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Performance of Awassi Lambs Fed a Citrus Pulp and Olive Cake Silage

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ABSTRACT:

This experiment was conducted to investigate the effects of feeding different silages on the performance of fattening lambs and nutrients digestibility. Sixteen uniform males of Awassi lambs were used in feeding trial that was lasted for 77 days. The trial was followed by a digestion trial. Lambs were divided into four experimental groups during the trial and had free access to water. Three types of silage were prepared using wheat straw (WS), olive cake (OC) and citrus pulp (CP). The three by-products were mixed in the following ratios for silage 1 (60:27:13), for silage 2 (20:54:26) and for silage 3 (0:48:52), respectively. The forages were offered to lambs along with fixed amount of a commercial fattening concentrate which was 78% of total rations fed on air dry basis. Silage type had no effect on lambs weight development and lambs average daily gain. The feed conversion efficiency was the highest (P<.05) in lambs fed the silage 1. However, the cost of gain was the lowest (P<.05) in lambs fed the silage 3. Values of nutrient digestibility increased (P<0.05) for all types of silages, especially when wheat straw was excluded from the rations. The results of this study indicate that silages of wheat straw, olive cake and citrus pulp can be used for lambs in fattening operations.

الملخص:

تم إجراء هذه التجربة للتعرف على اثر استخدام أنواع من السيلاج المصنع محليا على خراف العواسي من حيث الأداء ومعاملات الهضم للعناصر الغذائية المختلفة والتي احتوتها العلائق. استخدم في التجربة 16 خروفا ذكرا من خراف العواسي مع مراعاة تماثل الوزن الابتدائي بين المجموعات التي استخدمت في تجربة التغذية لمدة 77 يوما. اتبعت هذه التجربة بتجربة هضم لمدة ستة أيام جمع براز حيث قسمت الخراف إلى 4 مجموعات تجريبية بما فيها مجموعة الشاهد، احتوت كل منها 4 خراف. تم تحضير ثلاثة أنواع من السيلاج باستخدام قش القمح وتفل الحمضيات و جفت الزيتون، المجموعات جهزت على النحو التالي السيلاج الأول باستخدام 60 / 27 / 13 والسيلاج الثاني باستخدام 02 / 54 / 26 والسيلاج الثالث باستخدام 0 / 48 / 52. تم تقديم السيلاج للخراف مع كميات محددة من العلف المركز والذي يشكل 78% من إجمالي الوجبة الغذائية ، لم يكن لنوع السيلاج اثر على كل من الزيادة في الوزن و معدل الزيادة الوزنية اليومية،

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الا انه اثر معنويا على كل من معدلات الاستهلاك من العلف و نسبة التحويل الغذائى. و بينت التجربة ان معدلات هضم المواد الغذائية ارتفعت ($p<.05$) في الأنواع السيلاج وخاصة عندما استبعد قش القمح من العليقة. و يستنتج من التجربة اهمية استخدام السيلاج من المخلفات في علائق التسمين لما له من تاثير ايجابي على اداء خراف التسمين و زيادة معدلات الهضم و التوفير في ثمن الاعلاف المستخدمة.

INTRODUCTION:

