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The Effect of Feeding Alfalfa and Barley in Comparison with Different Dietary Composition of Total Mixed Rations on Milk Composition and Growth of Najdi Lambs

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Authors' Contribution
RSA designed the study, collected samples, did statistical analysis and wrote the manuscript. MMA helped in experiments and sampling. MA did lab and field work. AHA collected and analysed the blood samples. MMA, MA and AHA helped in writing the manuscript.

Key words
Najdi ewes, Lambing rate, Mortality, Blood metabolites.

ABSTRACT

A field experiment was conducted to investigate the lambing rate, lamb growth and survivability of newborn lambs of pregnant Najdi ewes fed two different total mixed rations (TMR) with different levels of energy and protein viz. higher protein than recommended by National Research Council (1985; TMR1), and higher energy than National Research Council (1985; TMR2) compared with the traditional feeding system of barley and alfalfa hay; Control). A total of 96 Najdi ewes, about nine months old, were divided randomly into three dietary treatments two months before parturition (Late gestation). Lambing percentage, lamb birth weight, lamb weaning weight and mortality rate were recorded. Blood samples were collected regularly during the different stages and analyzed for different important nutritional metabolites. In addition, colostrum, at parturition, and milk samples on day 30, 60 and 90 postpartum were collected for nutrient contents. The results showed an improvement in lambing rate of ewes in T1 and T2 (81 and 80%, respectively) compared to the control (78.8%). Moreover, ewes in T2 showed higher lambs survival rate and average daily gain up to 90 days. There was no significant effect ($P>0.05$) of treatments on the colostrum composition but milk composition altered by the time interval. Blood metabolites did not vary among the groups, however, urea concentration was significantly ($P<0.05$) in the T1 and T2 groups. In conclusion, feeding Najdi ewes a diet containing higher energy and protein than recommended by National Research Council (1985), in comparison with the traditional feeding system, improved the lambing rate and growth of the newborns.

INTRODUCTION

The nutritional status of ewes has a great impact on the reproduction performance from mating to lambing. It is well documented that maternal nutrition plays an important role in fetal growth and development especially at late gestation (Abdelrahman *et al*., 2017a). In Saudi Arabia, most of sheep raise under traditional or semi intensive systems that depend mainly on barley and alfalfa hay as a main source of nutrient supply (Abdelrahman *et al*., 2017b). This traditional system may negatively affect the reproduction efficiency and consequently high mortality rate of the newborns which could result in severe economic losses. Therefore, the productivity of sheep in the Kingdom of Saudi Arabia, in general, is below their genetic potential because of many suppression factors including under nutrition during the critical physiological conditions such as gestation and lactation (Alhidary *et al*., 2016a). Moreover, it is well documented from the previous studies that animal nutrient requirement is affected by breed and environmental conditions (Alhidary *et al*., 2016b).

Najdi sheep are considered to be one of the most popular breed in the central province of Saudi Arabia and well adapted to the extreme hot environment and feed and water scarcity (Al-Owaimer *et al*, 2008). Najdi sheep is used to produce meat and occasionally some milk; however, most of the milk produced by the ewes is used to meet the growth requirements of their lambs.

Enough dietary energy and protein to pregnant ewes especially at late gestation is very critical to meet the fetus requirement since almost 80% of fetal growth occurs during late gestation (Robinson *et al*., 1999). Udder development and consequently colostrum and milk production are mainly affected by energy and protein supply through diet which is considered essential for healthy newborn (McGovern,

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2015). Moreover, late gestation nutrition supports ewes at parturition by reducing the ketosis incidences since proper feeding adds extra body fat reserve. Many studies in the literature reported the importance of feeding concentrate diet to ewes' during gestation with adequate nutrient supply for improving their reproduction efficiency. Kara *et al*. (2010), Kochapakdee *et al*. (1994) and Robinson *et al*. (2001) reported the importance of proper feeding using pelleted complete diet on growth and reproduction efficiency of ewes especially during late gestation. Martin *et al*. (2004) and Husted *et al*. (2007) and (2008) reported that poor dietary supplement to pregnant ewes caused lower birth weight of newborn and increased mortality rate. Moreover, poor body score, low lambing rate and poor wool characteristics were reported in ewes suffered from lack of feed supplements during the gestation (Taylor *et al*., 2002).

Adapting the feeding system of complete total mixed rations (TMR) can be one of the solutions to improve the productivity and reproductive efficiency of ewes by supplying a well-balanced diet with adequate levels of energy and protein when compared with the traditional feeding system especially at late gestation and lactation periods because of high nutrient requirements. This experiment was conducted to study the effect of feeding two different TMRs with different energy and protein contents in comparison with alafalfa hay and barley in Najdi ewes at late gestation on lamb growth and milk composition of Najdi sheep.

