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EFFECT OF USING *QUERCUS INFECTORIA* GALLS IN THE DIET ON SHEEP PERFORMANCE IN LATE PREGNANCY AND EARLY LACTATION

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ABSTRACT

***Quercus infectoria* (QI) tree is one of the most world widely distributed tree and characterized by having a high level of tannin in a different part of the tree including leaves, stem, acorn, and galls. This experiment was designed to study the effect of supplemented different levels of galls of oak (*Quercus Infectoria*) to ewe's diet on blood metabolism and animal performance. Twelve single bearing ewes, six weeks pre-lambing were used in the experiment. Ewes were blocked according to their party and body condition scoring and randomly divided into three groups four ewes per group. The first group received a concentrated diet with no additive control *Quercus infectoria* (CQI), the second group received a concentrated diet supplemented with 5 g/kg DM gall oak, low *Quercus infectoria* (LQI) and last group was also received the same concentrated diet supplemented with g/kg DM gall oak, High *Quercus Infectoria* (HQI). The data were analysed as randomise complete block design using GenStat 17 Software. The results showed that supplemented different levels of gall oak to ewe's diet significantly increasing crude protein, crude fibre and organic matter digestibility compared to control. Moreover, concentrated feed with 10 g/kg DM oak gall found to increase milk yield by approximately 15% compared to other treatments. While the results showed that *Quercus Infectoria* had no effect on ewes' body weight, body condition scoring nor blood plasma metabolism.**

KEYWORDS: Tannin, oak galls, milk yield, apparent digestibility.

1. INTRODUCTION

Rumen microorganisms provide ruminants with the main amino acids that reach the small intestine from converting of poor feedstuffs such as fibres and non-protein nitrogen (NPN) into microbial protein (Taha, 2015). However, these microbes degrade most dietary protein and carbohydrate in the rumen and converting them to microbial protein, volatile fatty acids and greenhouse gases such as carbon dioxide and methane (Bahrami-Yekdangi et al., 2014). Highley rumen degradation consider an economical loses, environmental pollution and might lead to some metabolic disorders such as bloat (Zhang and Yu, 2012). Increasing by-pass protein to the small intestine would be necessary especially with high production animals (Taha, 2019; Howie et al., 1996).

Plant protein considered the main dietary protein source in ruminant animals and characterised by highly rumen degradable protein (70-80%) and digest by rumen bacteria without satisfying metabolizable protein requirements (AFRC, 1993). Many techniques have been used to reduce protein degradability and increasing by-pass protein such as chemical and physical methods (Taha, 2015). Treating the ruminant's diet with some plant secondary compound such as tannin are among these techniques to reduced protein degradation (Mueller-Harvey, 2006). Tannin described as a polyphenolic plant secondary compound with a high molecular weight found in different plants (Taha et al., 2015; Makkar, 2003). Tannin generally divided into two types: condensed and hydrolysable tannin (Lorenz, 2011), and both types have the ability to bind with plant protein creating a reversible tannin protein complex which is stable at rumen pH (6-7) (McSweeney et al., 2001). Post rumen, these bonds might breakdown in the abomasum (pH 2-3) and the protein will release

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from this complex leading to increase by-pass protein in the small intestine (Frutos et al., 2004). Therefore, feeding ruminant animals diet treated with a mix of tannin groups would enhance their performance (Taha et al., 2014).

Oak (Quercus spp.) trees are one of the most world's widely distributed tree especially in the Middle East (Jafari et al., 2018). *Quercus infectoria* (QI) tree characterized, by having a high level of tannin in a different part of the tree including leaves, stem, acorn, and galls. It has been reported that more than 70 % of oak galls considered as a mix of different tannin groups which is the highest naturally occurring tannin level compounds (Dar et al., 1976). The galls of QI have been traditionally used as a medical treatment plant for inflamed tonsils and skin inflammation in Asia (Abdulla et al., 2017). Feeding ruminants at different physiological states (late pregnancy and early lactation) with a diet naturally treated with tannins might increase undegradable protein and enhance their production. Therefore, the current experiment was designed to study the effect supplemented different levels of *Quercus infectoria* galls (Mazi in Kurdish language) to ruminant diet on sheep blood metabolism and performance in late pregnancy and early lactation.

