Ann. Zootech. 48 (1999) 389–395
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Original article

Optimum use of straw based diets for suckled Awassi ewes

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(Received 2 July 1998; accepted 23 June 1999)

Abstract — An experiment was conducted using three complete rations containing either 31.2, 45.0, or 58.6 % chopped wheat straw. Sixty Awassi ewes were divided into three experimental groups arranged in a randomized block design. Individual feed intake, milk yield from lambing to weaning of the lambs, and body weight of ewes and lambs were measured. The reduction in barley grain proportions with elevated levels of straw resulted in a reduction of the calculated metabolizable energy (ME) from 10.5 to 9.6 to 8.5 $MJ \cdot kg^{-1}$ in rations 1, 2, and 3, respectively. The crude protein (CP) contents were 14.2, 14.4 and 15.1 % DM for these rations, respectively. The voluntary feed intake decreased significantly and was lowest ($P < 0.05$) for group 3 until the seventh week, but leveled off thereafter until the end of the experiment at 13 weeks of lactation. Average body weights were 61.2, 60.1, and 51.6 kg at the end of eight weeks of the experiment for treatments 1, 2, and 3, respectively. The body weights in the third group were significantly lower ($P < 0.05$) than those of the other groups during the first 8 weeks post-partum. The decreased body weight of the third group was then maintained throughout the experimental period. Thus, the average body weights were 66.2, 66.9, and 56.4 kg for rations 1, 2, and 3, respectively, at the end of the experimental period. Total milk yields were not significantly different among the three groups, being 34.5, 37.9, and 39.0 for groups 1, 2, and 3, respectively. Such a pattern of milk yield was not, however, well reflected by the weight of lambs at weaning, which was the lowest ($P < 0.05$) for group 3 compared with the other experimental groups. (© Elsevier / Inra).

Awassi ewes / wheat straw / feed intake / body weight / milk production

Résumé — **Utilisation optimale de rations à base de paille chez des brebis Awassi allaitantes.** Une expérience a été conduite en utilisant trois rations complètes contenant 31,2, 45,0 ou 58,6 % de paille de blé hachée. Soixante brebis Awassi ont été réparties en trois groupes expérimentaux selon un dispositif aléatoire par blocs. La quantité ingérée, la production laitière, et le poids vif des brebis et des agneaux ont été mesurés. La réduction des proportions de grains d'orge avec les niveaux éle-

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vés de paille a eu comme conséquence une réduction de l'énergie métabolisable (ME) calculée : de 10,5 à 9,6 et 8,5 MJ·kg^{-1} pour les rations 1, 2, et 3, respectivement. Le pourcentage de matières azotées totales de ces rations a été respectivement de 14,2, 14,4 et 15,1 %. L'ingestion volontaire d'aliments a été diminuée significativement et a été la plus basse ($p < 0,05$) pour le groupe 3 jusqu'à la septième semaine, puis elle s'est stabilisée jusqu'à la fin de l'expérience (13 semaines). Les poids vifs moyens ont été de 61,2, 60,1, et 51,6 kg par animal à la fin des 8 semaines d'expérience pour les traitements 1, 2, et 3, respectivement. Le poids vif des brebis du groupe 3 a été sensiblement inférieur ($p < 0,05$) à celui des deux autres groupes pendant les 8 premières semaines après la mise bas. Ce résultat s'est maintenu durant toute l'expérience. Ainsi, les poids vifs moyens à la fin de la période expérimentale ont été de 66,2, 66,9, et 56,4 kg pour les rations 1, 2, et 3, respectivement. Les productions laitières n'ont pas été significativement différentes entre les groupes : 34,5, 37,9, et 39,0 pour les groupes 1, 2, et 3, respectivement. Cette absence de différence de production laitière ne s'est pas traduite au niveau des poids des agneaux au sevrage, qui était le plus bas ($p < 0,05$) pour le groupe 3 comparé aux deux autres groupes expérimentaux. (© Elsevier / Inra).

brebis Awassi / paille de blé / ingestion / poids vif / production laitière

1. INTRODUCTION

The Awassi breed of sheep is widely spread throughout the Middle East area and is also considered to be the major indigenous breed in Jordan. Natural selection has allowed this breed to be very well adapted to dry ranges, a harsh environment, and to local diseases.

The estimated sheep population in Jordan is about 2.5 million, providing 26 % of the total locally produced [8]. Most of the sheep in Jordan graze on the rangelands in eastern and southern Badia under low average rainfall. Grazing is poor during late pregnancy (mid September, October) and early lactation (November, December). As a consequence, sheep are fed straw, barley grains, and other supplements.