The fattening operations are among the important activities within animal production sector. The income from such operations is estimated to be 50% of the total income of animal production (Palestinian Ministry of Agriculture, 2006). Under our local conditions, feed contributes about 75% of the total cost of animal production, where most of ingredients are imported from foreign sources at a high cost (Azmouti, 2003; Nierat, 2006). Utilizing by-products as components of animal feeds would decrease the total cost of feeding, which could increase the profitability for livestock producers. Large amounts of local agricultural by-products are available. It varies in amounts, nutritive value and location. Among these are olive cake, vegetable by-products and citrus pulp. More than 40 thousand tons of raw olive cake is produced each year (Abo Omar, 2002). In practice, most of agro-industrial by-products are fed to animals individually with variable effects on performance (Ben -Ghedalia et al., 1989; Ammerman and Henry, 1991; Miron et al., 2001). Abo Omar and Gavoret, 1995; Abo Omar, 2001; Scerra et al., 2001; Bueno et al., 2002; Abo Omar, 2002; Hjazi and Abo Omar, 2009). Drying fresh by-products is an expensive procedure. On the other hand, fresh by-products, due to its high moisture content, cannot be stored for a long period. In this respect, ensiling fresh by-products is a sensible proposition for the conservation of destined for year-round animal feeding, particularly for the dry season when grass is scarce. In addition, it is more advantageous to mix them with other dry feed materials before ensiled (Ashbell et al., 1995; Scerra et al., 2001). Making silage is among the best methods for utilizing by-products as feed for ruminants without harmful effects. Silage making eliminates pathogens, and reduces the effect of drugs and pesticides that are used locally (Hadjipanayiutou, 1998; Azmouti, 2003). The use of agro-industrial by-products silage seems to be a convenient and economically viable method for producing sheep with similar or better performance than that obtained with common feed resources. In practice, however, the adoption of silage technique is still limited. It has been demonstrated that silage of citrus pulp together with cereal straw or other feed materials is an excellent alternative to minimize the negative aspects linked to the ensilage of the by-product alone (D`Urso et al., 1984; Licitra et al., 1988; Scerra et al., 2001). Little or no information is available on utilizing silage made from local by-products in livestock operations. The objectives of this research were to investigate the effect of silage made from wheat straw, citrus pulp and olive cake on the performance, feed intake, cost of gain and nutrient digestibility of Awassi lambs.

2. MATERIALS AND METHODS

2.1 PREPARATION OF SILAGE

Fresh citrus pulp was mixed with olive cake and wheat straw (Table 1) and ensiled in a trench silo of approximately 1 m high and .5 m wide that was coated with a plastic sheet. After filling the silo, the mass was air-tight, closed with a plastic sheet and covered to secure anaerobic conditions for fermentation. After 30 days, the silo was opened and silage samples were taken for chemical analysis.

Three types of silage containing different levels of wheat straw, citrus pulp and olive cake were prepared (Table 1).

2.2 FEEDING TRIAL

The trial involved 16 weaned Awassi male lambs, obtained from a local farm in Tulkarm. Soon after lambs were received at the experimental site, they were randomly divided into four groups and were allotted in collective pens (four animals per pen). Lambs had free access to fresh water and mineral blocks. The distribution of the lambs between the different groups was done in such a way that the average body weight in each group was similar to that in the other groups. An adaptation period of 14 days was allowed. During the adaptation period, lambs were treated against common parasites and diseases.

Table (1). Composition of silages used in feeding lambs

Ingredient	Silage 1	Silage 2	Silage 3
Wheat straw (%)	60	20	0
Citrus Pulp (%)	27	54	48
Olive Cake (%)	13	26	52
Total	100	100	100

The first diet (control) was based on wheat straw and a commercial concentrate (Table 2) in a ratio 22/78 (on DM bases). The other diets were based on silage and a commercial concentrate (Table 3). Diets were formulated to meet the NRC (1985) lambs nutrient requirements. Samples from each treatment group were bulked and stored for later chemical analysis. Lambs were weighed at weekly intervals.

2.3 DIGESTION TRIAL

Samples from rations, refusals, and feces were taken daily to measure the digestibility over a week following the growth trial. Refusals were collected daily at 08.00 h, weighed, sampled, and then stored. Total daily fecal output for each animal was also collected, weighed and homogenized. Then, two

samples, one of 100 g was dried for 24 h at 105 ◦C to measure fecal DM and the second of 40 g was kept at −15 ◦C. Pooled samples of feces obtained from each animal were used for chemical analysis.

2.4 CHEMICAL ANALYSIS

Feed and silage samples were analyzed utilizing the AOAC (1990) methods for dry matter, crude protein, crude fiber, ADF, NDF and crude ash.