MATERIALS AND METHODS

Animal husbandry and experimental design

The study was approved by the Departmental Committee on the Rights and Welfare of Animals, King Saud University, Riyadh, Saudi Arabia.

A total of healthy 96 Najdi ewes (homogenized in term of age, size and body weight) were selected from the local market to be used in this trail. The ewes, two months before mating, were divided randomly into three groups. The ages of the ewes were from 7 to 9 months. The three dietary treatments were as follow, control group, ewes were fed traditional feed which mainly consist of barely (70% of DDMI) and alfalfa hay (30% of DDMI); T1, total mixed ration (TMR1) complete pellet feed, T2, TMR2 complete pellet feed (Table I). The nutritive value of T1 was formulated to supply pregnant ewes at late gestation with recommended metabolizable energy but higher protein levels (NRC, 1985). For the T2 contained recommended protein levels but higher energy (NRC, 1985). Feed sample were analyzed regularly on weekly basis for the nutritive values.

All ewes were housed at Al-Amarreh research station, King Saud University farm. Ewes were kept in different pens of groups, ten or more ewes/pen, with at least 2.5 m^2/head. After mating, a real time B-mode ultrasound scanner equipped with a 2.5 to 10 MHz probe (Chison 8300 Vet, Chison Co. Ltd., China) was used for diagnosing the pregnancy and identifying the late gestation stage for the pregnant ewes to start supplementation. The amounts of feed offered were changed according to the body weight and nutrient requirements at different physiological status.

Table I.- Chemical composition of control and experimental groups.

Nutrients	Barley	Alfalfa hay	T1	T2
Dry matter (%)	88.50	93.44	93.60	92.92
Crude protein (%)	11.45	17.90	13.7	12.2
Metabolizable energy (Mcal/kg)	2.93	2.82	2.17	2.39
NDF (%)	31.15	43.30	41.8	42.2
ADF (%)	5.71	34.58	26.9	26.4
Ash (%)	2.65	9.46	11.27	8.75
Calcium (%)	0.05	1.34	2.39	1.86
Phosphorus (%)	0.34	0.23	0.92	0.37

Blood collection

Blood samples were collected from newborn lambs at birth, 30, 60 and 90 days old and centrifuged at 3000 rpm for 15 min and serum was separated. Serum samples were stored at –20°C until analysis.

Sample analyses

Blood glucose, triglyceride, total protein, cholesterol, urea-N, calcium and phosphorus levels were measured by spectrophotometer using different available commercial kits (United diagnostics Industry, Dammam 31413, KSA).

Performance traits

Feed intake was measured on weekly basis. Body weight of newborns was measured at birth, 30, 60 and 90 days (weaning). Mortality rate were recorded. Colostrum samples were collected for the first three days from each treated groups and analyzed for the nutritive value using Milko Scan (Minor Type 78,100, Foss Electric, Denmark).

Pregnancy, lambing, fecundity, lamb survival and mortality rates were calculated for each group.

Statistical analysis

The data were statistically analyzed using SAS Software (2002). Descriptive analyses and frequencies were carried out with PROC MEANS and PROC FREQ. When significant differences among treatment and other

factors were found, means were separated with LSD and LSMEANS tests. Statistical significance was assessed at P<0.05.

Table II.- Composition of colostrum of different feeding treatments.

Composition	Treatments		
	Control	T1	T2
Fat (%)	10.35±0.74	9.06±1.01	9.20±1.09
Protein (%)	11.98±0.32	12.47±0.44	12.07±0.47
Lactose (%)	2.29±0.15	2.57±0.22	2.95±0.26
Total solids (%)	26.44±0.87	25.76±1.19	25.44±1.28

Table III.- Effect of treatments and stages of lactation on milk composition in the control and treated groups.

Composition (%)	Month	Treatments		
		Control	T1	T2
Fat	1	4.73 ± 0.39^{b}	4.68 ± 0.53^{b}	4.40±0.51
	2	5.47 ± 0.46^{abA}	6.40 ± 0.69^{aA}	4.46 ± 0.60^{B}
	3	6.02 ± 0.44^{aA}	5.10 ± 0.74^{bA}	3.91 ± 0.74^{B}
Lactose	1	4.61±0.17	4.43±0.25	4.91±0.21
	2	4.54 ± 0.19^{A}	4.05 ± 0.26^{B}	4.40 ± 0.27^{A}
	3	4.40±0.19	4.46±0.31	4.50±0.29
Total solid	1	13.14 ± 0.53^{b}	13.09±0.75	13.02±0.69
	2	14.28 ± 0.64^{ab}	12.49±0.80	13.66±0.85
	3	15.01 ± 0.60^{aA}	13.62 ± 0.95^{A}	11.64 ± 0.82^{B}

a,b, mean values within the same column bearing different superscripts are significantly different at P<0.05. A,B, mean values within the same row bearing different superscripts are significantly different at P<0.05.

