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Effect of Propolis as a Feed Additive on Nutritional and Productive Performance of Pregnant Ewes and their Lambs under Halaib-Shalateen Pastures Condition

Badawy, H. S. *

Animal and Poultry Nutrition Department, Animal and Poultry Nutrition Division, Desert Research Center, P.O. Code 11753 Mataria, Cairo, Egypt.

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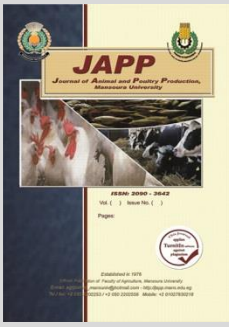

ABSTRACT

Thirty, 3-4 year of age, female Abu-duleik sheep, local breed, in late pregnancy period were chosen to study the effect of feeding two levels from propolis(P)during late pregnancy and postpartum period on nutritional and productive performance. Animals were divided into three equal groups(10 ewes in each).The first group was fed on concentrate feed mixture(CFM)without propolis (P0) as a control ration, while, the second(P1)and third(P2)groups received the control ration supplemented with propolis at the levels of 100 and 200 mg /kg DM, respectively.All animals were fed CFM at 2.5% of live body weight(LBW)and allowed to graze on *Panicum turgidum* as a basal range plant for 8 hours daily. The results could be summarized as follows:Propolis treatments led to significant increases in all nutrients digestibility.Propolis improved ruminal condition represented by a decrease(P<0.05)in pH, ammonia-N and volatile fatty acids concentrations. Propolis treatments showed lower(P<0.05)total bacteria count(X 10^{10}/ml),especially ruminal gram positive bacteria, compared with control treatment.Also, 4% fat correct milk yield and percentage of constituents (fat, protein and total solid) increase(P<0.05)with increasing the level of propolis. Lambs belonging to the P1 and P2 groups recorded a significant increase in the average daily gain, total gain and weaning weight compared to lambs belonging to the control group. Propolis treatments improved ewe's production index represented by weaning weight index percentage at a rate of22.60 and 33.53%for P1 and P2 ewes compared with control ewes. Generally,propolis additive under arid-area rangelands condition improved nutritional and productive performance of pregnant ewes and their lambs beside improved economic efficiency

Keywords: Propolis, rangelands, ewes, digestibility, productive performance

INTRODUCTION

The productivity of small ruminants, especially sheep, was record be low, especially in arid and semi-arid regions, due to several factors including, environment, health conditions, and scarcity of feed which have negative effects on productive and reproductive performance of animals (Abdalla, *et al*., 2019). The routine use of antibiotics for livestock feeding has been criticized and restricted recently (Ozturk *et al*., 2010). As a result, several studies have recently been conducted in order to discover other alternative feed additives that are natural products that are acceptable to consumers. More recently, propolis has been considered among the alternative natural fodder for antibiotics in the diets of ruminants. Propolis (bee glue) is produced by bees where they collect the resinous substance from plant buds and mix it with salivary and enzymatic secretions and beeswax (Castaldo and Capasso 2002). The use of propolis as a natural alternative to the ionophores for ruminant diets was suggested by Stradiotti *et al.* (2004) and Oliveira *et al.* (2006).

Propolis contain more than 300 ingredients, some of which are nutrients such as proteins, amino acids, vitamins, minerals and other natural compounds such as polyphenols, terpenoids, and steroids (Buratti *et al*., 2007). Propolis is a natural source of antioxidant (flavonoids) and has strong antioxidant activity. Propolis always shows great biological activity, especially against the growth of gram positive bacteria, antifungal, antiprotozoal and antioxidant and thus may be a useful additive for modifying microbial fermentation in the rumen. Also, propolis has been used in critical periods of animal life such as flushing, pregnancy and lactating, and to improve productive performance and animal immunity against intestinal parasites (Soltan *et al*., 2014, Aguiar *et al*., 2014, Morsy *et al*., 2011, 2013 and 2015). Furthermore, Mathivanan *et al*. (2013) statement that animal nutritional supplementation with Propolis can increase growth performance and digestion performance. Ozturk *et al.* (2010) and Oeztuerk *et al.* (2010) they suggested that propolis may be a useful additive for reducing rumen ammonia production and for improving nitrogen utilization in ruminants. Selem (2012) stated that Propolis as a natural dietary additive can be used to manipulate rumen fermentation towards less methanogenic and may affect the reproductive and productive performance of the animal. Freitas *et al*. (2009) indicated that the addition of an ethanolic extract of Propolis had a positive effect on milk production and protein level in it. Emtnan *et al.* (2005) reported significant increases in the daily body gain by 21.5% and digestion coefficient of CP by using propolis. It also improves the conception rate, twinning rate, kid's vitality, immune-stimulant and it also protects the liver Baladi does.

* **Corresponding author.**
E-mail address: Hassanein_Sa3d@yahoo.com
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Therefore, the current work aims to study the effect of Egyptian Propolis as an additive on pasture intake, digestion of nutrients, some rumen parameters, milk production and composition, weight of lambs at birth and weaning, and some reproductive characteristics of ewes under dry pastures conditions.