Table (2). Concentrate ingredients on as feed basis and chemical composition of the concentrate ration on dry matter basis

Ingredients	Percent %
Corn	38.5
Wheat	5.0
Wheat bran	5.0
SBM	20.2
Sunflower Meal	7.0
Barley	20.0
Premix×	0.1
Chemical Composition	
CP %	18
CF %	6.1
NDF %	22.5
ADF %	12.5
EE %	3.3
Ash %	5.2
Moisture %	12
ME(MJ / Kg)	12
Ca %	1.2
P %	0.6

* Each 1 kg of premix includes: (Vit. A-8mg, Vit. D3-1.6mg, Vit. E-20mg, Cobalt-1gm, Manganeze-30gm, Iodine-½gm, Selenium-.1gm, Calcium-440gm, Antioxidant-15gm).

Control	Silage 1	Silage 2	Silage 3	
Concentrate	78	78	78	78
Wheat Straw	22	14	7	-
Citrus Pulp	-	6	9	12
Olive Cake	-	2	6	10
Chemical composition (%)				
DM	87.8	84.8	81.9	78.7
Crude protein	14.7	15.1	15.6	16
Crude fiber	14.6	13.2	11.9	10.6
NDF	73.0	74.0	75.5	76.0
ADF	52.1	46.6	43.4	47.0
EE	2.4	2.6	2.8	3
Ash	7.6	7.4	7.3	7.1

Table (3). Experimental rations used in the feeding trial and nutrient composition (%)

2.5 DATA ANALYSIS

The experiment was designed according to the completely randomized design (CRD). All data were analyzed by ANOVA using the linear model procedure of SAS (SAS, 1988) to determine the effect of feeding different silages on the target parameters

3. RESULTS AND DISCUSSION

3.1 COMPOSITION OF SILAGE

Table (4) shows the chemical composition of the three types of silage prepared and used in the feeding trial. Values reported here in are similar to those reported by previous research using similar by-products (Bath et al., 1980; NRC, 1985; Brown and Johnson, 1991; Arosemena et al., 1995; Marten-Gracia et al., 2003). The dry matter contents of the three silages were higher compared to values reported by McDonald et al. (1988). The high dry matter values reported here give advantage to the quality of silages. It was previously reported that when dry matter content of ensiled material is low, it may result in dry matter losses (McDonald et al. 1988). Cervera et al. (1985) reported losses of dry matter as high as 32% in ensiled citrus pulp. The pH of used silages ranged from 4.2 to 5.5. These values agree with results reported by Volanis et al. (2004). However, Martinez-Pascual and Fernandez-Carmona (1978) reported pH values for citrus pulp silage ranging from 3.2 to 3.6. These low pH levels in feeding practice will alter the rumen environment causing a severe depression on the activity of cellulytic bacteria.

Table (4). Chemical composition of the experimental silage

	Silage 4	Silage 2	Silage 1
DM	54.9	56.7	54.0
Crude Protein	7.0	6.5	5.2
Crude Fiber	5.1	6.5	7.8
ADF	34.0	30.0	30.2
NDF	37.0	40.1	47.0
Gross Energy Cal. / g	4591	4418	4327
Ash	4.2	5.3	6.1

3.2 FEED INTAKE:

Dry matter intake by lambs was not significantly increased in all of the experimental groups (Table 5). However, there was a trend of increasing DM intake by lambs fed with silages. The increase in DM intake was affected by composition of silage as having dry matter contents. Dry matter intake increased as level of wheat straw decreased. However, the highest intake was observed in the lambs fed rations without wheat straw (2.1 and 1.72 kg/ day for lambs fed with silage 3 and the control rations, respectively). This can be explained by the improvement of palatability that is associated with high levels of citrus pulp regardless of bulkiness of rations. Utilization of silage made from olive cake and other by-products such as citrus pulp improved silage quality and resulted in a well-preserved palatable feedstuff, and voluntary feed intake (Kayouli and Lee, 1993). Feed intake was always higher in lambs fed silage compared to that of lambs fed the control ration. In contrast, the feed intake of lambs was not affected by silage (Kayouli and Lee, 1993).

3.3 BODY WEIGHT DEVELOPMENT AND AVERAGE DAILY GAIN:

Data presented in (Table 6) shows that type of silage had no significant effect on lamb's average body weights. Incorporation of different types of silage in lamb's rations had some but not significant advantages through its effect on lamb's average weight. However, lambs fed the third type of silage that contained only citrus pulp and olive cake had the lowest final average weights. In general, lambs fed the first type of silage had the highest final average weights compared to other feeding groups. These trends were observed for each week of the feeding trial.

