EVALUATION OF MEDICINAL PLANTS (*QUERCUS INFECTORIA* AND *ASTRAGALUS ERIOCEPHALUS*) AS FEED ADDITIVES IN AWASSI EWE'S RATION

1. DIGESTIBILITY, MILK YIELD AND COMPOSITION

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ABSTRACT

To evaluate the impact of two medicinal plants *Quercus infectoria* and *Astragalus eriocephalus* on digestibility, milk yield, its compositions and economic efficiency, twenty eight lactating Awassi ewes at their mid-lactation were selected based on their pre-treatment milk yield, were divided into four groups and fed ration containing 1% Gall oak, 2% Astragalus, 0.5% Gall oak with 1% Astragalus, and Control. Twelve ewe lambs were used to study the effect of rations on the digestibility. Herbal active compounds were obtained by GC-MS analysis. Results revealed that fifty-six and twenty-four compounds identified in *Astragalus eriocephalus* and *Quercus infectoria* samples, with the major compound being P-Cymene and Carvacrol, respectively. Ewes fed Astragalus diets showed significantly (P<0.05) higher digestibility dry and organic matter. Daily and 0.4 FCM milk yield in treated groups were significantly (P<0.05) higher than control. Milk composition were significantly (P<0.05) affected by diet treatment. Economic and relative efficiency were better in treated groups than the control. It can be concluded that supplementing herbal plants to the lactating ewes' diet improve their digestibility, milk yield and economic efficiency.

Keywords: **Gall oak, Astragalus, digestibility, milk production, sheep.**

تقييم النباتات الطبية (*Quercus infectoria* و *Astragalus eriocephalus*) كاضافة علفية في عليقة النعاج العواسية

1. الهضم, انتاج الحليب ومكوناته

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المستخلص

يهدف البحث دراسة تاثيراضافة كل من العفص والكثيراء في انتاج الحليب ومكوناته ومعامل الهضم والكفاءة الاقتصادية فلقد تم توزيع 28 نعجة عواسية اعتماداً على انتاج الحليب الى اربع مجاميع حيث غذيت نعاج المجاميع الاربعة على علائق حاوية على 1% العفص, 2% الكثيراء, 0.5 العفص+1% الكثيراء ومجموعة السيطرة. كما تم استخدام 12 فطائم عواسي لدراسة تاثير العلائق انفة الذكر في معامل الهضم. اتضح من النتائج وجود 56 و 24 مادة فعالة في كل من نباتي العفص والكثيراء وكانت اعلاهما مادتي P-cymene و Carvacrol على التوالي. كما وجد تأثير معنوي على هضم كل من المادة الجافة والعضوية اذ كانت اعلاها في مجموعة المغذاة على الكثيراء. كما تفوقت المجاميع المعاملة معنوياً في انتاج الحليب وتركيبه مقارنة بالسيطرة وعليه فلقد كانت الكفاءة الاقتصادية للمجاميع المعاملة افضل مقارنة بالسيطرة. ويمكن ان نستنتج بان اضافة النباتات الطبية لعليقة النعاج الحلوبة يعمل على تحسين كل من معامل الهضم وانتاج الحليب والكفاءة الاقتصادية.

الكلمات المفتاحية: العفص, الكثيراء, معامل الهضم, انتاج الحليب, الاغنام

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INTRODUCTION

In recent years, natural additives like herbs and spices have been attracted the concern of scientist for their potential role in treating disease, alternating growth, and improve animal productivity. This is due to the fact that antibiotics used in ruminant ration to make resistant antimicrobial strains and many other common strains between human and animals, persisting of drug residues in animal products, imbalance the microbial population of digestive tracts, so it become doubted using chemicals in ruminant nutrition (14). However, using medicinal plants and herbs have been encouraged by the World Health Organization (WHO) to minimize or substitute the use of these chemicals through global trend and go back to nature (2). In farm animals, the beneficial effects of medicinal plants to improve feed intake, digestibility, immune stimulation and antibacterial (19). However, traditional growth promoters have been replaced by medicinal plants as feed additives due to its beneficial effect on animal performance (7). These plants are supplied in the form of dried plants and/or extract (10). *Cuminum cyminum*, *Leptadenia reticulata*, *Asparagus racemosus*, *Nigella sativa*, Chamomile flowers and many others are known for galactogogue effect (19; 12). EL-Ghousein (7), observed an increase in milk yield of ewes fed Chamomile flowers and Nigella sativa seeds. Also, Merkhan et al. (17) found an increase in daily and total milk yield, fat and protein yield of milk from goats fed oak acorns. It is well known that *Astragalus eriocephalus* contain bioactive compound a polysaccharide (24) and *Quercus infectoria* is rich in tannins contents (9). Moreover, due to their high proportion of these active compounds, they have been classified as medicinal plants (6; 24). This study aims to evaluate the effect of (*Astragalus eriocephalus* and *Quercus infectoria*) on ewe's performance: i.e. digestibility, milk yield, milk composition and economic efficiency.