MATERIALS AND METHODS

This study was carried out at Halaib and Shalateen Research Station, Desert Research Center (DRC), Egypt that lies nearly 1300 km southeast of Cairo (Latitude 22º, 00’, 720” N, Longitude 36º, 48', 955" E). The Animal Production Sector in this Station lies in Hadraba valley (Hadraba Research Station), at southeast borders of Egypt. Hadraba Research Station is placed to the south of the main station by 200 km.

Animals and treatments:

Thirty, 3-4 year of age, the females of Abu-duleik sheep, a local breed, were used individually to study the effect of using Egyptian propolis as a feed additive on the nutritional and productive performance of ewes fed on pastures in dry areas in Halaib region. Animals were selected at approximately 60 days before lambing and were randomly divided into three comparable experimental groups (10 animals per group). The first group: the control group received the concentrate feed mixture (CFM) without propolis (P0), while the second (P1) and third (P2) groups received the CFM plus 100 and 200 mg propolis / kg DM, respectively. All animals were fed 2.5% CFM of live body weight and allowed to graze for 8 hours daily. The experimental treatments lasted five months (two months before the expected lambing date and continued until three months into the lactation period).

Supplementary feed was provided to the ewes daily after grazing time. The ewes of all groups were kept under the same administrative and hygienic conditions, and the animals were allowed to drink water (desalinated seawater) ad lib at 08.00 a.m. (before grazing), 4.00 p.m. after coming back from grazing. Animals were weighed at the beginning of the experiment and monthly throughout the whole experimental period. Animals were weighed at 7.00 a.m. after fasting period of 12 hours.

Reproductive performance:

The reproductive performance of ewes was evaluated for all groups by calculating the following indicators: 1) The number of pregnant ewes, the number of aborted ewes and the number of lambing ewes; 2) Prolificacy to the number of lambs born and weaned relative to the number of pregnant ewes, and 3) growth performance of lambs (birth weight, biweekly weight, and weaning weight at week 12 after lambing was recorded using the digital balance).

Milk yield and milk composition

Milk production was recorded every two weeks for individual ewes from the second week after parturition until the eighth week of the lactation period using manual milking technique after the ewes were separated from their offspring temporary for one day in individual pens. Milk samples (50 ml) were taken at fourth and eighth weeks in plastic containers to determine fat, protein, lactose, total solid (TS) percent (%) using Milk scan (Bentley - Belgium). The formula of Mavrogenis and Papachristoforou (1988), FCM (4%) kg = M × (0.411 + 0.147 × fat %) was used to convert the actual milk yield to 4 % fat corrected milk (FCM). Where M is milk production (kg)

Digestibility trials:

The digestibility trial was conducted at the sixth week of the lactation period, using five ewes selected randomly from each group. The preliminary period lasted for 14 days and followed by 7 days as a collection period. Animals were housed in individual pens and fitted with collection bags (harness). During the collection period, bags are emptied daily at 7.00 a.m. before grazing and at 6 p.m. after return to the farm. Quantitative feces were collected from each animal and ten percent of each fecal sample was taken and dried at 65º C for constant weight and ground to pass through a 1.0 mm mesh screen for chemical composition.

Rumen liquor analysis: -

Samples of rumen fluid were obtained at the end of the digestibility trial using a stomach tube at 3 hours after feeding and filtered through two layers of gauze cloth to remove feed particles. The pH value in rumen liquor was measured immediately using the pH meter model the pHep. Then 1 ml toluene and 1ml paraphen oil were added to the filtered rumen fluid and stored in deep freeze at (-20ºC) until the analysis was strained. Ammonia nitrogen concentration (NH3-N) was determined according to A.O.A.C (2000), the total volatile fatty acids (TVFA’s) were determined according to Warner (1964). The number of rumen protozoa per 1 ml from rumen fluid was estimated via flittered fluid immediately through one layer of gauze, then fixed and stained a volume 4 times of methyl-green formalin saline solution as described by Ogimoto and Imai (1981) (100 ml formaldehyde 35 %, 900 ml distill water, methyl-green 0.6 g and sodium chloride 0.8 g), then stoked in dark place until examination. After gentle mixing of the fixed rumen liquor sample, one drop was poured onto a hemocytometer slide, cover with cover slip and examined under a light microscope. The number of rumen protozoa per 1 ml was calculated as follow:

Calculation: - number of protozoa /1 ml rumen liquor = N*5*10*4

Where: -

N = count the number of protozoa in one large corner square of white blood cell.

To count the bacteria, samples of the various rumen contents were taken by inoculation of 1 ml in 9 ml of nutrient broth. Serial dilutions of 10 suspended bacteria already inoculated in peptone water were prepared in duplicate enumeration of viable aerobic bacteria and enumerated with standard platelet count agar after incubation at 37oC for 48 hrs as described by Slaby et al., (1981).

Analytical procedures:

Dry matter (DM), organic matter (OM) and crude protein (CP) content of feeds and feces were determined as described by AOAC (2005). Neutral detergent fiber (NDF) was determined according to the procedures of Mertens (2002). Apparent digestibility coefficients of the nutrients were calculated using the ordinary methods of AOAC (2005).