2. MATERIALS AND METHODS

A total of twelve single bearing ewes with an average body weight of 63.2 ±2.3 kg were used in the current study. An ultrasonic diagnostic equipment (SUN-806L Sunbright group Co. Limited®) was used to know the ewe's litter size. The ewes were oestrus synchronised to lamb at the end of November 2018, using progestogen impregnated sponges. Six weeks pre-lambing, the ewes were blocked according to their age and body condition scoring and randomly divided into three different groups (four ewes per group). The first group received a concentrate diet with no additive of QI, control *Quercus infectoria* group (CQI). The second group received the same concentrate diet with supplemented 5 g/kg DM of QI, low *Quercus infectoria* (LQI). The last group also received the same concentrate diet with supplemented 10g/kg DM of QI, high *Quercus infectoria* (HQI). The ewes with all groups were also offered 1 kg/day/animal of wheat straw. The oak galls were provided from Duhok Government mountains as it has grown naturally in oak trees in the region. The galls then air-dried and powdered using a 1 mm screen grinder and used for treating the experimental treatments. Diets were calculated to meet the requirement of single bearing ewes and produced 1.5 litter of milk (Table 1) according to (AFRC, 1993). Sample of the diet was analysed according to (AOAC, 2000) for dry matter (DM) using hot oven (60ºC for 48 h), crude protein (CP) using Kjeldahl method for nitrogen measurement, organic matter (OM) using muffle furnace (550 ºC for 4 h), starch using near-infrared machine (Perten Instruments a PerkinElmer Company®), crude fibre (CF) and neutral detergent fibre were determined according to (Goering and Van Soest, 1979). Then diet metabolizable energy was calculated according to (AFRC, 1993). The diet ingredients and chemical composition are shown in Table1.

Table (1): The concentrated diet ingredients and the chemical analysis.

Ingredient	CIQ	LIQ	HIQ
Barley g/kg	250	250	250
Maize g/kg	300	300	300
Soybean meal g/kg	120	120	120
Wheat bran g/kg	300	295	290
Gall of oak g/kg	0	5	10
Chemical analysis			
Parameter		g / kg DM	
Dry matter		920	
Crude protein		148	
Organic matter		950	

Crude fibre	96
NDF	97
Starch	445
Metabolizable Energy (MJ /kg DM)	11.96

QIC: control 0 g/kg, LQI: low level 5g /kg DM, HQL: high level 10g /kg DM, NDF: neutral detergent fibre.

2.1. EXPERIMENTAL DETAILS

The experiment lasted for 12 weeks straight, six weeks pre-lambing and six weeks post-lambing. The first two weeks considered as adaptation period and the next 10 weeks as an experimental period. The ewes were group-housed according to the experimental treatments and fed in group feeding intervals and received the treatment feeding regime as mentioned previously. During the experimental period, the weight and body condition of each ewe were recorded every week.

Ewes daily milk yield were measured, and taken manually every two weeks were lambs separated from their dams for 12 hours (9 PM until 9 AM) then in the next morning the ewes were milked manually, and the milk yield were multiplied by two for calculating the daily milk yield. Blood samples were taken from each ewe via jugular venepuncture at 11:30 (2-3 hours post morning feeding) at biweekly intervals. Ten ml of Lithium heparin vacutainer tubes were used for blood sample collection. The samples were then centrifuged at 5000 rpm for 20 minutes, and the blood plasma transferred into small cups (2 ml) and stored at -20ºC for further analysis. Frozen plasma samples were defrosted in the fridge and analysed for urea, total protein and glucose concentration using Cobas-Mira (Mira plus ABX Diagnostics) blood analyser machine at a private laboratory in Duhok city.

Two weeks pre-lambing (week six of the experimental period) each ewe from all experimental groups was placed in an individual pen for one week in order to measure feed digestibility. Diet DM, OM, CP and CF component digestibility were measured using acid insoluble ash method (as an indirect marker for measuring feed digestibility). Acid insoluble ash was determined based on (Van Keulen and Young, 1977). Approximately 40 g of faeces samples were collected directly from the rectum of each of the 12 ewes for 4 days at 11:00 am. The faeces samples of each ewe for each day was kept separately in small plastic cup and frozen at -20ºC. Then the samples were defrosted and oven-dried at (60°C) for 48 h. The dried samples of each ewe in the 4 days were bulked and milled through a 1 mm screen. Five grams exactly of milled bulked faeces samples of each ewes were used for apparent digestibility measurement as described by (Van Keulen and Young, 1977) method.