MATERIALS AND METHODS

Location

This study was conducted at the animal farm, Department of Animal Production, College of Agriculture, University of Duhok, Iraq.

Herbal selection

Collection and supplement preparation

Both *Quercus infectoria* acorn and *Astragalli radix* whole plant were collected from Ora Village Mountains located in Duhok city of Kurdistan Region-Iraq. *Astragalli radix* was cut into small pieces and exposed to air for several days. Afterwards, both of them were grinded separately by a mechanical grinder.

Gas chromatography–mass spectrometry (GC–MS) analysis

Both plants were analyzed by the mass selective detector 5975C Agilent grouped to 7890A Agilent gas chromatography, equipped with a capillary column DB-5 (30 m×0.25 mm, 0.25_m film thickness, Agilent Technologies). The used carrier gas was Helium (flow rate, 1.2 mL/min) and 250 ^{o}C as an injector. After that, 40 ^{o}C for 2 min was used in the oven and it was increased by 5 ^{o}C/min to 150 ^{o}C and held for 1 minute, then raised by 10 ^{o}C/min to 250 ^{o}C and maintained for 5 min. Electron impact ionization mode at 70eV was used for mass spectra measurement, 150 oC and 230 ^{o}C were the temperature of the quadrupole mass detector and ion source, respectively and 280 ^{o}C for transfer line. For scanning the mass spectra with no solvent delay, 29-300 amu with 4.37 scan/s were used as the m/z range. The Retention Index (RI) of the volatile compounds was calculated by running the mixture of n-alkanes following the same samples conditions. The mass spectra of the samples were compared with the data system library (NIST 11), retention index (RI) and authentic references for tentative volatile compounds identification.

Chemical analysis

Samples from each plant used were analyzed for crude protein (CP), crude fiber (CF), ether extract (EE), dry matter (DM) and ash contents according to AOAC (3), and by related formula Organic Matter (OM) were calculated (Table 1).

Table 1. Chemical composition of the herbal plants

Chemical composition %	*Astragalus eriocephalus*	*Quercus infectoria*
Dry matter	**80.47**	**90.10**
Crude protein	**8.75**	**3.5**
Crude fiber	**35**	**18.5**
Ether Extract	**5.58**	**8.14**
Ash	**5.20**	**6.10**
Organic matter	**94.80**	**93.90**

Apparent digestibility

Design and sample collection:

Twelve yearling ewes were placed into separate cages (3 for each treatment), fed 1 kg/head/day for eight days an experimental ration (Table 2) for adaptation. Then, ewes were separated into individual cages for five days and fed twice (1 kg/head. day) on experimental rations only. During these days, residual feed were weighed as well as faeces samples were collected directly from rectum for feed digestibility by acid insoluble ash (AIA) method (23). Faeces samples were stored in a refrigerator until analysis.

Feed digestibility

Feed digestibility was measured according to Van Keulen and Young (23) by AIA method. About 5 g of both experimental rations and faeces samples were weighed by an electronic balance in the pre-weighed furnace crucibles. Then, they were put in an oven for 2 h at 135 °C. Next, the crucibles were transferred to desiccators for cooling and re-weighed. After that, they were moved to muffle furnace and heated for 4 hrs at 550 ^{o}C. For each sample, an equal amount of ash was put into a beaker and 100 ml of HCl (2 N) was added and boiled for 5 minutes. Then, a flask with filter paper was used for filtration to separate the ash from acid. Hot deionised water (~ 80 °C) was used to wash the filter paper from any remaining acids. The filter papers, containing the residual, were put into crucibles and transferred to muffle furnace for 4 hrs at 550 ^{o}C. Finally, the sample was cooled, re-weighed and the AIA were calculated as follows.

$$\mathbf{AIA} = \frac{\left(\mathbf{weight\ of\ crucible\ (g) + ash - weight\ of\ crucible\ (g)}\right)}{\left(\mathbf{weight\ of\ dry\ smaple\ (g)}\right)} \mathbf{X\ 100} =$$