Dry matter intake and nutrients digestibility of the pasture were determined using the internal marker (acid insoluble ash; A.I.A) indicator technique as followed by (Van Keulen and Young, 1977). The general equation used for calculating dry matter intake was as follows:

Marker in range plant = Marker in feces – Marker in concentrate diet

Estimated DMI, g/day= Total marker in pasture intake/Concentration of marker in pasture on dry basis

Statistical analysis:

Data of feed intake, digestibility, body weight changes of ewes, lamb's performance and some rumen parameters were analyzed by General Linear Model (GLM) procedure SAS (2006) using the following model:

$$Yij = \mu + Ti + Eij$$

Where,

Yij = experimental observations, μ = the overall means, Ti = the fixed effect of treatments (i: P0-P1-P2), Eij = experimental error

Data for changes of milk production and milk composition during lactation period were analyzed by the GLM procedure using the following model:

$$Yij = \mu + Ti + Mj + (T*K)ij + Eij$$

Where:

Yij = experimental observations, μ = the overall means, Ti = the fixed effect of treatments (i: P0, P1 and P2), Mi = the fixed effect of time (j: 2, 4, 6, and 8), (T*K)ij = effect of the interaction of treatment × time, Eij = experimental error

Differences in mean values between treatments were compared by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Results

Chemical composition of feedstuffs and experimental rations:

The chemical compositions of the experimental feeds are shown in Table (1). The chemical composition indicated that, *Panicum turgidum* as a basal range plant had the lowest protein content compared to concentrate feed mixture (CFM); however, it was high in neutral detergent fiber (NDF). Concentrate feed mixture chemical composition within the normal ranges.

Table 1. Chemical composition of feed ingredients and calculated composition of the experimental rations.

Items	Chemical composition as DM basis (%)				
	DM	Ash	OM	CP	NDF
CFM*	91.16	5.94	94.06	16.91	38.45
Panicum turgidum	87.89	13.12	86.88	7.29	64.43
Calculated chemical composition of tested rations					
P0	91.20	5.93	94.07	16.81	38.50
P1	91.12	5.94	94.06	16.99	38.30
P2	91.16	5.95	94.05	16.93	38.55

CFM; concentrate feed mixture in a percentage ; 55% yellow corn, 24% wheat bran, 17.5 Soybean meal, 2% Limestone, 1% salt, 0.3 mineral mixture and 0.2% yeast P0: without propolis; P1: 100 mg propolis / kg DM; P2:200 mg propolis / kg DM.

Feed intake and Digestibility:

The data in Table (2) showed that a similar forage intake was observed through the treatments, when it expressed as g/kg BW. Similar results were observed in total DM, OM, CP and NDF intake. Although similar intake of DM was reported via treatments, greater (P<0.05) digestibility values for DM, OM, CP and NDF were observed in ewes receiving a concentrate feed mixture with propolis (P1 and P2) than those in without propolis (P0) group.

Table 2. Effect of propolis additive on feed intake and digestion of the experimental rations fed to ewes.

Items	Treatments			±SE
	P0	P1	P2	
Body weight,				
Kg	30.90	31.00	30.10	0.63
$Kg^{0.75}$	13.10	13.14	12.85	0.20
Forage intake, DM / day				
g/h/d	627.4[a]	609.2[ab]	599.4[b]	7.37
g/ kg BW	20.38	19.66	19.92	0.40
Concentrate intake, DM / day				
g/h/d	772.5	775.0	752.5	15.78
g/ kg BW	25.00	25.00	25.00	0.00
Total intake, DM / day				
g/h/d	1399.9	1384.2	1351.9	19.25
g/ kg BW	45.38	44.66	44.92	0.40
Digestion, %	58.21[b]	60.41[ab]	63.94[a]	1.38
Organic matter intake ,				
g/h/d	1346.8	1331.1	1300.3	18.33
g/kg BW	43.66	42.96	43.20	0.39
Digestion, %	64.04[b]	67.81[a]	69.51[a]	1.19
Crude protein intake,				
g/h/d	182.7	181.6	176.9	2.90
g/kg BW	5.92	5.86	5.88	0.03
Digestion, %	55.82[b]	61.78[a]	64.22[a]	1.34
Neutral detergent fiber intake,				
g/h/d	757.0	744.6	728.8	9.22
g/kg BW	24.55	24.03	24.21	0.30
Digestion, %	54.33[b]	60.74[a]	62.72[a]	1.51

[a, b] values within the same row with different letters differ significantly (P<0.05).

P0: without propolis; P1: 100 mg propolis / kg DM; P2:200 mg propolis / kg DM.