These finding are in agreement with those of Bampidis and Robinson (2006) who reported that the low performance in lambs fed high citrus pulp was due to hydration. Hydration can affect bulk density by causing swelling of the feed

matrix due to absorption of water, So hydration rate is important in determining the effective bulk density in the rumen. On the other hand, the high levels of olive cake in silages 2 and 3 may have influenced patterns of fermentation which in turn negatively affected lambs, performance (Bampidis and Robinson, 2006; Molina and Yanez-Ruiz, 2007). The improvement in performance might be due to the presence of easily digestible cell walls in citrus pulp that has a positive effect on rumen microflora and to the high degradability of ADF and NDF in the presence of limited lignin content. Ben-Ghedalia et al. (1989) showed that citrus pulp improved the utilization of dietary fiber due to its positive effect on rumen microflora activity. Moreover, it has been proposed that the highly digestible fibrous fraction of citrus pulp, like pectin, may increase the number of bacteria ruminal fluid. The average total gain in lambs fed the four rations was 25.3, 27.4, 26.0, and 24 kg for the four diets, respectively (Table 7). The highest gain was noted in lambs fed type one silage which contained the three silage components (wheat straw, citrus pulp, and olive cake). Similar findings were reported earlier (D' Urso et al., 1984; Licitra et al., 1988; Scerra et al., 2001; Capparra et al., 2007).

The average daily gain in the four rations used was 329, 355, 337 and 312 g (Table 7). The highest daily gain was ($P=0.05$) in lambs fed silage 1. This result contrasted with those reported by Caparra et al. (2007) who showed that such type of silage used may decrease the absorption of certain metabolites then resulted in some metabolic disorders.

The presence of citrus silage improves the utilization of dietary fibrous fractions possibly due to its positive effects on rumen microflora (Ben Ghedalia et al. 1989; Flackowsky et al. 1993). The highly digestible fibrous fractions like those in silage 1 and 2 may have caused the number of bacteria in ruminal fluid. The easily digested fiber in citrus pulp silages as in this research may create favorable conditions in the rumen of lambs for the enhancement of microbial activity. The result of this pattern of fermentation caused the production of acetic acid which promoted fat syntheses (Volanis et al. 2006). However, the differences observed in daily gain among lambs in different experimental groups may be attributed to a different pattern of volatile fatty acid production.

4.4 FEED CONVERSION RATIO:

The feed conversion ratios were 4.6, 4.5, 4.7 and 4.9 kg for the four rations used in the feeding trial (Table 7). The best ($P<0.05$) feed conversion ratio was for lambs fed silage 1. The large portion of citrus pulp in silages 2 and 3 might be the reason as explained by the higher feed intake observed in lambs fed with these silages. Caparra et al. (2007) reported similar findings. However, using dried olive cake as in silage 3 resulted in poor feed conversion efficiency which agreed with previous research (Scerra et al., 2001).

Table (5). Average daily feed intake in kg DM/lamb throughout the feeding trial

Weeks	Control	Silage 1	Silage 2	Silage 3	LSD
Week1	1.00	0.92	0.88	0.94	.02
Week2	1.10	1.00	0.97	1.00	.04
Week3	1.16	1.13	1.10	1.20	.1
Week4	1.24	1.18	1.22	1.30	.12
Week5	1.34	1.30	1.34	1.40	.09
Week6	1.42	1.42	1.44	1.53	.1
Week7	1.48	1.51	1.56	1.64	.13
Week8	1.54	1.60	1.68	1.73	.12
Week9	1.62	1.67	1.78	1.85	.13
Week10	1.68	1.76	1.90	1.97	.3
Week11	1.72	1.83	2.00	2.10	.25

Table (6). Average cumulative body weight of lambs (kg).