Digestibility (kg/ kg$^{)}$ of DM was calculated as follow:

$$\mathbf{Digestion\ coefficient}\left(\frac{\mathbf{kg}}{\mathbf{kg}}\right)\mathbf{of\ DM} = \mathbf{1000} - \mathbf{1000x}\frac{\mathbf{DM\ indicator\ in\ feed\ (kg)}}{\mathbf{DM\ indicator\ in\ faecal\ (kg)}}$$

The following equation was used to calculate the faecal DM output (g/d) for each ewe:

Faecal DM output (g/d) = DM Intake (kg) – (DM Intake (kg) x digestibility (kg/kg))

Samples of the feces and feedstuff were analyzed according to AOAC (3) techniques to determine CP, CF, Ash content, and OM.

Study design

Management and feeding: wenty eight lactating Awassi ewes with body weight (48.87±1.17 kg) at their mid- lactation were selected based on their pre-treatment milk yield were divided equally into four groups. The ewes were fed for 8 weeks on the following treatments: Control group was without any supplement, Astragalus group was supplemented with 20 g (2%) of *Astragalus eriocephalus* per a kilogram of concentrate, Gall oak group was supplemented with 10 g (1%) of *Quercus infectoria* per a kilogram of concentrate, Mixture group was supplemented with a 10 g (1%) and 5 g (0.5%) of Astragalus and Gall oak, respectively per a kilogram of concentrate. Ewes were fed the experimental rations at 8:00 a.m. and 8:00 p.m. (750 g/head.day); to meet the animal requirements as recommended by NRC (21). Also, they were allowed to graze on natural pasture with free availability of water and hay, the feedstuffs and chemical composition of ingredients are shown in Table (2).

Table 2. Formulation and chemical composition of experimental diets

Ingredients, Kg	Experimental diets [1]			
	Control	Astragalus group	Gall oak group	Mixture group
Gall oak	-	-	10	5
Astragali	-	20	-	10
Wheat	100	100	100	100
Barley	550	550	550	550
Corn	200	200	200	200
Soybean	140	140	140	140
Vitamin-mineral premix[2]	10	10	10	10
Chemical composition/ as DM				
Dry matter %	89.62	89.33	91.46	89.34
Crude Protein %	16.14	16.5	16.19	16.31
Crude fiber %	24.3	33	25.1	28
Ether Extract %	5.75	6.81	8.15	6.61
Ash %	4.61	4.59	4.30	4.51
Organic matter %	95.39	95.41	95.7	95.49

[1]Ewes were fed a basal diet (CON) or basal diet supplemented with either 2% *Astragalus eriocephalus* (Astragal group), 1% Quercus infectoria (gall oak group), or 1% *Astragalus eriocephalus* + 0.5% Quercus infectoria (Mixture group).

[2]Vitamin-mineral premix: contained 500000 IU of vitamin A, 100000 IU of vitamin D3, 250 Mg of vitamin E, 11 Mg of vitamin B1, 18537 Mg of vitamin B2, 9.8 Mg of vitamin B6, 1 Mg of vitamin B12, 11 Mg of vitamin K3, 12 Mg of vitamin C, 1200 Mg of Niacin (vitamin B3), 5000 Mg of Iron (Fe), 1000 Mg of Copper (Cu), 5000 Mg of Zinc (Zn), 5000 Mg of Manganese (Mn), 15000 Mg of Magnesium (Mg), 80 Mg of Iodine (I), 10 Mg of Cobalt (Co), 10 Mg of Selenium (Se), 2700 Mg of Phosphor (P), 5400 Mg of Calcium (Ca), 35000 Mg of Sodium (Na) and 100 Mg of Antioxidant (BHT).

Milk yield, sampling and analysis

Milk yield was determined for each animal at weekly intervals by hand milking using a graduated cylinder. A sample of 50 ml of milk from each ewe was collected to determine milk components (fat, protein, lactose, solid non-fat (SNF) and total solid (TS)) by using EKO MILK TOTAL (Eon Trading LLC, U.S.A.). Fat Corrected Milk (4% fat) was measured according to Gaines (11) by using the following formula:

4% FCM = 0.4 X milk yield (L) + 15 X fat yield (L).