Some rumen parameters

The data of rumen parameters values for different experimental treatments are presented in Table (3). The data explained that ruminal pH, ammonia-N (mg/100 ml) concentration and total volatile fatty acids values (TVFA's, mg/100 ml) decreased (P<0.05) with ewes fed P1 and P2 compared to that fed P0. However, propolis in both concentrations did not significantly affect (P>0.05) the number of rumen protozoa ($x10^4$ cell/ml of rumen fluid). The total count of ruminal bacteria ($X\ 10^{10}$/ml) decreased (P<0.05) after the adding propolis in both concentrations compared to control. In the same context, the number of gram-negative bacteria represented about 82.50 and 87.21 % of the total number of rumen bacteria for ewes fed on P1 and P2, respectively, while, it represented about 62.54 % for control group. However, the number of gram-positive bacteria decreased (P<0.05) in ewes fed P1 and P2 compared control group.

Body weight changes of ewes:

Table (4) shows the changes in body weight (BW) in ewes as affected by the addition of propolis during late pregnancy and lactation periods. The results indicated that propolis supplementation to ewes in groups P1 and P2 had no significant effect on BW compared to control ewes (P0). However, ewes in the P1 and P2 groups had a slight increase in BW compared to ewes in P0 group.

Table 3. Some rumen parameters of ewes affected with propolis additive.

Items	Treatments			±SE
	P0	P1	P2	
pH	7.24^{a}	6.75^{b}	6.65^{b}	0.06
Ammoina-N, mg/100ml	18.05^{a}	16.60^{a}	10.19^{b}	1.44
TVFA's, mg/100 ml	10.91^{a}	7.94^{b}	7.68^{b}	0.84
Total protozoa count, $x10^{4}$ cell/ml	2973	3100	3206	88.81
Total bacteria count, x 10^{10}/ml	30.70^{a}	27.77^{b}	20.57^{c}	0.58
Gram negative bacteria count, x 10^{10}/ml	19.20^{b}	22.91^{a}	17.94^{b}	0.45
Gram positive bacteria count, x 10^{10}/ml	11.50^{a}	4.85^{b}	2.63^{c}	0.15

$^{a, b}$ values within the same row with different letters differ significantly (P<0.05).

P0: without propolis; P1: 100 mg propolis / kg DM; P2:200 mg propolis / kg DM.

Table 4. Body weight changes of ewes affected by propolis additive during late pregnancy and lactation periods

Items	Treatments			±SE
	P0	P1	P2	
Exp. Period, days		150 days		
Initial body weight; IBW, Kg	30.60	30.45	30.50	1.13
Second 30 days (before lambing), Kg	32.15	32.25	32.11	1.11
After lambing, Kg	28.15	28.20	27.65	1.06
Second 30 days (after lambing), Kg	29.00	29.15	28.80	1.03
Second 60 days (after lambing), Kg	30.95	30.90	29.95	1.02
Second 90 days (after lambing), Kg	31.70	31.95	32.15	0.94

P0: without propolis; P1: 100 mg propolis / kg DM; P2:200 mg propolis / kg DM.

Milk yield and composition

The data presented in Table (5) showed that, the overall mean of 4% fat correct milk yield (FCM, ml/day) was significantly (P<0.05) increased in the propolis groups (864 and 1133 ml/day) compared to the control (705 ml/day). Also, ewes in the P2 group had a higher (P<0.05) value of milk yield than that in the P1 group. In the same context, milk yield increased as the lactation period progressed to the sixth week and then began to decline in the eighth week for all groups; highest milk yield was recorded in the sixth week (1044 ml/day), while, the lowest was recorded in the second week (781 ml/day) for all groups. Similar results were observed for a treatment × week interaction.

Changes in the ewe's milk composition affected by added propolis are shown in Table (6). The interaction of treatment × week was observed on milk fat and total solid percentage. Ewes in groups P1 and P2 had higher (P<0.05) values of fat, protein and total solid percentage compared to group P0 either at week 4 or week 8. Also, ewes in P2 had higher (P<0.05) values of fat % in week 4 and total solid % in week 8 than those in the P1 group. Regardless of treatments, the fat % increased (P<0.05) during the advanced lactation period, whereas, no effect of the lactation week on protein, lactose and total solid percentage.

Table 5. Changes of milk yield (ml/day) of ewes affected by propolis supplementation level

Items	TRT	Weeks				overall	±SE		
		2	4	6	8		T	W	T*W
4% fat correct milk yield (FCM), ml/day	P0	597^{g}	694^{f}	857^{d}	673^{fg}	705^{c}	16.80	19.40	33.60
	P1	749^{ef}	887^{d}	1002^{b}	818^{de}	864^{b}			
	P2	999^{c}	1156^{b}	1274^{a}	1103^{b}	1133^{a}			
	overall	781^{c}	912^{b}	1044^{a}	865^{b}				

P0: without propolis; P1: 100 mg propolis / kg DM; P2:200 mg propolis / kg DM.

