

## Effect of Different Levels of Propolis on Some Productive Traits of Awassi Ewes

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### ABSTRACT

This study was conducted to investigate the influence of different levels of propolis on the productive traits of Awassi ewes. Twenty-five ewes with similar weights and ages were used and divided into five groups, with five ewes per treatment. Propolis was administered to the ewes daily for a month pre-mating and a month before the expected birth. The groups included: Control group without adding propolis; 5, 10, 15 & 20 g of propolis/ewe/day Dosed to T1, T2, T3 & T4 were closed respectively. The experiment continued until the end of lactation season for these ewes. The T3 treatment exhibited higher ( $P \leq 0.01$ ) ewe's weight at mating than other groups, greater ( $P \leq 0.05$ ) weight at pregnancy than T1 and T4 treatments, and higher ( $P \leq 0.05$ ) weight was observed at birth than the T1 and T2 treatments was observed. The T3 and T4 were significantly superior ( $P \leq 0.05$ ) in the daily milk yield (DMY) over the control for the 1<sup>st</sup> and 2<sup>nd</sup> productive months. Moreover, T3 exhibited higher ( $P \leq 0.05$ ) DMY than T4 and the control in the 3<sup>rd</sup> productive month. Higher ( $P \leq 0.05$ ) milk fat percentage was noticed for T4 than other groups and in the 2<sup>nd</sup> productive month, whereas T4 was higher ( $P \leq 0.01$ ) than with other groups in the percentage of lactose for the 2<sup>nd</sup> productive month. Higher ( $P \leq 0.01$ ) milk protein percentage was observed in T4 treatment over than T2, T1, and C groups. In conclusion, different levels of propolis affected positively the production performance of Awassi ewes.

Keywords: milk components, milk production, propolis, sheep



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### INTRODUCTION

Childbirth is a fundamental physiological event for all living things, so reproductive health and fertility are of particular importance for maintaining health and body condition, and thus improving the productive status of animals. However, the development of reproductive status and fertility of animals is significantly influenced by modern lifestyle conditions such as increased exposure to environmental and behavioral stressors (Almuhayawi, 2020; Kumar & Singh, 2015; Pasupuleti et al., 2017). The production of ruminants, especially sheep, is low, especially in arid and semi-arid areas, due to several factors, including the genetic environment, health conditions, and scarcity of feed, which have negative effects on the productive and

reproductive performance of animals (Leite et al., 2021; Manyi-Loh et al., 2018). At late pregnancy, ewes' energy and protein requirements increase rapidly, while the growing fetus in utero allows less space for feed intake and digestion, causing feed intake in ewes to decrease by 30% (De Sousa et al., 2023). In many cases, a common way to meet nutrient requirements is to increase the amount of concentrate supplied, but in this scenario, metabolic disturbances can occur. Otherwise, enhancing nutrient utilization in the ration by manipulating the rumen's microbial fermentation pattern and maximizing the rumen's ability to degrade can improve production efficiency without excessively increasing nutrient supply (Malyugina & Horky, 2024). To this end, several nutritional

supplements have been tested. Antibiotics and growth promoters (e.g., ionophores) used as rumen-modifying feed additives in ruminant diets during the last few weeks of gestation have been found to improve propionate synthesis, reduce ruminant methane emissions, and thus enhance nutrient energy utilization and support the transition from pregnancy to lactation (Ungerfeld, 2020). The routine use of antibiotics in livestock feed has been criticized and restricted in recent years. There is controversy over their use in animal feeds due to the risk of residues being transferred to meat and milk, promoting the development of resistant strains of bacteria. These concerns have prompted a search for alternative natural feed additives (Boudalia et al., 2024; Senkal et al., 2023). The World Health Organization (WHO) also banned the use of unnatural sources of feed, such as synthetic compounds (antibiotics), because they pose a risk of adverse effects on animal and human health (Ahmad et al., 2021). As a result, many studies have been conducted recently to discover other alternative feed additives that are natural products. Propolis (bee glue) has been considered among the natural feed additives that are alternatives to antibiotics in the diet of ruminants. Propolis is produced by bees, as they collect the resinous substance from plant buds and mix it with salivary and enzyme secretions and beeswax (Soltan & Patra, 2020). Propolis contains more than 300 components, some of which are nutrients such as proteins, amino acids, vitamins, minerals and other natural compounds such as polyphenols, terpenoids and steroids (Woźniak et al., 2023). Propolis is a natural source of antioxidants (flavonoids). Propolis shows great biological activity especially against bacterial growth, and antifungal, and therefore may be a useful additive to modify microbial fermentation in the rumen. Propolis has also been used in critical periods of animal life such as feeding, pregnancy and milking to improve productive and reproductive performance and animal immunity against intestinal parasites (Badway, 2021; Soltan et al., 2016). As propolis has a positive effect on milk production and its components by improving the nutritional and health status of

