg	4.67	4.47	4.38	4.49	4.37	
DCP, kg/ gain, kg	0.644	0.602	0.592	0.608	0.597	
Economic efficiency, L.E/h/d:						
Price of daily gain, L.E.	8.05	8.96	9.67	9.23	10.04	
Daily feed cost, L.E.	4.10	4.35	4.61	4.41	4.59	
Relative feed cost, %	100	106.10	112.44	107.56	111.95	
Feed cost / kg gain, L.E.	27.52	26.20	25.75	25.79	24.68	
Economical return, L.E.	3.95	4.61	5.06	4.82	5.45	
Relative economical return, %	100	116.71	128.10	122.03	137.97	
Economic efficiency, L.E. *	1.96	2.06	2.10	2.10	2.19	
Relative economic efficiency, %	100	105.10	107.14	107.14	111.73	

a and b mean in the same row with different superscripts are significantly ($P \leq 0.05$) different. SE=standard error.

Based on prices of the Egyptian market during the experimental period (2019). The price of one ton of CFM, clover hay and one kg of rosemary, laurel and live body weight were 4800, 2400, 24, 25 and 54 L.E., respectively.

**Economic efficiency (%) = Price of daily gain (L.E) / Daily feed cost (L.E).*

CONCLUSION

In conclusion, rosemary or laurel dry leaves could be used as a natural feed additives in rations of growing lambs with positive effect on nutrient digestibility, some blood parameters, growth performance and economic efficiency, when it adding at 1% level of concentrate feed mixture.

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تأثير أوراق إكليل الجبل أوالغار كإضافات غذائية على أداء الحملان النامية

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تم إختيار ٣٠ ذكر من الحملان الرحماني الخليط (رحماني × فنلندي) بعد الفطام بعمر٣ أشهر وقسمت عشوائيًا إلى خمس مجموعات متشابهة (٦ حملان لكل مجموعة) وفقًا لوزن الجسم الحي (٦٦, ٢٠± ١٦٥., كجم) وتم تغذيتها علي العلائق التجريبية لمدة ٢٠ أسبوعًا كفترة تجريبية لبحث تأثير الأعشاب الطبية لإكليل الجبل أو الغار كإضافات غذائية لعلائق الحملان على وظائف الكرش وقابلية الهضم وبعض مقاييس الدم وأداء النمو للحملان النامية. تم إضافة أوراق إكليل الجبل أوالغار الجافة إلي خليط العلف المركز عند مستويات ٠، ٥,٠، ٥,١، و ١٪ في علائق الحملان (العلف المركز١، العلف المركز٢، العلف المركز٣ ، العلف المركز٤، العلف المركز٥ على التوالي) . تم توزيع كل مجموعة عشوائيا لتغذيتها علي إحدي العلائق التجريبية وهي ر١ (الكنترول): ٦٠٪ علف مركز١+ ٤٠٪ دريس برسيم (عليقة كنترول)، بينما العلائق المختبرة ر٢: ٦٠٪ علف مركز٢+ ٤٠ ٪ دريس برسيم ، ر٣: ٦٠٪ علف مركز٣ +٤٠٪ دريس برسيم، ر٤: ٦٠٪ علف مركز٤ +٤٠٪ دريس برسيم، ر٥: ٦٠٪ علف مركز٥ +٤٠٪ دريس برسيم. تم حساب العلائق وفقا لمقررات NRC (2007) للأغنام. تم إجراء خمس تجارب هضم لتقييم مدي قابلية الهضم والقيمة الغذائية للعلائق التجريبية. أشارت نتائج التحليل الكيماوي إلي إحتواء أوراق إكليل الجبل أوالغار الجافة علي (٦,٢٣, ٨,٢٥)، (٢٢,٧٢, ٢٣,٨٦)، (٨,٤٨, ٨,٤١)، (٥٣,٦١, ٥٤,٥٤)، (٨,٩٦, ٤,٩٤)٪ لكل من البروتين الخام والألياف الخام ومستخلص الإثير والكربوهيدرات الذائبة والرماد علي التوالي. كان محتوى الزيت العطري في أوراق الغار ضعف المحتوي الموجود في أوراق إكليل الجبل تقريبا (٣,٠, ١,٦٪، علي التوالي). تحسن نتائج معاملات هضم معظم العناصر الغذائية والقيمة الغذائية (البروتين الخام المهضوم) مع زيادة مستوى أوراق إكليل الجبل أوالغار الجافة في العلائق، بينما زادت قيم مجموع المركبات الكلية المهضومة بصورة معنوية مع زيادة مستوى أوراق الغار الجافة في العلائق مقارنةً بالكنترول. انخفضت قيم درجة الحموضة في سائل الكرش بعد ٣, ٦ ساعات من التغذية مع زيادة مستوي أوراق إكليل الجبل أوالغار الجافة حتي مستوي ١٪ في العلائق. بينما حدث العكس في تركيز الأمونيا و الأحماض الدهنية الطيارة الكلية حيث زادت قيمها مع زيادة مستوي النباتات الطبية في العلائق المختبرة خلال أوقات أخذ العينات الثلاثة. لم توجد اي فروق معنوية بين المعاملات في معظم خصائص الدم بإستثناء الجلوكوز والدهون الكلية والدهون الثلاثية والكوليسترول الكلي والكوليستيرول عالي الكثافة والكوليستيرول منخفض الكثافة والتي تحسنت بشكل ملحوظ مع زيادة مستوى أوراق إكليل الجبل أوالغار الجافة في العلائق. كما زادت القدرة الكلية لمضادات الأكسدة في بلازما الدم بصورة معنوية مع إضافة مستويين من كل من أوراق إكليل الجبل أوالغار الجافة الي العلائق الاربعة المختبرة مقارنة بالعليقة الكنترول. إرتفاع معدل الزيادة الكلية واليومية لوزن الجسم بصورة ملحوظة بين العلائق المختبرة والتي تحتوي علي نسبة عالية من النباتات الطبية (ر٣ , ر٥) مقارنة بالعليقة المقارنة، في حين أن العلائق الأخرى التي تم اختبارها والتي تحتوي على مستوى منخفض من النباتات الطبية (ر٢ , ر٤) كانت ضئيلة. زيادة إجمالي كمية المادة الجافة المأكولة ومجموع المركبات الغذائية الكلية المهضومة المأكولة بصورة ملحوظة مع زيادة نسب النباتات الطبية (أوراق إكليل الجبل أوالغار الجافة) في العلائق الأربعة المختبرة، مقارنة بالعليقة الكنترول، حيث يبدو أن المستوى المرتفع (١٪) من النباتات الطبية كان أكثر تأثيراً من المستوي المنخفض على الغذاء المأكول. بينما تحسنت الكفاءة الاقتصادية بشكل ملحوظ مع العلائق التي تحتوي على النباتات الطبية وخاصة مع ١٪ من أوراق الغار الجافة مقارنة مع الكنترول والعلائق التجريبية الأخري. يمكن الاستنتاج أنه يمكن التغذية على العلائق المحتوية علي أوراق إكليل الجبل أوالغار الجافة (١٪ إضافة الي العلف المركز) ويمكن التوصية بها للحملان النامية لما لها من تأثير إيجابي علي أداء النمو والحالة الصحية بالإضافة إلي زيادة الربحية.