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The nutritive value of available varieties of barley straw in Lebanon. Effects of feeding barley straw of three varieties on liveweight gain in Awassi lambs

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SUMMARY – Differences in the nutritive value of three varieties of barley straw available in Lebanon were investigated, using the *in sacco* (nylon bag) technique in 3 fistulated sheep. The disappearance from the nylon bags varied between varieties from 14.7-23.7% at zero hours and from 34-52% after 24 hour incubation. The current experiment aimed to compare the results of nylon bag degradation of the straws with performance of animals. For this purpose, 3 varieties were selected. These were similar in their seed (4520-5530 kg/ha) and straw production (12420-14030 kg/ha) but differed in nutritive value according to nylon bag degradation. In the 3 selected varieties Rihan, Pamir and Saiidi, the disappearance percentage at zero time was 15.2, 16.6 and 22.2% and 35.8, 39.8 and 48.7% after 24 hours incubation, respectively. Three groups of Awassi lambs with a mean weight of 49.2 kg were offered 250 g/head of ground barley and *ad libitum* straw (20% in excess of previous daily intake) during a 7 day adaptation period, followed by a 48 day period in which intake was recorded daily. Liveweight was recorded weekly. The daily intakes of straw were 790, 802 and 853 g/day for the varieties, Rihan, Pamir and Saiidi, respectively. Daily liveweight gains differed significantly ($P < 0.05$), with gains of 36, 50 and 86 g for the varieties Rihan, Pamir and Saiidi, respectively. Animal performance reflected the differences between varieties obtained with the nylon bag technique. However, the proportion of leaf to stem in the straw did not follow the same trend. Because of the importance of straw in diets for ruminants in the Lebanon and the Middle East, it is suggested that selection of new cereal varieties should take into consideration the nutritive value of the straw as well as the quantities of seed and straw they produce.

Key words: Awassi, lambs, straw, barley, dry matter rumen degradation, liveweight gain.

RESUME – *"Valeur alimentaire des variétés de paille d'orge disponibles au Liban. Croissance des agneaux de race Awassi recevant différentes variétés de paille d'orge". La différence de valeur nutritive entre 3 variétés de paille d'orge au Liban a été étudiée en utilisant la technique* in sacco *(sachets de nylon) utilisant 3 brebis fistulées. Les objectifs de l'expérience ont porté sur la comparaison entre les résultats obtenus avec les sachets de nylon et les performances des animaux. Pour cela, 3 variétés de paille d'orge ont été choisies : Rihan, Pamir et Saiidi ayant une production semblable de grains (4520-5530 kg/ha), et de paille (12420-14030 kg/ha) mais différant pour la valeur de dégradation de la matière sèche. Le pourcentage de dégradation de la matière sèche a été de 15,2, 16,6 et 22,2% après zéro h d'incubation et de 35,8, 39,8 et 48,7% après 24 h d'incubation et ceci pour les 3 variétés étudiées. L'expérience a été effectuée sur trois groupes d'agneaux de la race Awassi ayant un poids moyen initial de 49,2 kg. Chaque agneau a reçu 250 g d'orge et une quantité* ad libitum *de paille par jour (20% en plus de la consommation du jour précédent). L'expérience a duré 48 jours, pendant lesquels la consommation quotidienne a été enregistrée. Les agneaux ont été pesés tous les 7 jours. Pour les 3 variétés, la consommation moyenne de paille a été de 790, 802 et 853 g/jour. De même, le gain de poids journalier de 36, 50 et 86 g a été significativement différent entre les 3 lots ($P < 0,05$). Les performances des animaux ont été en accord avec les valeurs de dégradation de la matière sèche dans les sachets de nylon. La proportion entre les feuilles et les tiges chez les 3 variétés n'a pas donné d'indication fiable sur les performances des animaux. Puisque la paille est importante pour l'élevage des ruminants au Liban et au Moyen-Orient, il est conseillé de prendre en considération la valeur nutritive des nouvelles variétés sélectionnées de paille et non pas seulement la production de grains.*