Economic efficiency

The estimation of feed and production costs was calculated according to the local market prices, feed costs including the basal ingredient and used medicinal plants. Subsequently, the economic efficiency (EE) for each treatment was computed according to the following equation described by Hussen (13):

$$\mathbf{EE} = \frac{\mathbf{Net\ revenue}}{(\mathbf{Total\ revenue} - \mathbf{Net\ revenue})}$$

Where:

Net revenue= Total revenue – total cost

Total revenue= Total milk yield (L) × price of milk unit (price/L),

Total cost= total feed quantity unit (Kg) × price of feed unit (price/Kg)

Also, relative economic efficiency (EE %) was calculated according to following (13),

$$\mathbf{EE}\ \% = \frac{\mathbf{Net\ revenue\ of\ each\ treatment}}{\mathbf{Net\ revenue\ of\ Control\ group}} \times \mathbf{100}$$

Statistical analysis

Data were analyzed as a completely randomized design by ANOVA using the General Linear Model (GLM) procedures of SAS (22). The model included the fixed effect of treatment. Treatment means were calculated using Duncan's option of the same software.

RESULTS AND DISCUSSION

Volatile Compounds' Proportions in the supplemented plants

Fifty six compounds were identified in the *Astragalus eriocephalus* sample by GC-MS. Among them, the major compounds were p-Cymene (24.52%), hexanedioic acid (22.78%), and gamma-terpinene (17.48%), respectively (Table 3a), whereas, twenty-four compounds were identified in the *Quercus infectoria*

sample being Carvacrol (64.03%) was the most abundant component, followed by 2-nonanone (6.12%) and beta-Caryophyllene (5.09%) (Table 3b). Poor smallholder farmers have always used medicinal plants in livestock as a resource of therapy (20). Due to the presence of 56 and 24 volatile compounds in *Quercus infectoria* and *Astragalus eriocephalus*, respectively, and most of them have parasitism, antioxidant and antimicrobial properties (20). Therefore, they may be used as medicinal plants in the rations of animal.=

Table 3a. The volatile compounds detected in *Astragalus eriocephalus* samples analyzed by GC-MS

seq.	retention time	% peak area	Identified Compound	Quality
1	17.480	24.52	P-Cymene	93
2	18.252	17.48	Gamma-Terpinene	91
3	20.135	4.64	Nonanal	58
4	20.593	1.29	Thiazole	43
5	23.168	2.52	Decanal	76
6	25.536	0.48	Thiocyanic Acid	38
7	26.080	0.81	1-Octadecanol	49
8	26.223	0.17	4-Cyanothiophenol	49
9	26.887	1.84	Carvacrol	81
10	27.579	0.15	Dichloroacetic Acid	27
11	28.020	1.18	Octadecen	50
12	28.283	0.35	4-Methylene-1,3-Dioxolane	30
13	28.523	0.42	Cyclopropane, Nonyl-	49
14	29.273	1.21	Oxirane, Tetradecyl-	58
15	29.393	0.29	Carbonic Acid	38
16	29.570	0.44	2-Sec-Butyl-3-Methyl-1-Pentene	35
17	30.040	1.20	2,6,10,10-tetramethylbicyclo [7.2.0] undeca-1,6-diene	38
18	30.755	0.15	1-Dodecanol, 3,7,11-Trimethyl-	46
19	31.745	0.50	Pentafluoropropionic Acid	68
20	31.962	0.30	Unknown	49
21	32.294	0.16	Tetradecanal	52
22	32.426	0.72	Oxirane, Dodecyl-	83
23	32.752	0.43	Dodecyl Fluoride	49
24	32.992	0.19	Pyridinium	53
25	33.685	0.24	3-Eicosene, (E)-	53
26	33.685	0.24	Tetradecanal	80
27	35.779	0.16	1-Chlorooctadecane	86
28	36.546	0.16	Cyclohexanone	50
29	36.929	1.75	Diethyl Phthalate	74
30	37.089	0.13	Trifluoroacetic Acid	43
31	37.221	0.14	2-Propenoic Acid	58
32	37.638	0.36	Oxirane, [(dodecyloxy)methyl]	43
33	37.890	0.17	(9z)-Octadecenoic Acid	49
34	38.199	1.61	Tetradecanal	80
35	38.531	1.21	Oxalic Acid	72
36	38.989	1.09	Benzoic Acid	35
37	39.899	0.23	2-Hexyl-1-Decanol,	87
38	40.236	0.12	Oxirane, [(Dodecyloxy)Methyl]-	47
39	40.557	0.28	1-Heptadecanol	43
40	40.780	0.70	Bicyclo(3.3.1)nonane-2,6-dione	72
41	41.037	0.61	Tritetracontane	87
42	41.175	0.37	1-Hexacosanol	38
43	41.363	0.28	6-Octenal, 3,7-Dimethyl-, (R)-	43
44	42.405	0.26	2-Nonenal	43
45	42.657	0.36	2,5-Dimethylhexane-2,5-Dihydroperoxide	35
46	42.903	0.39	6-Octenal,3,7-Dimethyl	50
47	42.971	0.32	14 Z -Methyl-8-hexadecenal	68
48	43.212	0.56	2,2-Dideutero Octadecanal	87
49	43.332	0.33	Phthalic Acid	58
50	43.406	0.52	1-Chlorooctadecane	80
51	45.775	0.55	Bicyclo(3.3.1)Nonane-2,6-Dione	43
52	45.901	0.46	1-Bromooctadecane	72
53	49.969	0.42	Citronellal	49
54	50.765	0.38	Benzyl Methyl Ether	68
55	51.503	0.37	E-8-Methyl-9-Tetradecen-1-ol Acetate	43
56	55.514	22.78	Hexanedioic Acid	94