2.2. EXPERIMENTAL ANALYSIS

The experimental data were analysed as a randomised complete block design ANOVA using GenStat 17 (VSN, International, Oxford, UK). The effect of different levels (0, 5 and 10 g /kg DM) of supplemented *Quercus infectoria* to concentrated diet was calculated. Data on body weight and condition scoring, milk yield and blood plasma parameters (total nitrogen, glucose, and urea) analysed as repeated measurements to study the effect of different levels and experimental periods. Microsoft Excel was used for measuring means of linear regression and for drawing curves of each of body weight and condition scoring, milk yield and blood plasma parameters.

3. RESULTS AND DISCUSSION

3.1. BODY WEIGHT AND CONDITION SCORING

Ewe’s body weight during the experimental period is showing in Figure 1. The results showed that the overall mean of total ewes’ body weight was 65.3 kg. The average body weight was increased by approximately 15% during late pregnancy due to the development of the foetus. Supplemented different levels of QI had no significant effect on body weight during the experimental period.

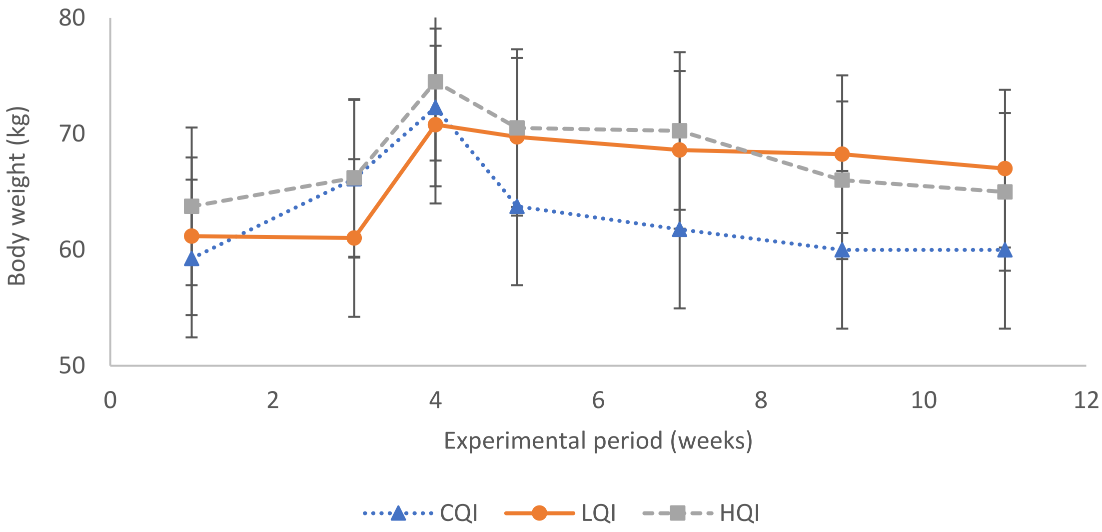

Fig. (1): Effect of supplemented different levels of gall of oak (*Quercus infectoria)* on ewes' body weight at late pregnancy and early lactation.
CQI: control 0 g/kg, LQI: low level 5g /kg DM, HQL: high level 10g /kg DM.

The overall body condition scoring at the beginning of the experiment was 3.2 and slightly reduced to 3.0 at the end of the experiment. The reduction might be due to the effect of milk production during the lactating period as producing milk required high energy, some of this energy provided by the dam's body (conserved energy), which can be seen in most lactating animals. The results showed that supplemented different levels of QI did not affect significantly (Figure 2).