Table 6. Changes of milk composition of ewes at weeks 4 and 8 from lactation period affected by propolis supplementation level

Items	Weeks	Treatments			overall	±SE		
		P0	P1	P2		T	W	T*W
4% fat correct milk yield (FCM), ml/day	W4	694^{c}	887^{b}	1156^{a}	912	21.11	17.24	29.86
	W8	673^{c}	818^{b}	1103^{a}	865			
	overall	683^{c}	853^{b}	1130^{a}				
Fat, %	W4	4.03^{d}	5.25^{b}	6.03^{a}	5.11^{b}	0.08	0.07	0.11
	W8	5.13^{bc}	4.82^{c}	6.26^{a}	5.40^{a}			
	overall	4.58^{c}	5.04^{b}	6.14^{a}				
Fat yield (g)	W4	31.78^{d}	44.70^{b}	70.98^{a}	49.15	1.11	0.91	1.58
	W8	30.79^{c}	41.22^{b}	67.75^{a}	46.59			
	overall	31.29^{c}	42.96^{b}	69.36^{a}				
Protein, %	W4	3.56^{b}	3.80^{ab}	3.91^{a}	3.75	0.07	0.06	0.10
	W8	3.63^{b}	3.76^{ab}	3.99^{a}	3.79			
	overall	3.59^{b}	3.78^{ab}	3.95^{a}				
Protein yield (g)	W4	24.91^{c}	33.53^{b}	45.66^{a}	34.70	0.80	0.65	1.13
	W8	24.13^{c}	30.91^{b}	43.59^{a}	32.88			
	overall	24.52^{c}	32.22^{b}	44.62^{a}				
Lactose, %	W4	5.58	5.84	5.64	5.69	0.09	0.07	0.13
	W8	5.66	5.60	5.92	5.73			
	overall	5.62	5.72	5.77				
Lactose yield (g)	W4	39.00^{c}	50.73^{b}	66.70^{a}	52.14	1.21	0.98	1.70
	W8	37.78^{c}	46.78^{b}	63.66^{a}	49.41			
	overall	38.39^{c}	48.76^{b}	65.18^{a}				
Total solid, %	W4	10.92^{c}	12.85^{a}	13.08^{a}	12.28	0.11	0.09	0.15
	W8	12.11^{b}	11.82^{b}	13.20^{a}	12.38			
	overall	11.51^{c}	12.33^{b}	13.14^{a}				
Total solid yield (g)	W4	79.87^{c}	109.36^{b}	151.89^{a}	113.71	2.61	2.13	3.69
	W8	77.38^{c}	100.84^{b}	144.98^{a}	107.73			
	overall	78.62^{c}	105.10^{b}	148.44^{a}				

P0: without propolis; P1: 100 mg propolis / kg DM; P2:200 mg propolis / kg DM.

Similarly, yields of milk fat, protein and total solid (g/d) were increased (P<0.05) in propolis groups (P1 and P2) compared with P0 group. On the other hand, there is no significant effect for weeks on yields of all milk constituents. However, treatment × week interaction was observed on yields of fat, protein, lactose and total solid.

Lamb's performance

Data for growth performance of lambs are shown in (7). There is no significant difference on birth weight between the treatments. Weaning weight for lambs born from ewes supplemented with propolis (P1 and P2) was significantly (P<0.05) increased compared to lambs born from control ewes. Weaning weights were 14.94, 16.49 and 17.96 kg for P0, P1 and P2 groups, respectively. Moreover, lambs born from ewes in P2 group had higher (P<0.05) values of weaning weights than those born from ewes in the P1 group. In the same context, lambs born from ewes in group P2 had had higher (P<0.05) values of total gain (TG, kg) and average daily gain (ADG, g) than those born from ewes in the P1 and P0 groups. The mean values were 12.52, 14.06 and 15.42 kg for TG and 139.11, 156.22 and 171.33 g for ADG in the P0, P1 and P2 groups, respectively. The improvement gains were 12.30 and 23.16% of the daily gain for P1 and P2 lambs, respectively.

Table 7. Growth performance of lambs affected by propolis supplementation level

Items	Treatments			±SE
	P0	P1	P2	
Exp. Period, days		90 days		
Birth weight, kg	2.42 ^{a}	2.43 ^{a}	2.54 ^{a}	0.08
Weaning weight, kg	14.94 ^{c}	16.49 ^{b}	17.96 ^{a}	0.26
Total gain, kg	12.52 ^{c}	14.06 ^{b}	15.42 ^{a}	0.29
Average daily gain, g	139.11 ^{c}	156.22 ^{b}	171.33 ^{a}	3.24
Relative growth rate, %	518.5 ^{b}	593.9 ^{ab}	613.3 ^{a}	28.59
Improvement gain of lambs %	--	12.30	23.16	--

$^{a, b}$ values within the same row with different letters differ significantly (P<0.05).

P0: without propolis; P1: 100 mg propolis / kg DM; P2:200 mg propolis / kg DM.

Ewe's reproductive performance and Production index:

Data of reproductive performance and Production indices of ewes as affected by propolis additive were summarized in Table (8). There were 10 ewes pregnant in each group and recorded 100, 100 and 100 % as lambing rate in P0, P1 and P2 groups, respectively. Data of lambs live born were 10, 10 and 10 for P0, P1 and P2, respectively. Lambs mortality, % of born alive, was 10, 0, and 0 %, for P0, P1, and P2, respectively. Therefore, ewes in control group the weaned lambs were only 9 because there was one case of death, meanwhile, treated ewes (P1 and P2) weaned 10 healthy lambs per group.