Around 200 000 tons of wheat straw are available yearly for feeding sheep, goats, and cows [16]. Sheep and goats are fed for several months during the summer with residual field straw with little supplements. Therefore, sheep have to mobilize body reserves. Chopped straw constitutes only half of the energy provided to small ruminants, due mainly to its low digestible energy content [29]. The use of straw in ruminant feeding has been studied by many researchers in warm climate countries [4, 5, 22]. In order to optimize the use of poor quality roughages by ruminant it is necessary to either improve the quality of the roughage or to use the appropriate supplementation and feeding techniques [30]. Ramalho Ribeiro [27] conducted an experiment on sheep, comparing straw treated with urea or supplemented with soybean meal and concluded that for the overall parameters, DM, OM, or energy there was no significant effect between treatment and supplementation. In this experiment, straw fed in a total mixed ration with the proper supplementation of protein and minerals ensures an optimum utilization.

The objective of our study was to examine the maximum rate of straw inclusion in total mixed diets, with an appropriate supplementation for lactating ewes without decreasing ewe and lamb performance.

2. MATERIALS AND METHODS

2.1. Experimental animals

The experiment began on January 1996 and lasted for 13 weeks. A total of 60 mature multiparous Awassi ewes with their lambs (60 lambs) were obtained from the Jordan University of Sci-

ence and Technology (JUST) flock. The lambs were born on January and weaned at an average of eight weeks of age.

The average body weights of the ewes ranged from 62.8 to 66.5 kg and they were aged from three to five years. All ewes had similar prepartum feeding regimens. The ewes were randomly divided into three equal groups according to their age. Ewes were individually penned in special pens constructed for such studies at the JUST experimental station.

2.2. The feeding experiment

The ewes were individually fed total complete rations containing either 31.2, 45.0, or 58.6 % chopped wheat straw (on a dry matter basis) and a concentrate containing high amounts of barley which is a local feed available as an energy source. The composition of the chopped wheat straw mixed totally with the ground feed is given in *table I*. The offered and refused feeds were measured daily for each animal and were recorded on a weekly basis to minimize day to day intake variations within or between the groups. Feed refusal was discarded daily. A daily allowance of 1.1 × the previous days intake was offered to each ewe during the experimental period. In weeks 5 and 6 when the lambs began to eat from the complete rations the feed was given once daily, when the lambs were kept apart from their dams. After weaning (8 weeks), the ewes were fed ad lib as in the first four weeks of the experiment.

2.3. Body weight changes, lambing performance, and lamb growth

The body weights of the ewes were measured every two weeks. The number of ewes lambed and the lambs born alive or dead were also recorded, together with the birth and weaning weights of the lambs. Lambs were weaned on the average at two months of age.

2.4. Estimation of milk yield

Milk yield before weaning was measured by the lamb-weight increment technique and by

Table I. Dietary composition of the experimental rations and their chemical analyses and energy content.

Ingredients used (%)	Diet 1	Diet 2	Diet 3
Wheat straw	31.2	45.0	58.6
Barley grain	42.8	27.4	12.8
Soybean	13.8	15.0	15.0
Wheat bran	10.0	10.0	10.0
Urea	0	0.4	1.4
Limestone	1.0	0.5	0.5
Dicalcium phosphate	0.5	0.5	0.5
Salt	0.5	0.5	0.5
Trace mineral	0.2	0.2	0.2
Chemical analyses			
DM (%)	93.3	93.7	94.2
CP (% DM)	14.2	14.4	15.2
Ash (% DM)	7.0	9.0	9.5
EE (% DM)	1.4	1.4	0.8
CF (% DM)	14.2	19.0	21.4
NFE (%)	15.7	21.0	24.0
NDF (% DM)	36.5	42.8	49.9
ME (MJ/kg / DM)	10.5	9.6	8.5

DM: dry matter, CP: Crude protein, EE: Ether extract, CF: Crude fiber, NFE: Nitrogen free extract, NDF: Neutral detergent fiber, ME: Metabolizable energy.

milking-out [11, 18]. The lambs were separated from their mothers at night for 12 h. The lambs were weighed just before suckling, and allowed to suckle their mothers. The lambs were weighed again after they had obtained as much milk as possible. After suckling the udder was emptied by hand-milking and any left over milk was measured. The amounts of milk suckled and the milk obtained by hand-milking was multiplied by two to estimate the total milk yield of the ewes per 24 h. Milk production was measured and recorded every two weeks. After weaning, ewes were hand-milked twice a day.