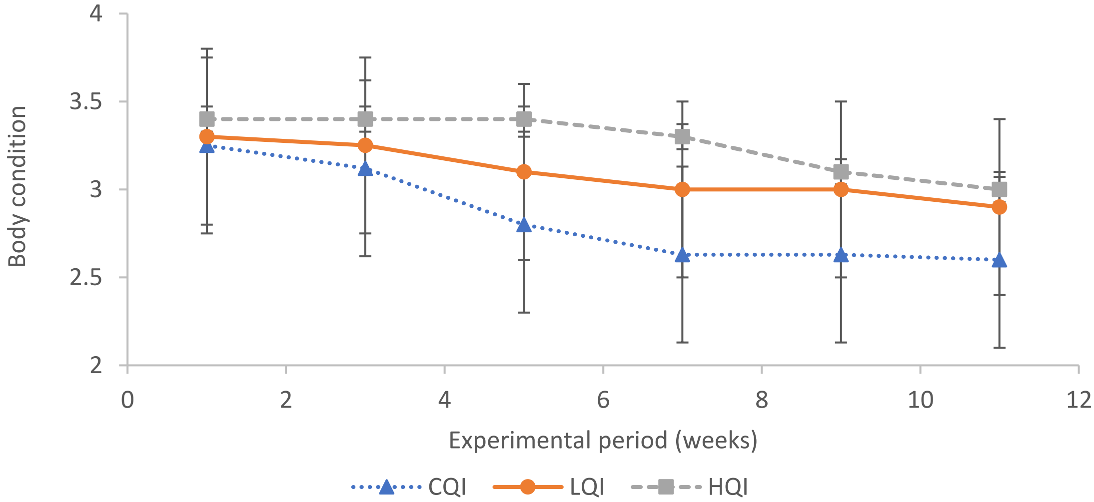

Fig. (2): Effect of supplemented different levels of gall of oak (*Quercus infectoria)* on ewes' body condition scoring at late pregnancy and early lactation.
CQI: control 0 g/kg, LQI: low level 5g /kg DM, HQL: high level 10g /kg DM.

These results are in agreement with the finding of serval researchers (Merkhan et al., 2019; Taha, 2015; Bahrami-Yekdangi et al., 2014; Deaville et al., 2010) that treating sheep diet with different levels and/or types of tannin had no effect on body weight nor body condition.

3.2. APPARENT DIGESTIBILITY

The apparent digestibility of different diet parameters were shown in Table 2. The data showed that supplemented both levels (5 and 10 g/kg) of QI have a trend (P=0.06) to increase DM digestibility compared to the untreated group (0.81, 0.85 and 0.85 for CQI, LQI, and HQI respectively). Both supplemented QI levels (5 or 10 g/kg DM) found to significantly (P<0.05) increased OM and CP digestibility, while there was no effect between both supplemented QI levels (Table 2).

Table (2): Effect of supplemented different levels of gall of oak (*Quercus infectoria)* on ewes' apparent digestibility at late pregnancy and early lactation.

Parameters	CQI	LQI	HQI	SED	P-value
Dry matter %	81	85	85	1.69	0.06
Organic matter %	81^{b}	85^{a}	85^{a}	1.57	0.05
Crude protein %	86^{b}	88^{a}	89^{a}	1.09	0.05
Crude fibre %	42^{c}	52^{b}	59^{a}	5.05	0.03

CQI: control 0 g/kg, LQI: low level 5g /kg DM, HQL: high level 10g /kg DM. Data with different litter are differed significantly at 0.05 level (P<0.05), SED: slandered error or deviation, P-value: probability.

Crude fibre digestibility found to increase linearly when using different levels of supplemented QI (0.42, 0.52 and 0.59 for CQI, LQI, and HQI respectively). In a study conducted by Merkhan et al. (2019), they found that using 10 g/kg gall oak did not have any significant effect on apparent digestibility except there was a trend to increase DM digestibility. They went to show that using herb plants as a ruminant feed supplement might have a positive effect on stimulating salivary glands to increase their secretion and hence increasing feed digestibility. Furthermore, the herb plant has a positive effect on the activity of rumen microorganisms and therefore, increasing rumen degradation (Merkhan et al., 2019). However, Taha et al.(2015) found that supplemented 25 and 50 g/kg DM tannin to forage diet will increase DM, OM, and CP digestibility. While (Ben Salem et al., 2005) noticed that DM digestibility reduced when they grazed lamb a diet rich in tannin (59.6 g kg/DM). Similar results were also reported by Deaville et al. (2010) who found that supplemented 55 g/kg DM of tannin to ruminant's diet reduced DM and OM digestibility. The variation between the results obtained from different studies might be due to the differences of tannin source and types used in each study, as it has been reported that tannin types, source, and dosage play an important role in its effect (Taha, 2015). From the results obtained in the current experiment and from the literature, the gall of oak might be one of the good choices to use as a supplemented diet in order to increase diet digestibility and, hence improving their performance.