Ewe's production index was calculated for the three groups as shown in Table (8). The yield of lambs born and weaning per 100 pregnant ewes was 90, 100 and 100 lambs for P0, P1 and P2, respectively. The total weight of lambs born (kg) yield per 100 pregnant ewes were 242.0, 243.0 and 254 for P0, P1 and P2, respectively. Therefore, born weight index, % increased by 4.95 % for P2 compared to P0 group. Also, lambs weaned kg per100 pregnant ewes were higher in P2 (1796 kg) and P1 (1649 kg) compared to P0 (1345 kg). Therefore, weaning weight index, % was increased by 22.60 and 33.53 % for P1 and P2 compared to P0 group.

Table 8. Reproductive performance and production index of ewes and lambs affected with propolis additive

Items	Treatments		
	P0	P1	P2
No of pregnant ewes	10	10	10
lambing rate %	100	100	100
Live lambs born	10	10	10
lambs mortality, % of born alive	10	0	0
Weaned lambs	9	10	10
lambs born live / 100 does pregnant	100	100	100
lambs weaned / 100 does pregnant	90	100	100
Average birth weight of lambs:	2.42	2.43	2.54
Average weaning weight of lambs:	14.94	16.49	17.96
Ewes production index:			
Kg born / 100 ewes pregnant	242.0	243.0	254.0
Born weight index , %	100	100.41	104.95
Kg weaned / 100 ewes pregnant	1345	1649	1796
Weaning weight index , %	90.00	122.60	133.53

P0: without propolis; P1: 100 mg propolis / kg DM; P2:200 mg propolis / kg D

Economic evaluation of ewes affected with propolis additive:

The economic evaluation of growing lambs from birth to weaning was calculated and presented in Table (9). Weaned lambs feeding cost was calculated through their mothers (suckling ewes) as a group. Recorded data indicated that ewes received P2 (200 mg propolis/kg DM) and P1 (100 mg propolis/kg DM) were more efficient in terms of kilogram weight gain from their lambs compared to those on P0 (without propolis). This is due to the increase in the Kg weaned / per ewe pregnant in P1 and P2 compared to P0 group. Net return / feeding cost, % per ewe was 22.4 and 24.1 % for P1 and P2 compared to P0 group.

Table 9. Economic evaluation for ewes affected with propolis additive

Items	Treatments		
	P0	P1	P2
Average body weight (ABW), kg	30.78	31.48	30.90
CFM as 2.5% from ABW, g	769	787	773
CFM, kg/h/150d	115.4	118.1	115.9
Propolis supplement, mg/kg DM	0	100	200
Propolis supplement, mg/h/d	0	78.7	154.6
Propolis supplement, g/h/150d	0	88.55	231.90
Total cost of CFM, EP/ewe/150d*	577.0	590.3	579.4
Total cost of propolis supplement, EP/ewe/150d**	0	118.06	231.9
Total Feeding cost , EP	577.0	708.4	811.3
Kg weaned / per ewe pregnant	14.94	16.49	17.96
Kg weaned / 100 ewes pregnant	1345	1649	1796
Net return of weaned lambs / per ewe EP ***	1008.8	1236.75	1347.0
Net return / feeding cost, EP/ per ewe	431.75	528.35	535.7
Net return / feeding cost, % / per ewe	100	122.4	124.1

P0: without propolis; P1: 100 mg propolis / kg DM; P2:200 mg propolis / kg DM.

*** The cost of 1 Ton of concentrate feed mixture (CFM) was calculated at 5000 (Egyptian pound) EP**

**** Market price for propolis was estimated as EP 1000 / kg.**

***** It assumes 1 Kg live weight for lambs weaned 75 EP / Kg live weight.**

Discussion

The improvement in the digestibility of the diet of the propolis groups may be due to the antimicrobial activity of propolis which was higher against Gram positive than against Gram negative bacteria. Gram positive bacteria produce more ammonia, hydrogen, and lactate than the Gram negative species, and compounds that inhibit gram positive ruminal bacteria have increased feed efficiency as reported by Gonsales et al. (2006). Moreover, propolis may inhibit deamination, specific carbohydrate digestion and reduce methane production (Oliveira et al. 2006). Selem (2012) stated that propolis as a natural feed additive can be used to manipulate rumen fermentation towards less methane (CH4) and that it may affect the productive performance of the animal. Part of the increase in digestibility may be due to the fact that propolis acts as a useful additive for reducing rumen ammonia production (Table 8) and for improving nitrogen utilization in ruminants by converting it into microbial protein (Oeztuerk et al., 2010). Also, propolis consists of flavonoids, enzymes, vitamins and amino acids. These components have increased due to increased digestibility and can be attributed to increase of nutrient absorption efficiency and/or nutrient utilization. Furthermore, Yosra et al., (2016) indicated that different propolis extracts may enhance the degradability of rumen nutrients, while amino acid deamination and/or growth rate of amino acid fermented bacteria may decrease, thus different propolis had similar positive effect on rumen nitrogen metabolism. These results are consistent with those obtained by Zeedan and Komonna (2013) who reported that supplementation of buffalo cow with propolis improves the digestion of all nutrients (before and after parturition) and nutritive value. Moreover, Mathivanan et al. (2013) stated that supplementation with propolis increases digestibility of the diet. On the other hand, these results differ from those observed by Aguiar et al. (2012) who reported that adding propolis had no effect on DM and nutrients digestibility (except for ADF, which was higher) or microbial synthesis efficiency. Also, Oeztuerk et al. (2010) indicated that propolis did not significantly affect dry matter digestibility. In dairy goats, Lana et al. (2005) showed no effect of propolis extract on rumen fermentation, and digestibility.