RESULTS

The effect of feeding different regimen on the colostrum composition is given in Table II. No significant difference was found between the control and treated groups in colostrum composition. The effect of treatments on the milk composition at different stages of milk of production is given in Table III. Milk fat was significantly (P<0.05) low in T2 at different months of lactation. Similarly, milk fat was improved during the second and third months in control group while in T1 it was highest during the second month and then declined in the third month. Lactose concentration was significantly (P<0.05) reduced in T1 compared to the control and T2. Total solids concentration reduced significantly (P<0.05) in T2 compared to the T1 and the control. Similar to fats, total solids improved significantly (P<0.05) improved in second and third month.

The survival rate of newborn lambs of the control and treated groups is given in Table IV. The higher values for the survival rate of the newborn lambs were found in lambs born from ewes fed with T2 compared with the control and T1 at weaning. The effect of feeding regimen on the body weight and average daily gain is given in Tables V and VI. No significant difference was found in body weight on different days of measurement. Significantly (P<0.05) higher average daily gain was found in lambs where their mothers were treated with TMR during the period of 0-30 days and 0-90 days. No significant difference was found in other intervals.

Table IV.- Survival rate of newborn lambs up to weaning.

Age (days)	Control	T1	T2
00	92.3	94.1	87.5
07	80.8	82.4	87.5
30	63.3	70.6	87.5
60	63.3	70.6	75.0
90	61.5	68.4	73.7

Table V.- The effect of different dietary regimen on body weight of newborns lambs from birth up to weaning.

Age (days)	Control	T1	T2
0	04.91	04.61	04.71
30	10.30	10.69	10.54
60	17.26	17.12	17.86
90	25.93	26.92	26.78

Table VI.- The effect of different dietary regimen on average daily gain (g) of newborns from birth up to weaning.

Days	Control	T1	T2
0-30 days	149.26 ± 19.00^{b}	202.41 ± 19.97^{a}	187.34 ± 19.71^{a}
30-60 days	182.08±23.25	238.19±26.25	209.25±24.44
60-90 days	297.84±29.55	323.62±34.34	341.27±30.76
0-60 days	164.08±18.22	215.27±20.57	195.13±19.15
30-90 days	236.13±18.85	275.10±20.67	269.56±19.51
0-90 days	208.80 ± 14.36^{b}	247.52 ± 15.74^{a}	240.87 ± 14.86^{a}

a,b, mean values within the same row bearing different superscripts are significantly different (P<0.05).

The effect of diet on serum metabolites of the newborn lambs at birth, 30, 60 and 90 days is given in Table VII. The results indicated that no significant (P>0.05) difference between dietary treatments on total protein and glucose levels in newborn lambs was found, however, differences

within the treatments by sampling time was significant. Total protein concentration in blood of newborn lambs from the traditional feeding group was significantly (P<0.05) higher at birth compared at 30, 60 and 90 days. Moreover, lambs from T1 showed a significantly (P<0.05) lower total protein levels at 90 days when compared with at birth. Significantly (P<0.05) lower blood urea was found in T1 and T2 compared to the control on day 0, 60 and 90.

Table VII.- The effect of different dietary regimes of ewes on the blood serum metabolites of the newborn lambs up to 90 days old.