3.3. MILK YIELD

The results showed that the overall peak milk yield was 570 ml/d and it was between weeks 2 and 4 post-lambing. The milk production continued for approximately 12 weeks and the average yield was 360 ml/d (Figure 3). Supplemented 10 g/kg DM of QI found to increase (P=0.04) milk yield compared to 0 and 5 g/kg DM. The increases in milk yield in ewes fed concentrate diet supplemented with high level of QI (10 g/kg DM) might be due to increasing diet digestibility especially CF and, hence receiving higher metabolizable energy compared to other groups. In addition, the gall oak is very rich in the tannin compound which has the ability to bind with feed ingredients such as dietary protein and increase by-pass protein (Taha et al., 2014; Makkar, 2003) and might have an effect of increasing milk yield. It was also noticed that milk yield was significantly increased when sheep diet supplemented with 10 g/kg DM gall of oak which probably due to their effect on increasing diet digestibility and feed efficiency (Merkhan et al., 2019). These results are in agreement with the results published by Hymes-Fecht et al. (2013), they noticed that feeding dairy cows with 10 g/kg DM tannin had increased milk yield by approximately 10% , while there were no differences in dry matter intake which expected that tannin would improve feed efficiency and digestibility. Furthermore, Taha et al. (2015) found an increase in milk yield was notices when alfalfa silage was treated with 25 g/kg DM chestnut tannin and fed ewes at early lactation. The high milk yield might be due to the combination between supplemented tannin and the feed nutritive value resulting an improvement of the dietary diet (Woodward et al., 2002). However, other researchers reported that treating ruminant diet with different types of tannins had no effect on milk yield and composition (Buccioni et al., 2015).

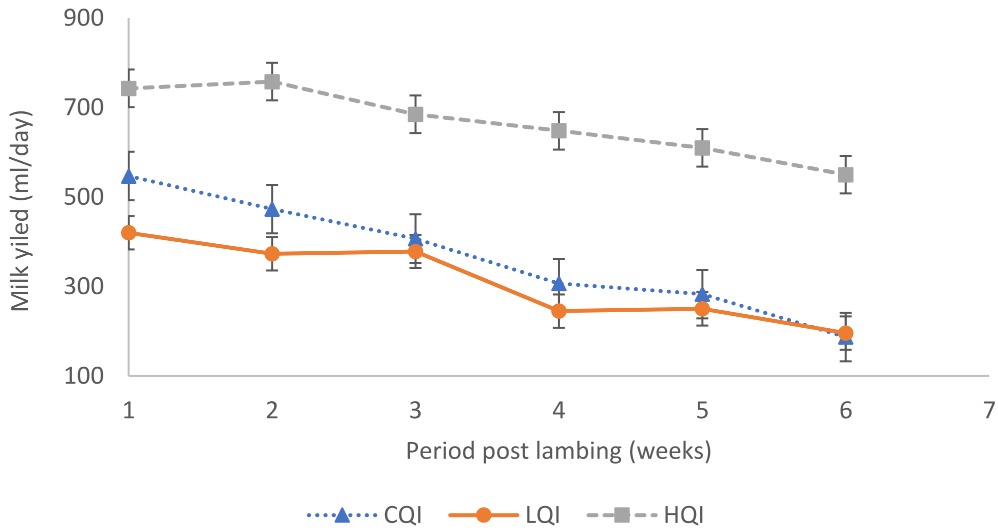

Fig. (3): Effect of supplemented different levels of gall of oak (*Quercus infectoria)* on ewes' daily milk yield at early lactation.
CQI: control 0 g/kg, LQI: low level 5g /kg DM, HQL: high level 10g /kg DM.