the animal in general, it is considered a substance that reduces heat stress (Dantas et al., 2023; Varela et al., 2023). The study aimed to explore the effect of dosing propolis at different resource levels on productive performance of Awassi ewes.

## **MATERIALS AND METHODS**

This study was conducted at the Ruminant Research Station, Agricultural Research Directorate, Animal Wealth Department, Ministry of Agriculture in Abu Ghraib, Iraq, for the period from November 15, 2023, to September 15, 2024. The objective was to investigate the effect of dosing different levels of propolis on the productive performance of Awassi ewes. Twenty-five ewes with similar body weights and ages were utilized in this experiment. The ewes were randomly assigned to five treatments based on propolis dosage levels, with five ewes per treatment. Propolis was administered orally to the ewes daily for one month pre-mating and one month prior to the expected lambing date. The experimental treatments were distributed as follows:

**Control treatment (C):** Basal diet without propolis supplementation.

**Treatment 1 (T1):** Dosed with 5 g propolis/ewe/day.

**Treatment 2 (T2):** Dosed with 10 g propolis/ewe/day.

**Treatment 3 (T3):** Dosed with 15 g propolis/ewe/day.

**Treatment 4 (T4):** Dosed with 20 g propolis/ewe/day.

The experimental period continued until the end of the lactation season for all ewes. Chemical Analysis of Propolis Propolis samples were chemically analyzed to identify their basic active compounds at the laboratories of the Ministry of Science and Technology, following the high-performance liquid chromatography (HPLC) method described by Mizzi et al. (2020). The following active compounds were detected:

1. **Detection of Glycosides:** The procedure described by Al-Sheikhly et al. (1993) was followed to detect the presence of glycosides.

2. **Detection of Alkaloids:** Alkaloids were detected according to the method outlined by Daley and Badal (2024).

**3. Detection of Tannins and Saponins:** The method of Lopez et al. (2011) was adopted to detect both tannins and saponins.

Additionally, the propolis was chemically analyzed to identify its essential active vitamins at the Ministry of Science and Technology laboratories, according to the method established by Seal and Chaudhuri (2017).

#### Animal Body Weight

The body weight of the ewes was recorded regularly using a specialized 400 kg disc scale designed for weighing sheep (of Chinese origin).

#### Milk Yield

Milk yield was recorded throughout a production season lasting four months. Newborn lambs were isolated from their dams the night before the measurement day. Milk weight was recorded using a calibrated digital scale designated for this purpose. The total milk yield was calculated using the following formula:

Total Milk Yield = Daily Milk Yield Rate x Number of Milking Days

#### Milk Components

Milk composition was analyzed monthly for three consecutive months. Milk samples (50 mL per ewe) were collected, and a Milkoscope Julie Z7 device was used to determine the percentages of protein, lactose, and fat. Milk density was calculated according to the following formula based on the device reading:

Milk Density = (Device Reading / 1000) + 1

#### Statistical Analysis

The data were analyzed using the SAS Institute (2018) software package to evaluate the effect of the different propolis treatments on the studied characteristics under a Completely Randomized Design (CRD). Significant differences between the means were compared using Duncan's (1955) multiple range test. Significant differences between percentages were evaluated using the Chi-Square test. Statistical significance was set at probability levels of  $P < 0.05$  and  $P < 0.01$ . The underlying mathematical model was applied as follows:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where:

$Y_{ij}$ : The observed value of the  $j$ -th individual belonging to the  $i$ -th treatment.

$\mu$ : The general mean.

$T_i$ : The fixed effect of treatment  $i$  (propolis levels).

$e_{ij}$ : The random residual error, assuming a normal distribution with a mean of 0 and a variance of  $e$ -variance.

### RESULTS AND DISCUSSION

The results of the analysis of propolis indicate that it contains many vitamins, minerals and some active compounds. Table (1) showed the level and concentration of compounds found in propolis.