Maintaining a suitable environment for the rumen microflora through a neutral pH, reducing the concentration of ammonia-N and VFA's, and increasing the count of gram-negative bacteria as shown in Table (3) may be due to the effect of the bacterostatic action of propolis which is useful to control ruminal fermentation and it may inhibit deamination, specific carbohydrate digestion and decreasing methane production (Oliveira et al. 2006). In this regard, Oeztuerk et al. (2010) indicated that propolis may act as a useful additive to reduce the production of rumen ammonia and improve the nitrogen utilization in ruminants by converting it into microbial protein and it can inhibit the growth of gram positive bacteria, and it could also be a useful additive to modify bacterial fermentation in the rumen. On the other hand, the propolis treatments decreased ($P<0.05$) in the total rumen bacteria count (X 1010/ml). This result may be due to the antibacterial effect of propolis on different bacterial strains. Propolis and some components of cinnamic and flavonoids (Mirzoeva et al., 1997) have been found to separate the energy-transmitting cytoplasmic membrane and inhibit bacterial movement, which may contribute to antimicrobial action. These results are consistent with those of Ozturk et al., (2010) who found that the total number of rumen bacteria decreased ($P<0.05$) after adding 0.5 ml/day of 20% propolis ethanolic extract (PEE), and 0.5 ml/day of 60% PEE on fermenter in vitro trial.

In the present results, the increase in 4% fat correct milk (FCM) yield and the percentage of milk constituents (fat, protein and total solid, %) with Propolis supplementation may be associated with increased digestibility of nutrients in the propolis groups which is reflected in milk yield and composition. Propolis also contains many compounds such as flavonoids, enzymes, vitamins and amino acids that together cause an increase in the efficiency of nutrition absorption and/or nutrients utilization, thus reflecting better production and reproductive performance of animals. This result is similar to that reported by Shedeed et al., (2019) who reported that milk yield of Barki ewes increased ($p<0.05$) in the propolis group compared to the control and continued to increase as lactation progressed. They also found that milk fat and milk total solids (%) increased ($p<0.05$) in the propolis group than in the control group. In addition, Morsy et al., (2016) observed that oral administration of Brazilian red propolis extract to Santa Inês ewes (3 g /ewe/day) increased ($P<0.05$) milk yield, fat, protein, and lactose. Moreover, Abdullah et al., (2019) reported that milk yield and composition (%) was better ($P<0.05$) in cows with 20 ml methanol extract of Indian propolis per cow/day (MEIP20) and (MEIP30) compared to control and MEIP10. On the other hand, Stelzer et al., (2009) reported that adding propolis ethanolic extract to the diet at 30% w/v while feeding Holstein cows did not affect milk yield and milk composition.

The present results showed that weaning weight, daily gain and total gain of lambs (week 12) were significantly increased in both levels of propolis with the highest value for P2 compared with control lambs. The improvements were 12.30 and 23.16% for daily gains for lambs in the P1 and P2 groups, respectively. These results are due to the increase of milk yield of ewes fed a diet supplemented with Propolis (Table, 5) which reflected upon daily gain of lambs. In addition, the supplementation of Propolis improved milk composition concentration (fat, protein and total solid, Table 6) resulting in an increased weaning weight of lambs. In this regard, Hamdon, (2010) stated that lamb's growth is associated directly with enhanced milk production during the early lactation period, first 30 days after birth. Moreover, the flavonoids present in propolis can help improve gut health and relieve diarrhea in newborn lambs and can improve the growth of lambs (Yaghoubi, et al., 2007). Similar results were previously reported by Mathivanan, et al., (2013) who reported that dietary supplementation of animals with propolis can increase growth performance. Additionally, Zawadzki et al. (2011) reported that adding propolis extract to the diet increased weight gain and improved feed conversion.

Results revealed higher ewe's production index; especially weaning weight index, % in P1 and P2 than P0 due to increased digestion protein metabolism and percentage of milk constituents (fat, protein and total solid) resulting in increased weaning weight of lambs. Moreover, propolis contains a group of bioactive compounds such as phenolics, flavonoids, terpenes, lipid-wax substances, bioelements, vitamins (A, D, F, K, E, B1, B2, B5, B6, B12, C, H, P), minerals, enzymes (alpha and beta amylase), amino acids, sterols, steroids, plant steroids and plant sterols (ergosterol, stigmasterol, steroidal saponins, steroidal alkaloids as mentioned by Sahinler and Kaftanoglu, (2005). These compounds can possibly lead to an increase in the absorption rate from the gastrointestinal tract of the propolis groups reflecting the corresponding increase of milk yield and composition, therefore, of the weaning weight of lambs. Moreover, Yaghoubi et al., (2007) suggested that flavonoids affect the humoral immune response and could help improve gut health and relieve diarrhoea in young calves so that growth of young calves can be improved. In addition to those who found that these results were reflected on the economic evaluation of the study, as the economic efficiency increased by 8.1 and 19.9% for the P1 and P2 groups compared to the control group

CONCLUSION

It could be recommended that under arid-area rangelands, using propolis supplementation at level 100 and 200 mg / kg DM in ewes ration tended to improve the digestion coefficients, rumen microbial fermentation, milk yield and composition which is reflected in the increased weaning weight of lambs, ewes production index and economic efficiency.