3.4. BLOOD PLASMA METABOLISM

The collected ewes blood plasma during the experimental period were analysed for total protein, urea, and glucose concentration. The results showed that supplemented different levels of QI had no effect on total protein of blood plasma (Figure 4). Similarly supplemented different levels of QI have no effect on urea concentration inside ewes' blood plasma (Figure 5) nor glucose concentration (Figure 6). The results indicated that blood metabolism parameters were within the normal physiological condition of the ewes two hours h post morning feed as reported by Taha (2015). Several studies (Taha, 2015; Hymes-Fecht et al., 2013; Sinclair et al., 2009) reported that feeing ewes in late pregnancy and early lactation diet contain different levels of tannin had no effect on blood metabolism parameters. Taha (2015) noted that total protein and urea concentration in blood plasma in ruminant animals are highly corelated to ammonia nitrogen and volatile fatty acid concentration in the rumen. Rumen fermentation might be reduced if animal consumed high level of tannin (> 10 g/kg DM) (Muller-Harvey, 2006). Animals in the current study offered diet treated with either 0, 5 or 10 g/kg DM galls of oak, and these levels are lower than that reported by Muller-Harvey (2006), which might be the reason that no effect's was found in the blood metabolism parameters.

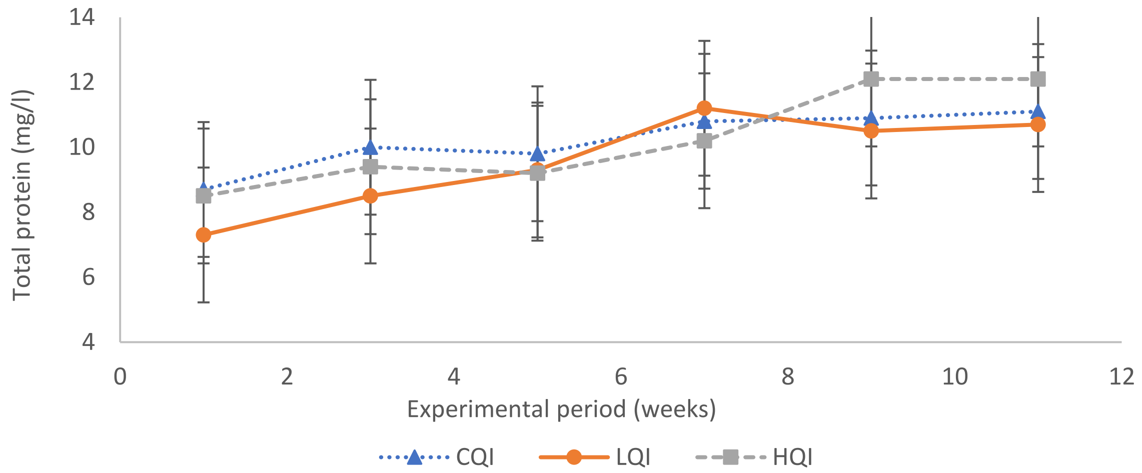

Fig. (4): Effect of supplemented different levels of gall of oak (*Quercus infectoria)* on total protein concentration of blood plasma of ewes at late pregnancy and early lactation.
CQI: control 0 g/kg, LQI: low level 5g /kg DM, HQL: high level 10g /kg DM.

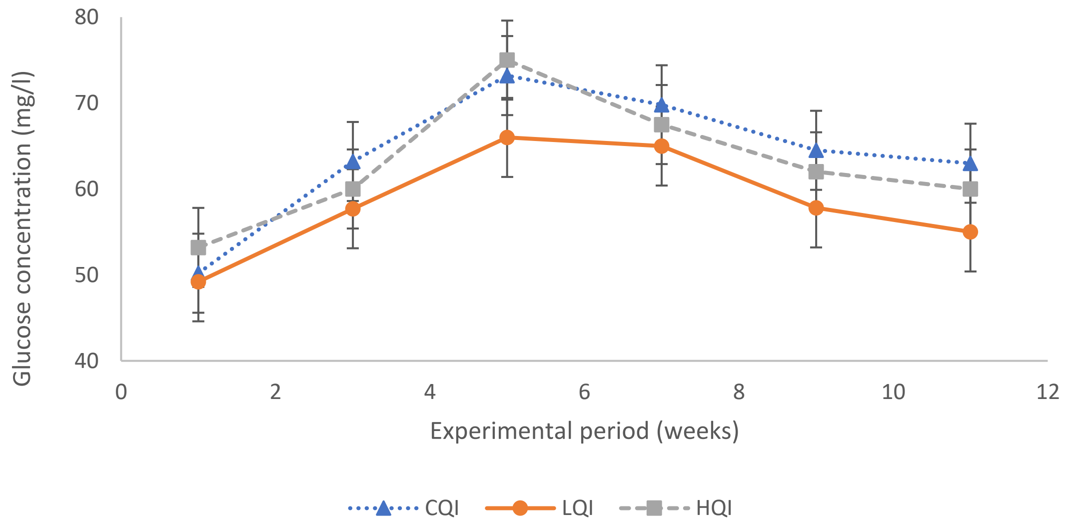

Fig. (5): Effect of supplemented different levels of gall of oak (*Quercus infectoria)* on glucose concentration of blood plasma of ewes at late pregnancy and early lactation.
CQI: control 0 g/kg, LQI: low level 5g /kg DM, HQL: high level 10g /kg DM.