**Table1.** Concentrations of some active compounds in propolis

Number	Compound Name	Concentrate
1	Alkaloid	++
2	Glycoside	+
3	Terpinen	++
4	Tannins	++
5	Saponine	+
6	Quercetine (mg)	120.4
7	Caffeic acid (mg)	74.9
8	Rutin (mg)	142.6
9	Kaempferol (mg)	98.7
10	Gallic acid (mg)	55.8
11	Mg (g)	35.9
12	Ca (g)	725.9
13	K (g)	1.25
14	Cu (ppm)	40.5
15	Fe (ppm)	89.0
16	B 1 (IU)	80.6
17	B 2 (IU)	45.6
18	B 6 (IU)	50.9
19	C (IU)	133.6
20	A (IU)	12.6

The results of Table (2) show a highly significant difference ( $P \leq 0.01$ ) in the weight of ewes at mating, as the T3 was superior by  $52.00 \pm 1.09$  kg compared to the rest of the experimental treatments and the control treatment ( $43.80 \pm 2.49$ ). Similarly, T3 recorded a significant ( $P \leq 0.05$ ) higher weight at pregnancy, namely  $53.80 \pm 0.96$  kg compared to the T1 and T4 treatments, being  $49.20 \pm 3.36$  and  $46.80 \pm 0.96$  kg, respectively. The results showed a significant superiority ( $P \leq 0.05$ ) for T3 treatment in the birth weight trait, which reached  $64.80 \pm 3.62$  kg over T1 and groups, namely  $50.75 \pm 3.26$  kg and  $52.30 \pm 3.44$  kg, respectively (Table 2).

**Table 2.** Effect of dosing propolis on body weight of Awassi ewes in different physiological stages (Means  $\pm$  SE).

Groups	Weight at mating (Kg)	Weight at pregnancy (Kg)	Weight at birth (Kg)
Control	43.80 $\pm$ 2.49 b	49.20 $\pm$ 3.36 ab	52.30 $\pm$ 3.44 b
T1	39.25 $\pm$ 1.43 b	42.25 $\pm$ 2.25 b	50.75 $\pm$ 3.26 b
T2	45.60 $\pm$ 0.68 b	46.80 $\pm$ 0.96 ab	59.60 $\pm$ 3.74 ab
T3	52.00 $\pm$ 1.09 a	53.80 $\pm$ 0.96 a	64.80 $\pm$ 3.62 a
T4	40.01 $\pm$ 3.30 b	44.20 $\pm$ 3.65 b	55.20 $\pm$ 2.71 ab
Significance level	P $\leq$ 0.01	P $\leq$ 0.05	P $\leq$ 0.05

Means with different letters within each column are significantly different

The observed increase in body weights among the propolis-treated groups may be attributed to the fact that propolis contains active compounds, minerals, and vitamins (Table 1). The presence of these bioactive components has been shown to increase the concentration of total short-chain fatty acids (SCFAs), as well as individual concentrations of acetate, propionate, and valerate. This increase in total SCFAs is mainly driven by a significant rise in acetate production (the major contributor to short-chain fatty acid synthesis) by up to 45% compared to monensin, an effect that subsequently enhances total dry matter digestibility (Lange et al., 2023; Morsy et al., 2015). Additionally, the improvement in prenatal body weight may be attributed to a better overall energy balance before parturition (Haslin et al., 2023). This improvement could also stem from propolis enhancing ruminal digestibility through its selective antimicrobial activity, which is notably higher against gram-positive bacteria than gram-negative bacteria. Gram-positive bacteria typically produce more ammonia, hydrogen, and lactate than gram-negative species; therefore, compounds that selectively inhibit gram-positive bacteria in the rumen are known to improve overall feed

efficiency (Almuhayawi, 2020; Majtan, 2019). Dietary supplementation with propolis extract in ruminants elicits a dose-dependent response; however, it does not usually affect voluntary feed intake or general digestibility (da Silva et al., 2021), while simultaneously enhancing growth performance, body weight gain, carcass characteristics, and feed efficiency (Paixão et al., 2022). Furthermore, there is established evidence of an improved immune response in ruminants receiving propolis extract (Abu-Seida, 2023; Cécere et al., 2021). The results in Table 3 illustrate the effect of the treatments on daily milk yield and milk components during the first lactation month of the Awassi ewes. The data indicate a significant difference (P < 0.05) in daily milk yield, with the T3 and T4 treatments outperforming the control group, reaching 400.03  $\pm$  83.66 g and 416.67  $\pm$  44.09 g, respectively. Meanwhile, T4 and T3 groups outperformed T1 and T2 numerically. In the same context, no significant differences (P > 0.05) were observed among the treatments regarding milk components, including fat, lactose, protein, solids-not-fat (SNF), and milk density.