Mots-clés : *Awassi, agneau, paille, orge, dégradation de la matière sèche, gain de poids.*

Introduction

In the rangelands areas of the Mediterranean regions a large proportion of animal production comes from systems that are extensive and predominantly based on ruminants grazing cereal crop residues or mature pastures if they exist (Al-Saigh and Al-Kass, 1992). As crop residues are mature and highly lignified with low protein, vitamins and minerals content, their nutritive value (i.e. digestibility and intake) is low (McDonald *et al*., 1988). The limited intake of such poor quality roughages does not meet the daily maintenance requirements of sheep or goats that are usually

forced to graze these poor quality roughages during the dry season. The decline in the quality and quantity of herbage affect negatively the fertility (conception and twinning) of adult females (Ghazal and Sayegh, 1980).

Several studies have been carried out to determine the nutritive values of different varieties of barley and wheat straws (Orskov *et al*., 1988) by direct feeding or using chemical and biological techniques (Khazaal *et al*., 1993, 1995). Significant differences have been observed in the chemical composition, dry matter (DM) and nitrogen degradability in the rumen and palatability for sheep of thirteen varieties of barley straw (Chriyaa and Amri, 1997).

In Lebanon, new varieties of barley are being selected and released according to their adaptability to the local environment, resistance to diseases and most importantly their seed and straw yield. This process of selection did not include the quality of straw for feeding ruminants as a criteria. However, residues of barley and wheat play a very important role in the feeding of ruminants in Lebanon and the Middle-East and are used by most farmers as stubble or straw.

Preliminary investigations on the nutritive value of several varieties of barley and wheat straw have shown a large variation in their degradation characteristics (Khazaal, 2001). The present study aims to investigate the effects of using the straw of three different local varieties of barley as the main feed for growing Awassi lambs.

Materials and methods

Local varieties of barley straw

From between several varieties of barley and wheat that are continuously screened with the nylon bag technique, three varieties [Rihan (R), Pamir (P) and Saiidi (S)] were selected for the present study. These varieties were selected because although they had similar yield of straw and seed (Table 1), their nutritive value was observed to be variable when assessed using the nylon bag technique. As a result the nutritive value of the straws for the varieties Rihan, Pamir and Saiidi were respectively ranked as low, medium and high.

Table 1. Differences in straw and seed yield of three varieties of barley straw available in Lebanon

Straw variety	Straw production (kg/ha)	Seed production (kg/ha)
Rihan	12,420	4,950
Pamir	15,170	5,530
Saiidi	14,030	4,520

Barley straws from the three selected varieties were harvested during the year 2000. Amongst the three selected varieties Rihan is most widespread and appreciated by farmers. The varieties Pamir and Saiidi were recently released.

Dry matter degradation

DM degradation was determined in triplicates by incubating about 2.5 g air-dry samples milled through a hammer mill to pass a 2.5-mm screen in nylon bags in the rumen of three fistulated sheep. The size of the bags was 120 × 70 mm and they were made from nylon filter cloth LT075 (Lockertex, Church Street, Warrington, England) with a pore size of 45 to 55 µm. Bags were withdrawn after 6, 14, 24, 48 and 72 h, were washed for 10 min in a washing machine and dried for 48 h at 60°C. Zero time washing losses were estimated by soaking two bags per sample in warm tap water (39°C) for 1 h followed by washing and drying as before.

Data for DM degradation (mean of triplicates using three sheep) were fitted to the exponential equation $p = a + b\ (1 - e^{-ct})$ of McDonald (1981) where p was defined as DM degradation at time *t* and (*a* + *b*) was the potential DM degradation and *c* the rate of DM degradation. *a*, *b* and *c* are constants in the exponential equation. However, in evaluation of roughages there is often an initial lag phase which gives rise to negative a value. The problem of negative values was tackled according to Orskov and Ryle (1990). This was achieved by measuring the actual amount of soluble material and this fraction was defined as A. The insoluble but fermentable matter was defined as B = (*a* + *b*) – A and the *c* in this case remained unchanged.