2.5. Chemical analyses

Feed samples were taken daily, mixed and stored for analysis. The samples were then dried at 100 °C overnight and ground using a Brabender® grinder with a 1-mm diameter screen. The ground samples were analyzed for the proximate components [2]. The DM contents were determined following oven drying at 55 °C for 72 h using a forced air circulation. Ash was determined by burning in a furnace at 600 °C for 4 h. The CP was determined by the macro-kjeldahl method (Kjeldahl N × 6.25), and NDF determination was carried out [13]. The ME values for all rations were calculated from the NRC standards [21].

2.6. Statistical analyses

The present experiment was arranged in a randomized block design with three treatments of 20 animals each over a 91-day period. The data were then analyzed using the least-square procedure [17]. Analyses were performed through the Likelihood Computer Program, PC-2 version.

3. RESULTS AND DISCUSSION

The individual ingredients of the total complete rations and their chemical analyses are shown in *table I*. Straw was incorporated in total mixed rations consisting of barley grain, urea and a good source of protein, soybean, plus minerals and vitamins to ensure maximum intakes and the utilization of straw without affecting the production. The increased level of straw and decreased level of grain have resulted in a linear reduction of the calculated ME values: 10.55, 9.60, and 8.50 $MJ \cdot kg^{-1}$ in ration 1, 2, and 3, respectively. Crude protein levels were lower in ration 1 and 2 than in ration 3, due to the inclusion of a larger amount of urea in that ration. This difference, however, was not statistically significant, and the CP values have in all cases met the minimum requirements of the experimental animals [21]. Large variations in the requirements of digestible protein during early lactation in ewes have been reported [3, 28]. A large part of that variation may be attributed to differences in breed, milk yield and composition, and the level of energy. Another source of variation is the expected change in weight and the utilization of body tissue for the synthesis of milk, especially in early lactation [24]. The current experiment was designed to have a sufficient crude protein level at the same levels for the three treatments to ensure an efficient utilization of the straw. NDF values, however, were higher in ration 3 due to the incorporation of a larger amount of straw into the ration.

The intakes of the complete rations is shown on *figure 1*. No difference in intake was observed between rations 1 and 2, showing that decreasing concentrate allowed on increase in straw intake, However ewes fed ration 3 reduced their intake by more than 0.5 $kg \cdot d^{-1}$. This reduction was significant ($P < 0.05$) in the first four weeks post-lambing, due to the physical limitation imposed by the high fiber content in their ration. This coincided with higher nutritional requirements imposed on the ewes during early lactation. This result was in agreement with previous findings [7, 9, 10, 14, 23]. Towards the end of the experiment, however, there were no significant differences in the feed intake between the three treatment groups. This may be due to the drop in ewe requirements after weaning.

The average liveweights in the three treatments decreased in the first eight weeks

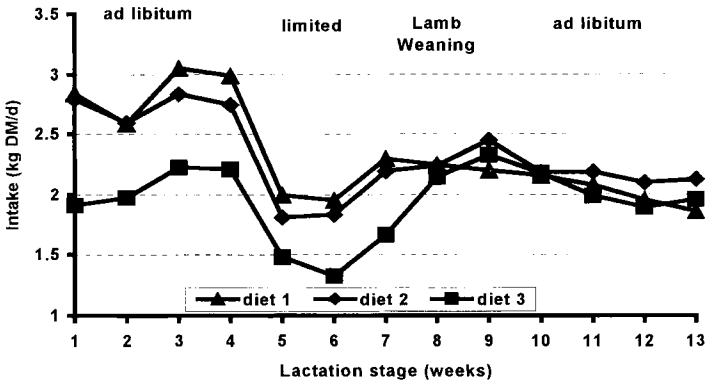

Figure 1. Feed intake of the Awassi ewes fed complete rations containing either 31.2 (diet 1), 45.0 (diet 2), or 58.6 (diet 3) % of chopped wheat straw.

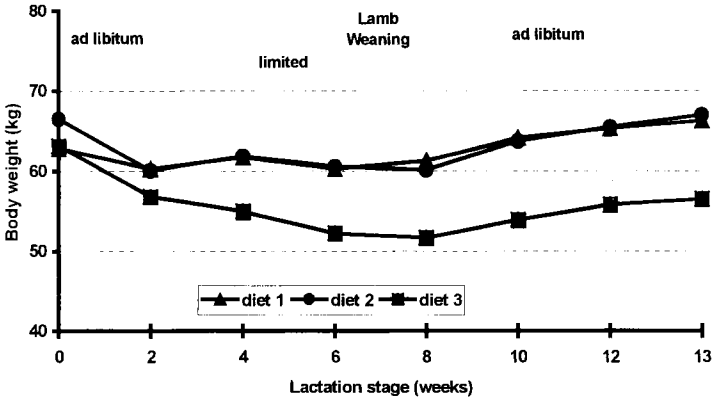

Figure 2. Average body weights of lactating Awassi ewes fed complete rations containing either 31.2 (diet 1), 45.0 (diet 2), or 58.6 (diet 3) % of chopped wheat straw throughout the experimental priod.