Metabolites	Age (days)	Control	T1	T2
Total protein (g/dl)	0	7.26±0.31^{a}	6.64±0.42^{a}	6.72±0.40
	30	6.14±0.48^{b}	6.03±0.55^{ab}	7.11±0.73
	60	6.01±0.42^{b}	5.85±0.51^{ab}	6.10±0.44
	90	5.91±0.39^{b}	5.40±0.46^{b}	5.63±0.42
Glucose (mg/dl)	0	61.15±5.83	62.58±7.89	56.94±7.58
	30	27.97±9.12	33.25±10.34	33.62±13.68
	60	48.56±7.89	48.50±9.67	40.60±8.25
	90	70.46±7.31	79.38±8.65	76.05±7.89
Triglyceride (mg/dl)	0	69.61±5.35	84.74±7.24	72.40±6.96^{a}
	30	83.10±8.37	81.52±9.49	82.22±12.55
	60	61.40±7.24	59.83±8.87	73.10±7.57
	90	65.90±6.71	66.79±7.94	79.58±7.24
Cholesterol (mg/dl)	0	65.10±4.45	68.69±6.02	59.12±5.78
	30	98.24±6.95	97.54±7.88	99.32±10.43
	60	95.40±6.02	89.76±7.38^{b}	79.40±6.29
	90	77.65±5.57	75.77±6.60	69.63±6.02
Urea-N (mg/dl)	0	54.50±2.29^{aA}	46.95±3.10^{aB}	43.42±2.98^{aB}
	30	36.56±3.58^{b}	36.30±4.06^{b}	36.65±5.38^{ab}
	60	46.29±3.10^{cA}	35.23±3.80^{bB}	27.69±3.24^{bC}
	90	51.84±2.87^{acA}	43.69±3.40^{aB}	37.21±3.10^{bC}

$^{a, b}$, mean values within the same column bearing different superscripts are significantly different (P<0.05).

DISCUSSION

In the current study, body weight was improved in the T1 and T2 compared to the control. These finding agreed with van Emon *et al*. (2014) and Ahmed *et al*. (2016) who reported that feeding ewes a high energy and protein diet during late gestation affected the survivability and growth performance of newborn lambs. During pregnancy, high energy contents enhance the growth and development of newborn lambs by increasing the availability of milk during suckling stage (Castro *et al*., 2012; Ahmed *et al*. 2016). This resulted of reducing the negative energy balance of ewes at late gestation and during lactation (Torreao *et al*., 2014).

The effects of the three different dietary regimes on milk composition are reported in Table VII. Milk used in our study has a similar percent of total solids (13.6%) with those previously reported in Najdi sheep (Ayadi *et al*., 2014), but lower compared to other reported values (16-19%) for a number of European and Asian dairy sheep breeds (Alichanidis and Polychroniadou, 1996). Milk total solid content did not differ between feeding treatments during the first and second months of lactation. However, the higher value of total solid content was obtained in traditional feeding group when compared with T2 group during the third month of lactation. The low total solid of ewes fed high energy levels , compared to control and T1 may be the resulted of high milk yield as a result of high production of propionic acid in the rumen (Alhidary *et al*., 2017). The same trends were reported for fat and protein percentages which can be explained as above.

The obtained milk fat content in our study after lambing was lower than the values reported for Lacuane (Castillo *et al*., 2009) and Awassi ewes (Nudda *et al*., 2004) but in the same range to those reported for Najdi ewes by Ayadi *et al*. (2014). Therefore, breed differences and nutrition programs can explain the discrepancies between our results and previous studies. One month after lambing, milk fat content was numerically higher in ewes than control group when compared with the T1, T2 and control groups. After two month of lambing, the milk fat content was significantly lower in ewes in T2 when compared with the traditional feeding and T1 groups. Significant increases of milk fat content from the first month to third month and from the first month to the second month after lambing were observed in ewes in the control and T1 groups. Similar increase of milk fat content throughout lactation was observed in some of the relevant work (Yilmaz *et al*., 2011, 2014).

On average milk protein and lactose contents were similar to the values previously reported in dairy ewes (Yilamiz *et al*., 2011; Ayadi *et al*., 2014). Milk protein content did not change according to the dietary regimen during the first and third months of lactation. However, in the second month of lactation, the value was significantly higher in ewes in T2 group. Milk lactose content did not differ between feeding treatments during the first and third month of lactation. Nevertheless, a significantly lower value in ewes' milk from T1 group was observed in the second month of lactation, when compared with the traditional feeding and T2 group.

Blood protein decreased significantly as the age of neonates increased. The reason may be the utilization of blood protein in the muscle growth of the neonates. Similarly, blood glucose reduced linearly till the age of 60 days and then sustained at the age of 90 days. The reason

could be the higher requirements of glucose during the early growth stage. Monitoring of blood urea-N levels can be used for measuring protein status in ruminant animals from different feeding regimes (Hammond, 2006). High blood urea levels could indicate a high protein intake or the excessive mobilization of muscle (Chimonyo *et al*., 2002). The blood urea was higher in the control group in the neonates compared to the T1 and T2. The reason could be due to the higher crude protein contents of alfalfa in the control group compared to the other counterparts.

CONCLUSION

In conclusion, feeding Najdi ewes a diet containing higher energy and protein than recommended by National Research Council (1994), in comparison with the traditional feeding system, improved the lambing rate and growth of the newborns.

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Statement of conflict of interest

Authors have no potential conflict of interest.

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