**Table 3.** Effect of dosing propolis on daily milk yield and milk components at first lactation month of Awassi ewes (Means  $\pm$  SE).

Groups	Daily milk yield (g)	Fat (%)	Lactose (%)	Protein (%)	Solids non-fat (%)	Milk density
Control	175.00 $\pm$ 25.03 b	4.70 $\pm$ 0.20	4.93 $\pm$ 0.19	3.16 $\pm$ 0.05	8.92 $\pm$ 0.20	1.028 $\pm$ 0.002
T1	316.67 $\pm$ 16.67 ab	4.77 $\pm$ 1.82	5.34 $\pm$ 0.10	3.58 $\pm$ 0.06	9.58 $\pm$ 0.25	1.032 $\pm$ $\pm$ 0.002
T2	287.50 $\pm$ 12.50 ab	3.79 $\pm$ 1.20	5.52 $\pm$ 0.10	3.54 $\pm$ 0.17	10.01 $\pm$ 0.21	1.033 $\pm$ 0.01
T3	400.03 $\pm$ 83.66 a	6.38 $\pm$ 1.43	5.79 $\pm$ 0.34	3.80 $\pm$ 0.28	9.13 $\pm$ 1.35	1.034 $\pm$ 0.01
T4	416.67 $\pm$ 44.09 a	5.75 $\pm$ 1.10	5.80 $\pm$ 0.24	3.77 $\pm$ 0.28	10.45 $\pm$ 0.56	1.035 $\pm$ 0.02
Significance level	P $\leq$ 0.05	N.S	N.S	N.S	N.S	N.S

Means with different letters within each column are significantly different. N.S: Non-significant

The results of Table (4) show the effect of studied treatments on the daily milk yield and milk components during the second lactation month of ewes, as the T3 and T4 treatments recorded a significant difference ( $P \leq 0.05$ ) in daily milk yield, which namely to  $850.02 \pm 165.83$  and  $800.34 \pm 57.73$  g, respectively, compared to the C group ( $350.00 \pm 50.02$  g). It was also noted that there were non-significant differences among the experimental treatments in the daily milk yield. Table (4) also showed a significant difference ( $P \leq 0.05$ ) in percentage of milk fat, as T4 ( $8.89 \pm 2.21\%$ ) outperformed all experimental treatments and control. A highly significant difference was also observed in T4 group in percentage of lactose ( $6.14 \pm 0.17\%$ ) compared to the rest of the experimental treatments and control, while T2 ( $5.53 \pm 0.12\%$ ) outperformed control ( $5.06$

$\pm 0.05\%$ ) significantly ( $P \leq 0.01$ ). On other hand, there were non-significant differences between the T3 and T1 groups with control in percentage of lactose, and no significant differences were observed among the T3, T2 and T1 in percentage of lactose. Table (4) indicates the presence of highly significant differences ( $P \leq 0.01$ ) in percentage of milk protein, as the T4 group, being  $3.98 \pm 0.26$ , outperformed to T2, T1 and control, namely to  $3.46 \pm 0.07$ ,  $3.41 \pm 0.12$ , and  $3.07 \pm 0.04$ , respectively. There is also non-significant difference among T3, T2 and T1. Non-significant differences were observed between T2 and T1 with control in percentage of milk protein. On the other hand, there was non-significant difference among the experimental treatments and control treatment in the percentage of non-fat solids and milk density.

**Table 4.** Effect of dosing propolis on daily milk yield and milk components at second lactation month of Awassi ewes (Means  $\pm$  SE).