post-partum and then increased. At the end of the experiment, the cumulated weight loss was greater ($P < 0.05$) in group 3 compared to the other two groups (*figure 2*). This was probably due to a reduced energy intake by animals in that group because feed intake and probably digestibility decreased. Annison and Armstrong [1] reported an inverse relationship between fiber content of feeds and the capacity of their ME to promote gain. Such a relationship was further demonstrated with Awassi ewes [10].

The average birth and weaning weights are shown in *table II*. There were no significant differences in lamb birth weights among the three animal groups ($P > 0.05$). Animals in group 3 gave the lowest weaning weight ($P < 0.05$).

Figure 3 shows the average estimated milk production values of 0.62, 0.68, and 0.70 kg·day^{-1} for the first 8 post-lambing weeks for treatments 1, 2, and 3, respectively. The production is consistent with previous results obtained in underfed Awassi ewes [9]. There were no significant differences in milk yield between the experimental groups, indicating that group 3 gave a similar milk production in spite of the reduced feed intake. This means that animals in group 3 depended heavily on their body fat reserves to compensate for the lack of energy required to maintain milk yield, with subsequent weight losses during the first eight weeks post-partum. This was contrary to findings who indicated that the milk yield of ewes increased linearly with an

Table II. Average birth weights, weaning weights and body weight changes of lambs in the three treatment groups (in kg).

Diet[1]	Birth wt	Weaning wt	Body wt changes of lambs
1	5.0	20.2[a]	+ 15.2
2	5.2	20.3[a]	+ 15.1
3	5.3	17.8[b]	+ 12.5

[a, b] Mean values in the same column with different superscripts differ significantly ($P < 0.05$).
[1] Diets containing either 31.2 (diet 1), 45.0 (diet 2) or 58.6 (diet 3) % of chopped wheat straw.

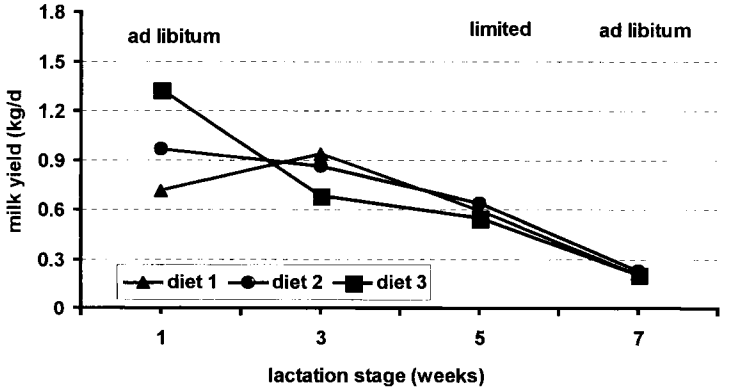

Figure 3. Average milk production of Awassi ewes fed complete rations containing either 31.2 (diet 1), 45.0 (diet 2), or 58.6 (diet 3) % of chopped wheat straw during the first 8 weeks (suckling period).

increasing level of energy intake during lactation [19, 20, 25]. On the contrary, other results [6, 12, 15, 26] reported that the influence of the body condition score was more important than good nutrition during early lactation. This might explain the non-significant differences between the experimental groups in our study. Such a pattern of milk yield was not, however, well reflected by the weight of lambs at weaning, which was the lowest ($P < 0.05$) for group 3 compared to other experimental groups, this may be due to low milk yield or to a determination of milk estimation inadequate.

4. CONCLUSION

Feeding of complete rations containing up to 45 % straw had no adverse effects on the lambing or milking performance of Awassi ewes. The suggested level of straw could even be increased to 58 % without affecting production parameters, provided that the body condition scores of the ewes are kept high before mating. This point, however, needs further investigation.

ACKNOWLEDGMENTS

This project was supported by the EU-Jordan co-operative program for Science and Technology. Ref.: SEM/03/628/033. The authors wish to thank J.P. Hanrahan for his help in carrying out the statistical analysis and to B. Obeidat and M. Abu Ishmais for their technical assistance. We also like to thank the farm crew at the Agricultural Centre for Research and Production at JUST for their help in carrying out this experiment.

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