Table 3b. The volatile compounds detected in *Quercus infectoria* samples analyzed by GC–MS

Pk	Retention time	Peak area%	Identified Compound	Quality
1	15.729	1.37	2-Pentylfuran	91
2	17.354	4.45	P-Cymene	93
3	18.127	2.50	Gamma-Terpinene	91
4	19.557	6.12	2-Nonanone	94
5	20.043	1.93	Nonanal	72
6	22.990	0.75	4-Thujanol	52
7	23.156	1.46	Decanal	83
8	25.525	1.18	Cyclohexanone	38
9	26.069	0.47	Tetradecanal	38
10	26.435	0.48	Phenol, 2-Ethyl-4,5-Dimethyl-	74
11	26.835	64.03	Carvacrol	87
12	27.442	5.08	Decanoic Acid	96
13	29.250	0.50	Tetradecanal	53
14	29.994	5.09	Beta-Caryophyllene	97
15	30.726	0.40	2R,4R-p-Mentha-1(7),8-diene, 2-hydroperoxide	50
16	31.779	0.33	Benzenemethanamine	30
17	32.414	0.40	Non-2-En-1-Ol	25
18	35.418	0.41	Octadecanal	72
19	37.427	0.36	Caryophyllene	76
20	37.850	0.36	Naphthalene	42
21	38.188	0.33	Lauraldehyde	64
22	38.268	0.50	Santalene	47
23	40.894	0.44	Trimethylammonium	64
24	55.497	1.06	Hexanedioic Acid	64

Apparent digestibility

Animals fed Astragalus diet showed significantly (P<0.05) higher DM, CF and OM digestibility than those fed Control diet, and there were no differences among treated groups in DM and OM digestibility, except CF was significantly (P<0.05) higher in Astragalus group than Gall oak group (Table 4). Thus, Astragalus and mixture groups resulted in a numerical improvement of CP digestibility compared with Gall oak and Control groups (Table 4). This improve in digestibility may be due to that saliva secretion is stimulated by most of the herbals and this lead to bile acids synthesis in the liver. Moreover, these secretions improve the lipids digestion and absorption. Additionally, pancreatic enzymes such as lipase, amylase and protease are stimulated by these herbal extracts which lead to maximize the gastric mucosa digestive enzymes (20). As a result of these, time of feed passage through gastrointestinal tract will be shortened and digestibility will be accelerated (10). It was also reported that digestibility of various nutrients was improved by feeding herbals due to stimulation the activity of rumen microflora and this increase the cellulytic bacteria community, concentration of total volatile fatty acids (TVFAs), DM, CF and OM digestion (1). Additionally, due to the presence of higher fiber contents and P-Cymene (Table 3a), which is the most abundant active compounds of *Astragalus eriocephalus* plant, the DM, CF and OM digestibility of this group was improved. These findings are similar to those reported by Ahmed et al. (1), Mirzaei et al. (19) and Galbat et al. (12), regarding to DM and OM digestion when using medicinal herbs. Also, Mirzaei et al. (19) found that digestion of CP was not affected by using medicinal plants mixture in dairy goats feeding.

Table 4. Apparent nutrient digestibility of the experimental rations.