Groups	Daily milk yield (g)	Fat (%)	Lactose (%)	Protein (%)	Solids non-fat (%)	Milk density
Control	$350.00 \pm 50.02$ b	$2.13 \pm 0.19$ b	$5.06 \pm 0.05$ c	$3.07 \pm 0.04$ c	$9.58 \pm 0.08$	$1.033 \pm 0.01$
	$683.33 \pm 33.34$ ab	$4.08 \pm 0.61$ b	$5.40 \pm 0.03$ ab	$3.41 \pm 0.12$ bc	$9.67 \pm 0.17$	$1.032 \pm 0.02$
T2	$650.07 \pm 64.55$ ab	$4.01 \pm 0.79$ b	$5.53 \pm 0.12$ bc	$3.46 \pm 0.07$ bc	$9.64 \pm 0.14$	$1.032 \pm 0.01$
	$850.02 \pm 165.83$ a	$4.92 \pm 0.83$ b	$5.47 \pm 0.12$ bc	$3.67 \pm 0.08$ ab	$9.93 \pm 0.24$	$1.033 \pm 0.02$
T4	$800.34 \pm 57.73$ a	$8.89 \pm 2.21$ a	$6.14 \pm 0.17$ a	$3.98 \pm 0.26$ a	$10.69 \pm 0.79$	$1.033 \pm 0.01$
	Significance level	$P \leq 0.05$	$P \leq 0.05$	$P \leq 0.01$	$P \leq 0.01$	N.S

Means with different letters within each column are significantly different. N.S: Non-significant

The results from Table (5) show the effect of studied treatments on the daily milk yield and milk components at third lactation month of experimental ewes, as T3 recorded a significant difference ( $P \leq 0.05$ ) in daily milk yield ( $190.02 \pm 18.70$  g) over both T4 and control ( $183.33 \pm 44.09$  and  $125.00 \pm 25.06$  g, respectively), while there was non-significant difference between T3, T2 and T1 among themselves, and between T4 and control for the daily milk yield. Similarity, the results of experiment revealed a highly significant difference ( $P \leq 0.01$ ) in percentage of fat, as the

experimental treatments outperformed control ( $2.83 \pm 0.44$ ), the T4 also outperformed highly significant ( $P \leq 0.01$ ) over control in milk protein percentage, namely  $3.75 \pm 0.16$  and  $2.55 \pm 0.87$  respectively, while there was non-significant difference between experimental treatments for the same trait, and there was non-significant difference among T3, T2 and T1 with control in percentage of milk protein. Table (5) indicates that there are non-significant differences in percentage of lactose, non-fat solids and milk density among experimental treatments and control group.

**Table 5.** Effect of dosing propolis on daily milk yield and milk components at third lactation month of Awassi ewes (Means  $\pm$  SE).

Groups	Daily milk yield (g)	Fat (%)	Lactose (%)	Protein (%)	Solid non-fat (%)	Milk density
Control	125.00 $\pm$ 25.06 b	2.83 $\pm$ 0.44 b	4.14 $\pm$ 0.32	2.55 $\pm$ 0.87 b	9.15 $\pm$ 1.92	1.355 $\pm$ 0.02
	166.67 $\pm$ 44.09 ab	7.80 $\pm$ 0.42 a	5.01 $\pm$ 0.25	3.36 $\pm$ 0.14 ab	9.17 $\pm$ 0.19	1.029 $\pm$ 0.01
T1	137.50 $\pm$ 23.90 ab	7.71 $\pm$ 0.34 a	5.65 $\pm$ 0.17	3.55 $\pm$ 0.12 ab	10.30 $\pm$ 0.12	1.031 $\pm$ 0.12
	190.02 $\pm$ 18.70 a	6.08 $\pm$ 0.62 a	5.53 $\pm$ 0.09	3.35 $\pm$ 0.07 ab	9.34 $\pm$ 0.28	1.031 $\pm$ 0.28
T2	183.33 $\pm$ 44.09 b	7.25 $\pm$ 0.56 a	5.88 $\pm$ 0.04	3.75 $\pm$ 0.16 a	10.17 $\pm$ 0.34	1.032 $\pm$ 0.002
	Significance level	P $\leq$ 0.05	P $\leq$ 0.01	N.S	P $\leq$ 0.05	N.S

Means with different letters within each column are significantly different. N.S: Non-significant