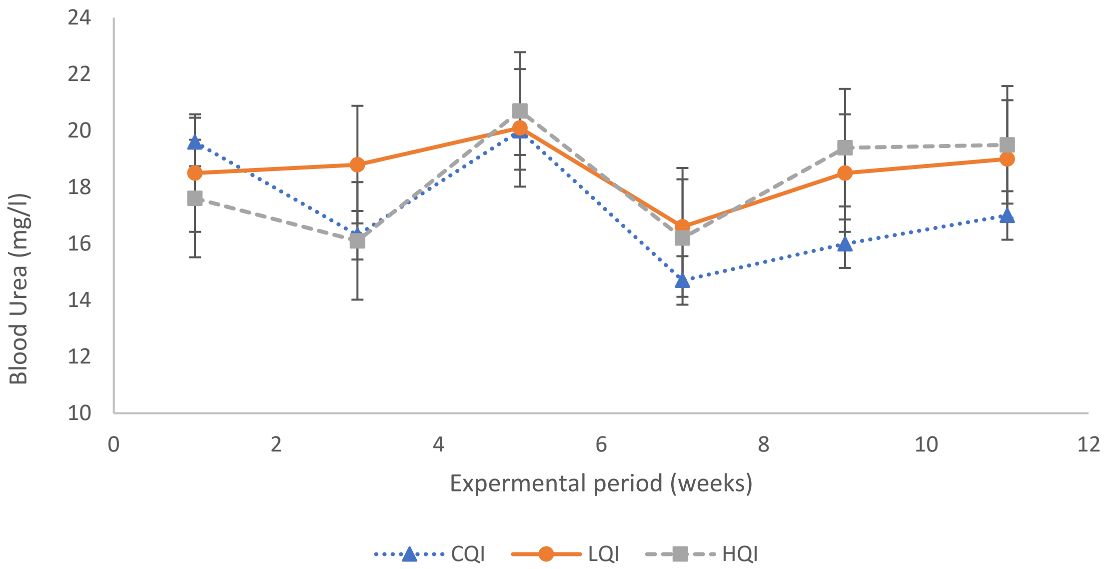

Fig. (6): Effect of supplemented different levels of gall of oak (*Quercus infectoria)* on urea concentration of blood plasma of ewes at late pregnancy and early lactation.

CQI: control 0 g/kg, LQI: low level 5g /kg DM, HQL: high level 10g /kg DM.

4. CONCLUSION

The main effect of treating a ruminant concentrated diet with gall oak *Quercus infectoria* (QI) were in the digestibility especially with CP and CF. Increasing diet digestibility would probably was the main reason for significantly (P<0.05) increased milk yield when ewes offered concentrated diet with 10 g/kg DM (QIH) at early lactation, while there were no other effects appear on ewes body weight, condition scoring nor blood plasma parameters. Therefore, further studies would be important to carried out on dairy cows' and sheep diet with the gall of QI during the lactation period.

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تاثير اضافة جرعات مختلفة من عفص البلوط لعف الحيوانات على اداء النعاج خلال فترة الحمل الاخيرة و بداية ادرار الحليب.