Feeding trial

Twelve Awassi lambs were used in the study and divided into three groups (R, P and S) in a way that average weight of animals and total liveweight of each group was similar (Table 2). Each group of animals was kept in a pen on the floor of a large room.

Table 2. Weight and number of lambs used in the experiment

Groups of animals	Group Rihan (R)	Group Pamir (P)	Group Saiidi (S)
No. of animals	4	4	4
Weight of group (kg)	195.5	198.0	196.5
Average weight of animals (kg/head)	48.9	49.5	49.1
Age (days)	218	216	219
Standard deviation	5.5	6.7	3.0

All animals had free access to drinking water and minerals licking blocks. Prior to the start of the experiment, an average of 0.5 kilogram of concentrate [16% crude protein (CP) and 11 Megajoule (MJ) of metabolizable energy (ME) per kg DM] in addition to abundant quantities of cereal and leguminous crop residues were fed to the animals.

At the start of the experiment barley straw was offered *ad libitum* (20% in excess of previous day consumption) during a 7 days adaptation period, followed by a 48 days period in which intake was recorded daily. Ground barley was offered to each group at the rate of 1 kg/day (i.e. 250 g/head) in two equal meals in the morning and evening. Liveweight was recorded weekly. During the experiment, sub-samples of the straws offered were also collected for chemical analyses.

Chemical analysis

All chemicals used were reagent grade. Analyses for neutral and acid detergent fibre (NDF and ADF), lignin and CP were carried out in duplicates according to AOAC (1990). DM was carried out by incubating samples in an oven (105°C) overnight.

Results and discussion

Except for Rihan straw which had a lower lignin and ADF content, chemical components of the three varieties of barley straw used were similar (Table 3). This is in contrast with several studies correlating lignin negatively to animal performance (van Soest, 1982; Nordkvist and Aman, 1986; Ford and Elliot, 1987; Mbwile and Udén, 1991; Jung and Voguel, 1992).

The proportion of leaves to stems was highest in Saiidi straw (54%) followed by Rihan (52%) and lowest in Pamir (48%). Thus, fibre components and proportion of leaves to stems of the straws did not reflect animal performance (intake, growth). However, the nutritive value of the straws was well reflected by their degradation characteristics. This was obvious with the soluble fraction (A) and more

clearly with the rate (*c*) at which the straw was degraded with time (Table 4). These findings were in agreement with previous studies by Khazaal *et al.* (1993, 1995).

Table 3. Chemical analysis of the diet components (g/kg DM) and proportion of leaves, stems and nodes of the varieties of barley straws offered to the animals

	Rihan	Pamir	Saiidi	Barley
DM (%)	95.0	95.4	97.6	88.6
NDF	625.0	621.0	632.0	338.0
ADF	416.0	430.0	449.0	53.0
CP	28.7	30.6	31.6	92.4
Lignin	23.1	26.9	30.7	4.3
Leaves (%)	52.1	48.0	54.0	
Stems and nodes	47.9	52.0	46.0	

Table 4. Differences in DM degradation characteristics of the straw varieties Rihan, Pamir and Saiidi using the *in sacco* (nylon bag) technique

Straw variety	% of DM degradation after						Characteristics of degradation	
	0 h (A†)	6 h	14 h	24 h	48 h	72 h	(A + B) Potential of degradation	C (degradation rate/h)
Rihan	15.2	18.8	30.7	35.8	46.3	60.8	60.4	0.0218
Pamir	16.6	19.1	29.5	39.8	59.4	57.1	60.3	0.0252
Saiidi	22.2	24.8	44.0	48.7	52.9	61.5	63.7	0.0290

†A (soluble fraction): is the soluble fraction at 0 h of incubation.