Apparent nutrients digestibility (%) DM[1]	Treatments[2]				SEM[3]	P-value
	Control	Astragalus group	Gall oak group	Mixture group		
DM	64.5^{b}	79.8^{a}	72.5^{ab}	75.6^{ab}	2.2	0.05
CP	82.2^{a}	86.8^{a}	81.8^{a}	84.6^{a}	1.3	NS[4]
CF	69.27^{b}	88.58^{a}	70.96^{b}	82.23^{ab}	2.86	0.05
OM	67.57^{b}	81.73^{a}	74.84^{ab}	77.82^{ab}	2.11	0.05
Feces DM output (g day^{-1})	22.75^{a}	14.57^{a}	14.94^{a}	15.03^{a}	1.49	NS

^{a,b}**Means in the same row with different superscripts differ significantly for treatment effect.**

[1]**DM: Dry matter, CP: Crude protein, CF: Crude fiber, OM: Organic matter**

[2]**Ewes were fed a basal diet (Control) or basal diet supplemented with either 2% *Astragalus eriocephalus* (Astragalus group), 1% *Quercus infectoria* (Gall oak group), or 1% *Astragalus eriocephalus* + 0.5% *Quercus infectoria* (Mixture group).**

[3]**Standard error of least squares means**

[4]**NS: no significant**

Milk yield and compositions

The addition of *Astragalus eriocephalus* and *Quercus infectoria* and their mixture resulted in a significant ($P<0.01$) increase in daily (470, 478.51 and 425.08 ml) and 0.4 FCM (0.64, 0.66 and 0.635 L) milk yieldas compared with control (359.09 ml and 0.47 L, respectively) (Table 5). This increase in milk yield may be due to many reasons; firstly the effect of active compounds present in the used plants (Table 3a and 3b). Secondly the growths of several bacteria species are inhibited by Carvacrol (Phenolic compounds) which is the most active compound in the Gall oak (5). Due to this reason, protein bypasses increased in the rumen and the CP digestibility of the Gall oak group was lower than other groups (Table 4). Overall, the DM, CF and OM digestibility of the treated groups were improved (Table 4) and therefore serum glucose, as an energy indicator, was increased (18), and resulted in an increase of milk yield. The third reason that included in other part of same trial, is that the concentration of blood triiodothyronine (T3) ($P<0.05$), thyroxine (T4) ($P>0.05$) and prolactine ($P>0.05$) was increased in ewes fed Gall oak group compared with control and other treated groups, in which these hormones stimulate the release of milk (18). Although there is no previous studies on the effect of *Astragalus eriocephalus* and *Quercus infectoria* on the milk yield and its compositions, the results in this work is compared with other close related plants. For instance, Merkhan et al., (17) observed a significant effect of oak acorn on the milk yield in lactating does being about (36 %). Moreover, these results were in agreement with Mirzaei et al., (19) and Galbat et al., (12) who indicated that there was a significant effect of polyherbal supplements on milk yield. In addition, El-Ghousein (7) observed a significant effect of adding Chamomile flowers and Nigella sativa seeds to basal diet on milk production in Awassi ewes. With the exception of protein, there was a significant effect of used plants on milk components. It appears from Table (5) that fat, SNF, lactose and TS were significantly higher in mixture group than control group. The addition of *Astragalus eriocephalus* and *Quercus infectoria* to ewes' rations increased milk lactose and TS, but the differences with Control group were not significant. Although milk production was higher in Astragalus and Gall oak groups than Mixture group, milk fat and TS were higher in the Mixture group than both Astragalus and Gall oak groups (Table 5). This may be due to the negative correlation between milk fat and milk yields (16); and TS and milk yield (15). The highest level of lactose in milk collected from ewes fed Mixture group would be due to high proportion of phenolic compounds (*Quercus infectoria*) (Table 3b) and polysaccharides contents (*Astragalli radix*) (24), Another explanation for this could be due to that Mixture group had higher glucose and total protein concentrations in the blood (18). In the mammary glands, the high level of glucose and amino acids contribute to a higher lactose synthesis. These results are in agreement with Merkhan et al. (17), who indicated that the addition of oak acorn to the lactating goat diet had a significant effect on lactose and non significant effect on protein. Additionally, Erasmus et al. (8) and Campanile et al. (4), observed no significant effect of polyherbal supplementation on milk protein in lactating goats. Economic efficiency and relative economic efficiency calculated as milk yield was improved in Astragalus group followed by Gall oak group, Mixture group and the least was Control group (Table 5). If the Control is considered as the standard treatment (100%), then the relative economic efficiency of Astragalus, Gall oak and Mixture groups will amount to 166.46%, 165.01% and 140.68%, respectively.