الخلاصة

شجرة البلوط تعبتر من اكثر الاشجار انتشارا على مسوى العالم و تتميز باحتوائها على كيمات عالية من التانينات في الاوراق و الاغصان و الثمار و العفص. صممت هذه التجربة لدراسة اضافة جرعات مختلفة من عفص البلوط لعليقة النعاج و تاثيرها على تمثيل الدم و كفائة النعاج. استعملت خلال هذه التجربة اثنا عشر نعجة حامل بجنين واحد ستة اسابيع قبل الولادة. تم تقسيم النعاج اعتمادا على عمرها و حالة الجسم وبعدها وزعت عشوائيا الى ثلاثة مجاميع بواقع اربعة نعاج لكل مجموعة. المجموعة الاولى (مجموعة السيطرة) حيث غذيت علف مركز بدون اية اضافات. المجموعة الثانية غذيت نفس العلف المركز مع اضافة 5 غم مسحوق عفص البلوط / كغم علف. و المجموعة الثالثة غذيت ايضا نفس العلف المركز مع اضافة 10 غم مسحوق عفص البلوط /كغم علف. تم تحليل البيانات بطريقة التحليل المجاميع العشوائية الكاملة باستخدام برنامج الجين ستات 17. اظهرت النتائج ان اضافة كلا المستويين من مسحوق العفص لعلف النعاج قد اتدت الى زيادة هظم البروتينات الخامة, الالياف الخامة و المواد العضوية مقارنة بمجموعة السيطرة. كذلك اظهرت النتائج اضافة 10 غم مسحوق عفص البلوط/ كغم علف ادت الى زيادة انتاج الحليب معنويا بحوالي 15 % مقارنة بالمجموعتين الاخريين. في حين اضهرت باقي النتائج ان اضافة مستويات مختلفة من عفص البلوط للعف المركز لم توثر معونيا على وزن النعاج, حالة الجسم و تحليل ميتابولزمات الدم.

كلمات مفتاحية: تانين, عفص البلوط, انتاج الحليب, الهظم.

کارتێکرنا زێدەکرنا ئاستێت جێواز ێت مازیا ل ناڤ ئالیکێ گیانەوەرا ل سەر رەوش و بەرهەمێ میهیا ل دیماهیا دەمێ ئاڤزبونێ و دەستپێکا شیردانێ.

پوختە

دارا بەریێ ئێك ژ بەربلاڤ ترین دارە لسەرانسەری جیهانێ و دهێت نیاسین وهەبونا رێژەکا زور یا تانینا دناڤ بەلگ و دار بەری و مازیێت وی دا. ئەڤ ڤەکولینە هاتە رێکخستن بو خواندنا کارتێکرنا بکارئینانا ئاستێت جیواز یێ هیرکێ مازیێ ل ناڤ ئالیکێ گیانەوەرا ل سەر میتابولزما خوینێ و بەرهمدانا میهان. 12 میهێت ئاڤز ب ئێك کاڤر, شەش هەفتیان بەری زانێ هاتن بکارئینان ل ڤێ ڤەکولینێ. میە هاتن جیواز کرن لدویف ژی و قەلەوی یا لەشێ وان و هاتن دابەش کرن ل سەر سێ گروپا. گروپێ ئیکی (کونترول) ئالیکێ گیانەوەرا خوار بێ چ زێدەهی. گروبێ دویێ هەمان ئالیك خوار زێدەباری 5 گرام مازێت هێرای / کلوگراما ئالیکی هاتبو تێکەل کرن. و گروپێ سیێێ دیسان هەمان ئالیك خوار زێدەباری 10 گرامێت مازێت هیرایی / کلوگرامەکا ئالیکی هانبو تێکەل کرن. داتا هاتن شروڤەکرن ب رێکا کومبلیت راندومایز بلوك دزاین ب کارئینانا سوفت وێرێ جین ستات15. ئەنجاما دیار کر بکارئینانا هەردو ئاستێت مازێت هێرای لناڤ ئالیکێ میهان هەرسکرنا پروتینێ خاڤ, فایبەرێت خاڤ و ئورگانیکا بشیوەکێ بەرچاڤ زێدەبون بەراورد دکەل گروپێ کونترولی. دسیان ئەنجاما دیار کر بئکارئینانا 10 گرام مازێت هیرایی / کلوگرامەکا ئالیکی بەرهەمێ شیری ب شیوەیەکێ بەرچاڤ زیدەکر (15%) بەرامبەری هەردو گروپێت دی. لێ بکارئنانا ئاستێت جیواز یێت مازیێ چ جیوازێت دی یێت بەرچاڤ نەبون ل سەر کێشە و رەوشا لەشێ میهان و هەمی سالوخەتێت میتابولزما خوینێ .

پێزیانێت سەرەکی: تانین, مازی, بەرهەمێ شیری و هەرسکرن