The reason behind the improvement in milk yield and certain milk components may be due to the fact that propolis contains numerous active compounds, vitamins, and minerals (Table 1), which function as highly effective antioxidants. These bioactive compounds have been shown to increase the degradability of rumen organic matter and enhance the utilization of individual and total short-chain fatty acids (SCFAs) within the diet. Dietary supplementation with antioxidants is likely to reduce oxidative stress, thereby promoting optimal conditions for rumen microbes to efficiently degrade nutrients and produce a higher yield of SCFAs immediately after parturition (Ponnampalam et al., 2022). This provides a plausible explanation for the observed increases in total milk yield, milk fat content, and fat production in the propolis-treated ewes. Furthermore, Morsy et al. (2015) reported a significant increase of 45% in ruminal acetate production following propolis supplementation. Consequently, the elevated milk fat percentage in this study can be directly attributed to the increased production of acetate, which serves as the primary precursor for milk fat synthesis in ruminants. Propolis has also been documented to possess robust antioxidant activities driven by its high concentration of isoflavones (da Silva et al., 2021; Oršolić & Jembrek, 2022). In alignment with these findings, Aguiar et al. (2014) demonstrated that the phenolic compounds present in propolis improve the nutritional quality of milk fat in dairy cows by increasing the concentration of conjugated linoleic acid

(CLA) isomers, reducing the omega-6 to omega-3 (n-6:n-3) ratio, and improving the overall antioxidant capacity of the milk. Accordingly, it can be suggested that propolis supplementation may help limit the primary oxidative deterioration reactions that typically occur during dairy product processing due to the high susceptibility of milk fat to oxidation. Nevertheless, the total yields of these nutritional components were substantially higher in the propolis-treated groups. This increase in the total yield of milk components in ewes receiving propolis could simply be a direct reflection of their overall increased daily milk volume (Sardinha et al., 2020).

### CONCLUSION

In conclusion, propolis contains a rich profile of bioactive compounds that exert potent antioxidant and antibacterial properties. Daily oral propolis supplementation, particularly at 15 g/ewe/day (T3), significantly improves the body weight of Awassi ewes from mating until lambing. Furthermore, it effectively enhances daily milk yield and improves fat, protein, and lactose percentages. These results establish propolis as a highly effective, natural alternative to synthetic antibiotics for improving the productive and reproductive performance of ewes.

### CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest regarding the publication of this manuscript. All authors have reviewed and approved the final version of the paper for submission.

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## تأثير مستويات مختلفة من البروبوليس في بعض الصفات الإنتاجية للنعاج العواسي

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### المستخلص

أجريت هذه الدراسة لمعرفة تأثير مستويات مختلفة من البروبوليس في بعض الصفات الإنتاجية للنعاج العواسي. تم استخدام 25 نعجة بأوزان وأعمار متشابهة وقسمت إلى خمس معاملات بواقع خمس نعجات لكل معاملة. تم إعطاء البروبوليس للنعاج يومياً لمدة شهر قبل التسفيد وشهر قبل الولادة المتوقعة. شملت المعاملات: مجموعة التحكم © بدون إضافة البروبوليس؛ جرعت النعاج 5، 10، 15 و 20 غم / بروبوليس / نعجة / يوم للمعاملات T1، T2، T3 و T4 على التوالي. استمرت التجربة حتى نهاية موسم الحلب لهذه النعاج. أظهرت المعاملة T3 وزناً أعلى ( $P \leq 0.01$ ) للنعاج خلال وقت التسفيد مقارنة مع بقية المعاملات، ووزناً أكبر ( $P \leq 0.05$ ) عند الحمل من المعاملات T1 و T4، ووزناً أعلى ( $P \leq 0.05$ ) عند الولادة من المعاملات T1 و T2. وكانت T3 و T4 متفوقتين بشكل ملحوظ ( $P \leq 0.05$ ) في إنتاج الحليب اليومي (DMY) على معاملة السيطرة C للشهرين الإنتاجيين الأول والثاني. فضلاً عن ذلك، أظهرت T3 أعلى DMY ( $P \leq 0.05$ ) من T4 والسيطرة C في الشهر الإنتاجي الثالث. لوحظت نسبة دهن الحليب أعلى ( $P \leq 0.05$ ) في T4 من المعاملات الأخرى وفي الشهر الإنتاجي الثاني، بينما كانت T4 أعلى ( $P \leq 0.01$ ) من المعاملات الأخرى في نسبة اللاكتوز للشهر الإنتاجي الثاني. لوحظت نسبة أعلى ( $P \leq 0.01$ ) لبروتين الحليب في المعاملة T4 مقارنة بالمعاملات T1 و T2 و C. نستنتج أن المستويات المختلفة من البروبوليس تؤثر إيجاباً في الأداء الإنتاجي للنعاج العواسي.

الكلمات المفتاحية: مكونات الحليب، نتاج الحليب، البروبوليس، الأغنام.