Table 5. Effect of medicinal plants on milk yield, FCM, milk composition and economic efficiencies of lactating ewes

Traits	Treatment[1]				SEM[2]	P-value
	Control	Astragalus group	Gall oak group	Mixture group		
Daily milk yield (ml)	359.09[b]	470.0 [a]	478.51 [a]	425.08[a]	13.67	0.01
FCM 0.4 (L)[3]	0.47[b]	0.64[a]	0.66[a]	0.635[a]	0.02	0.01
Milk composition %						
Fat	6.39[b]	6.57[b]	6.50[b]	7.37[a]	0.09	0.05
Protein	5.31[a]	5.23[a]	5.28[a]	5.41[a]	0.05	NS[4]
SNF[5]	10.42[b]	10.35[b]	10.54[ab]	10.76[a]	0.06	0.05
Lactose	4.28[b]	4.33[ab]	4.38[ab]	4.43[a]	0.02	0.05
Total solid	16.81[b]	16.93[b]	17.04[b]	18.13[a]	0.13	0.05
Economic efficiency (EE)	0.60	0.90	0.86	0.75		
Relative economic efficiency (R%)	100	166.46	165.01	140.68		

[a,b]Means in the same row with different superscripts differ significantly for treatment effect

[1]Ewes were fed a basal diet (Control) or basal diet supplemented with either 2% *Astragalus eriocephalus* (Astragalus group), 1% *Quercus infectoria* (Gall oak group), or 1% *Astragalus eriocephalus* + 0.5% *Quercus infectoria* (Mixture group).

[2]Standard error of least squares means

[3]4% FCM = 0.4 × milk (Lt) + 15 × fat (Lt); (11).

[4] NS: no significant

[5]SNF: Solid non fat

According to the design of the experiment, pretreatment milk yield was almost the same in all groups. As lactation progresses, milk yield of treated groups increased significantly (P<0.05) compared to Control group (Fig. 1). Within the first three weeks of lactation, milk yield was increased in Astragalus and Gall oak groups but not in the Control and Mixture groups which remained steady the same. In the last four weeks, milk yield in the Gall oak group was higher than all groups. Milk yield in both Astragalus and Mixture groups remained steady the same up to the end of the experiment. However, milk yield in the Control group was sharply and significantly decreased compared to other groups. Results presented in Fig. 2a shows that milk protein percentage was similarly increased during the first three weeks to reach its peak in all groups and then gradually decreased until the end of the experimental period. Although milk fat content was steady in the first five weeks and decreased slightly in the last two weeks, milk of treated groups had higher fat content than Control group during the trial period (Fig. 2b).

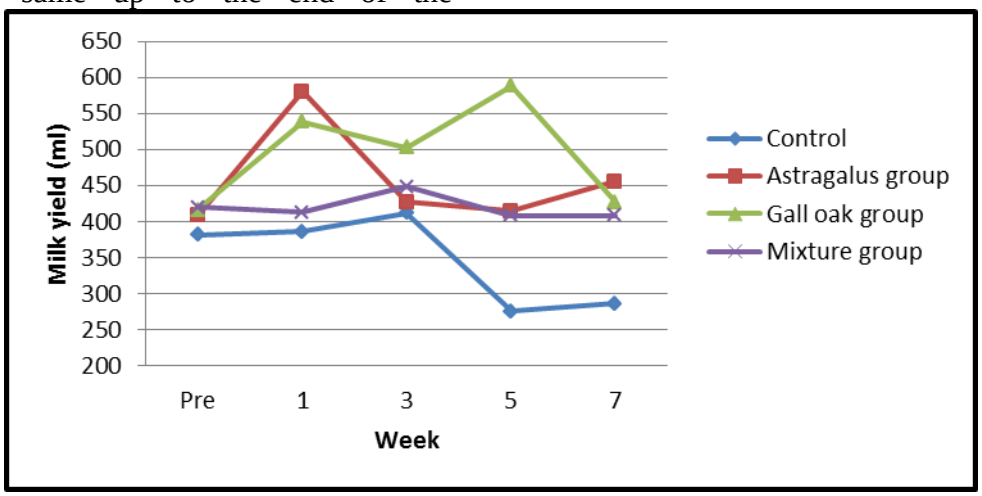

Figure 1. Lactation curve of ewes fed control diet or supplemented with Astragalus sp, Gall oak or a Mixture of Astragalus and Gall oak