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تأثير البروبوليس كأضافة غذائية على الاداء الغذائى والانتاجى للنعاج العشار وحملانها تحت ظروف مراعى حلايب - الشلاتين

حسانين سعد الدين محمود بدوى

قسم تغذية الحيوان والدواجن مركز بحوث الصحراء ص. ب - 11753 المطرية -القاهرة -مصر.

اجريت هذه الدراسة بالمزرعة البحثية للانتاج الحيوانى التابعة لمحطة بحوث حلايب وشلاتين - مركز بحوث الصحراء - بوادى رأس حدربة بمدينة حلايب محافظة البحر الاحمر. بهدف دراسة تأثير استخدام مستويين من البروبوليس (صمغ النحل) فى علائق نعاج ابو دليك خلال الفترة الاخيرة من الحمل (قبل شهرين من الولادة) وفترة ما بعد الولادة (ثلاثة أشهر بعد الولادة) على كمية المأكول من المرعى ، هضم المواد الغذائية، بعض مكونات سائل الكرش، التغير فى اوزان النعاج والحملان من الميلاد حتى الفطام ومحصول اللبن ومكوناتة وكذلك بعض الصفات التناسلية والتقيم الاقتصادى لاستخدام البروبوليس كأضافة غذائية فى علائق الاغنام .استخدمت فى هذه الدراسة ثلاثين نعجه من سلالة ابو دليك خلال فترة الحمل المتأخرة .وقد تم تقسيم الحيوانات إلى ثلاث مجموعات متماثلة فى الوزن (10 نعاج / مجموعة) وتم تغذية الحيوانات كلها على المرعى الطبيعى (نبات التمام الصلب) السائد فى منطقة الدراسة مع تدعيمها بالعلف المركز بمستوى 2.5 % على أساس وزن الجسم الحى. تم اعتبار المجموعة الأولى كمجموعة مقارنة بدون أضافة البروبوليس بينما غذيت المجموعتين الثانية والثالثة على العلف المركز المضاف اليه البروبوليس بمعدل 100، 200 مللیجرام لكل كجم علف مصنع على الترتيب. وقد أوضحت النتائج الأتى :زيادة معنوية فى معاملات هضم المكونات الغذائية (المادة الجافة ، المادة العضوية، البروتين والألياف المقاومة للوسط المتعادل) فى المجموعتين الثانية والثالثة بالمقارنة بمجموعة الكنترول -أدى أضافة البروبوليس للمجموعتين الثانية والثالثة الى حدوث أنخفاض (P<0.05) لدرجة حموضة الكرش وتركيز الأمونيا والأحماض الدهنية الطيارة فى الكرش كما أظهرت النتائج حدوث انخفاض (P<0.05) فى أعداد البكتيريا بصفة عامة فى مجموعتى البروبوليس بالمقابل حدث زيادة (P<0.05) فى اعداد البكتيريا السالبة الجرام عن مثيلاتها موجبة الجرام فى مجموعتى البروبوليس بالمقارنة بمجموعة المقارنة.-أدى اضافة البروبوليس الى زيادة معنوية فى الزيادة اليومية ووزن الفطام للحملان المولودة من نعاج المجموعتين الثانية والثالثة وكانت احسن نتائج الاوزان مع المجموعة الثالثة (P2) بالمقارنة بمجموعة الكنترول -أظهرت النتائج زيادة معنوية فى محصول اللبن ونسبة الدهن والجوامد الكلية وكذلك كميات جميع مكونات اللبن (جم/يوم) للمجموعات المضاف لها البروبوليس بالمقارنة بمجموعة الكنترول -.كان عدد الحملان المفطومة 100 حمل لكل 100 نعجة لمجموعات النعاج المضاف لها البروبوليس فى حين كان 90 حمل / 100 نعجة لمجموعة الكنترول-أضافة البروبوليس أدى الى حدوث تحسن فى الكفاءة الأقتصادية بنسبة 22.4 ، 24.1 % للمجموعتين الثانية والثالثة بالمقارنة بمجموعة الكنترول. من خلال النتائج يتضح ان أضافة البروبوليس لعلائق النعاج خلال الفترة الاخيرة من الحمل ولمدة ثلاثة اشهر خلال فترة الحليب حقق أداء غذائى وانتاجى افضل انعكس ذلك على الكفاءة الاقتصادية للمربى تحت ظروف المراعى الطبيعية فى المناطق القاحلة كمنطقة حلايب والشلاتين.