Daily intakes of straw were 790, 802 and 853 g/day for the varieties, Rihan, Pamir and Saiidi, respectively (Table 5). Daily liveweight gains differed significantly ($P < 0.05$), with gains of 36, 50 and 86 g for the varieties Rihan, Pamir and Saiidi, respectively.

Table 5. Average daily intake and changes in liveweight of lambs fed the three varieties of straws

	Varieties of barley straw		
	Rihan	Pamir	Saiidi
Average daily intake of straw g/day/animal	790	802	853
Amount of straw DM consumed g/day/animal	750.5	765.1	832.5
ME (MJ/amount consumed of straw)†	5.47	5.85	6.07
CP (g/amount consumed of straw)†	21.54	23.41	26.30
Total DM consumption (kg/day)††	1.01	1.02	1.07
Total ME consumption (MJ/day)††	8.53	8.91	9.13
Total CP consumption (g/day)††	42.0	43.87	46.76
Average weight at start of experiment	48.9	49.8	49.1
Average weight at end of experiment	50.6	51.9	53.3
Accumulated liveweight gain/animal (kg)	1.75	2.38	4.13
Average daily liveweight gain/animal (g)	36.5[a]	49.5[a]	85.9[b]

†Assuming that barley straw provides 7.3 MJ per kg DM according to McDonald *et al*. (1988).
††After addition of ME and CP supplied by the barley seeds.
[a,b]Rows with different superscripts are significantly different ($P < 0.05$).

If the amount of ME supplied by the straw and the barley were calculated according to the tables of McDonald *et al.* (1988) the barley straw would provide 7.3 MJ/kg DM whereas the barley seeds [250 g daily intake (221.5 g DM)] would provide 3.06 MJ/kg DM. However, the CP supply was calculated from the chemical analysis (Table 3) and thus the amount of CP supplied according to the daily intake of each straw is presented in Table 5. For the barley seeds the amount of CP supply was estimated at 20.46 g/head/day (Table 5).

According to McDonald *et al*. (1988) the maintenance requirements for a lamb weighing 35 kg are 5.7 MJ of ME and 66 g of CP. According to the AFRC (1993), and depending on the metabolizibility of the diet (M/D or q_m) the requirement for a lamb weighing 50 kg to gain 50 g per day can vary from 11.0 to 9.9 ME and 69 g of metabolizable protein (MP). The daily DM intake can also vary from 1.1 to 0.8 kg/day.

As shown in Table 5, the daily DM intake observed for the 3 varieties of straw were not very different and were well within the reported figures by the AFRC (1993). However, the amount of ME and CP consumption as calculated in Table 5 were slightly lower than the recommended requirements for a 50 kg lamb to gain 50 g/day. This, may have been due to the fact that the same value of ME (7.3 MJ) was assumed to the three varieties of straw. Obviously, the variability in the degradation characteristics of the three varieties of straws and the response they produced in term of daily liveweight gain indicate that they had different nutritive value that could not have been assessed by chemical analysis only.

In Lebanon and West Asia large numbers of small ruminants depend on cereal stubbles for grazing during the dry season. Under this system, very little or no concentrates as supplement are provided and as a result animal performance (growth, milk production, fertility, late maturity) is severely reduced (Treacher *et al*., 1994). The results of the present study indicate clearly that if the animals were not given any supplement (i.e. barley) the group fed on Rihan and possibly Pamir straws would have lost weight. However, the group fed on Saiidi straw would have been able to increase their weight slightly. This would be critical for small ruminants animals grazing stubble prior to the mating season from August to October.

Conclusions

Because of the importance of straw in diets for ruminants in the Lebanon and the Middle East, it is suggested that selection of new cereal varieties should take into consideration the nutritive value of the straw as well as the quantities of seed and straw they produce. The nylon bag technique proved to be a useful and accurate technique for screening the nutritive value of roughages.

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