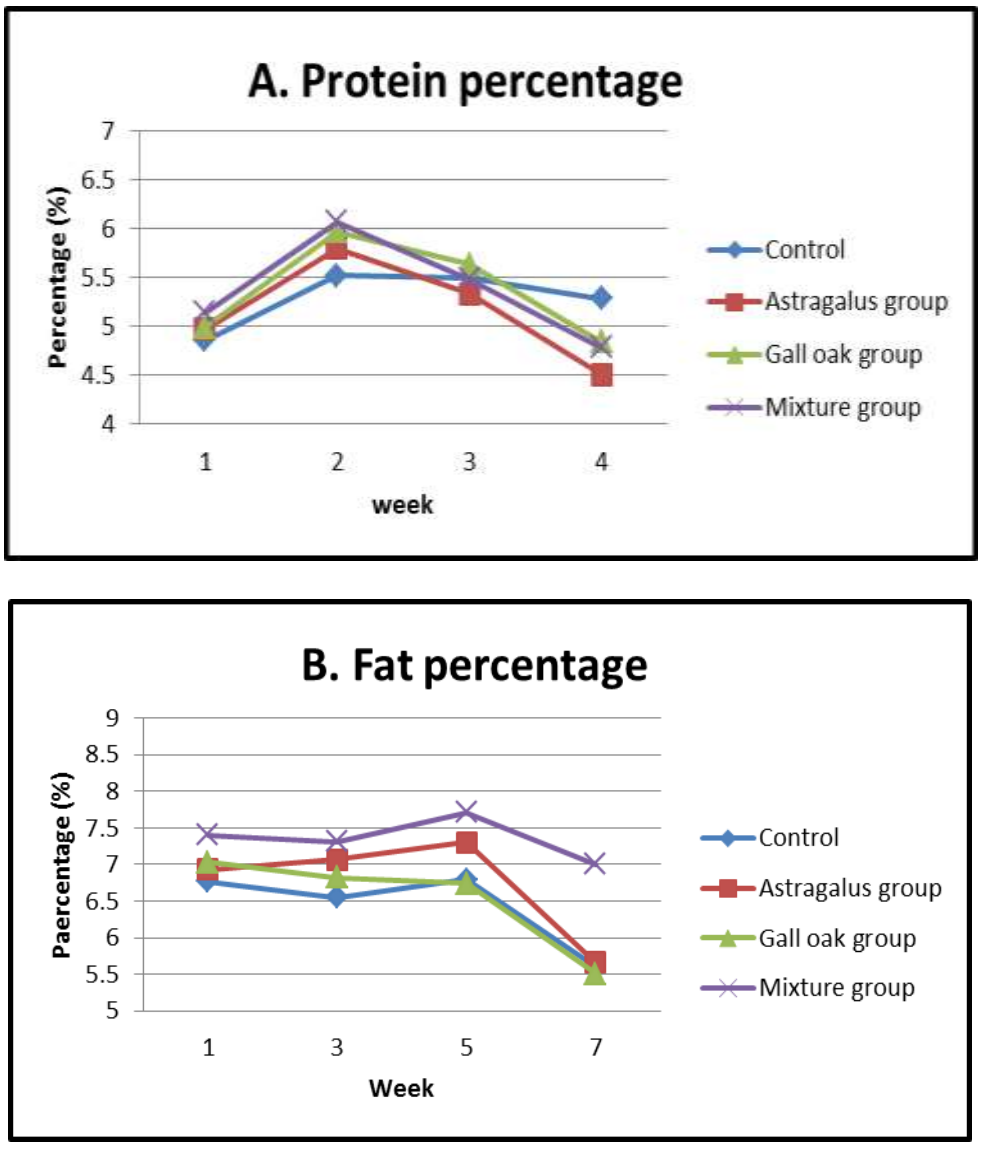

Figure 2. A. Protein and B. Fat percentages of ewes' milk fed control diet or supplemented with Astragalus sp, Gall oak or a Mixture of Astragalus and Gall oak

It can be conclude that lactating ewe's diets supplemented with medicinal plants (*Quercus infectoria* and *Astragalus eriocephalus*) resulted in an improvement of digestibility, milk yield and its composition as well as economical efficiency compared to ewes fed the Control rations. These herbs may have a beneficial effect on ewe's performance as feed additive. Gall oak can be used as a main source for extracting Carvacrol. However, further studies are needed to determine the exact levels of (*Quercus infectoria* and *Astragalus eriocephalus*) in the lactating ewes/does rations.

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