Weeks	Control	Silage 1	Silage 2	Silage 3	LSD
Week 0	23.1	23.1	23.0	23.1	3.5
Week1	25.7	25.8	26.0	25.4	4.1
Week2	28.4	28.4	28.6	27.5	4.3
Week3	30.7	31.0	31.0	29.7	4.8
Week4	33.0	33.4	33.3	32.0	5.3
Week5	35.2	35.9	35.7	34.2	4.8
Week6	37.7	38.5	38.1	36.4	5.8
Week7	40.0	41.0	40.5	38.6	4.6
Week8	42.4	43.3	42.9	40.7	5.0
Week9	44.6	45.6	45.0	43.0	4.9
Week10	46.5	48.0	47.1	45.1	5.0
Week11	48.4	50.4	49.1	47.1	5.2

Table (7). Economic impacts of silages used in the fattening trial

Parameter	Control	Silage 1	Silage 2	Silage 3
Number of lambs	4	4	4	4
Duration of the experiment, day	77	77	77	77
Average initial weight, kg	23.1	23.1	23.05	23.06
Average final weight, kg	48.4	50.4	49.1	47.1
Average total gain, kg	25.3	27.4	26.03	24.0
Daily feed intake, kg/lamb	1.515d	1.579a	1.565b	1.532c
Average daily gain, kg	0.329	0.355	0.337	0.312
Feed conversion efficiency	4.61c	4.45d	4.64b	4.91a
Cost of kg diet, NIS	1.71a	1.67b	1.63c	1.59d
Cost of total gain, NIS	218.7a	210.2b	203.3c	191.0d

Abcd Rows of different superscripts are significantly different ($P<0.05$).

3.5 COST OF GAIN:

The cost per kg gain is shown in Table (7). The highest ($P<0.05$) cost of gain was observed in lambs fed the control ration. Cost of gain was reduced through silages from 1 to 3. This can be explained by the significant differences in price per kg among these rations (Table 7). The reported figures from this experiment show the economic feasibility of feeding such type of ingredients and saving that can be achieved. In order to calculate the amount of saving that could be achieved by feeding the silage rations, the averages of total gain, the feed conversion ratio and cost of 1 kg feed of the three silage rations (25.8 kg, 4.7 and 1.6 NIS, respectively) were considered. Compared to the counterpart values of the control lambs, 24.3 kg, 4.6 and 1,71 NIS, the total feed expenses, assuming 2 million lambs under fattening, would be 38.8 and 39.8 million NIS for silage and control lambs, respectively. A net of about 1 million NIS can be saved when using the silage rations.

3.6 NUTRIENT DIGESTIBILITY

Digestibility of all nutrients was improved by the incorporation of silage in lambs rations (Table 8). The digestibility of dry matter significantly increased ($P<0.05$) in rations including the highest two levels of citrus pulp and olive cake.A similar increase ($P<0.05$) in the digestibility of crude protein was observed. In all of the nutrients tested, digestibility was improved by feeding silage, especially in rations where wheat straw was excluded. The availability of readily fermented NDF fraction caused the high ($P<0.05$) degree of improvement of this fraction. The digestibility of NDF in silage 3 was the highest ($P<0.05$) due to absence of wheat straw. This is in agreement with results reported by other research (Ben-Ghedalia et al., 1989; Ammerman and Henry, 1991; Miron et al., 2001).

Our results suggested that nutrient digestibility in general was improved by reduction of wheat straw levels. It seems that there is a positive associative effect that improves digestibility when only citrus pulp and olive cake were the ingredients in silage.

In conclusion, feeding silage made of by-products proved to have relatively good advantages. This was noticed by the good improvement in general performance, digestibility and the cost of feeding. Therefore, it is recommended to use high levels citrus by products in silage preparation in fattening rations similar to levels used in this experiment. However, more research is needed to confirm these findings.

Table (8). Digestibility of nutrients in the experimental rations.

Digestibility	Control	Silage 1	Silage 2	Silage 3	LSD
Dry matter	58.0c	67.0b	76.0a	78.0a	4.7
Crude protein	77.0c	78.0b	81.0a	83.0a	5.8
Crude fiber	74.0b	78.0a	80.0a	80.0a	7.0
Crude fat	77.0	77.0	79.0	82.0	7.9
Ash	76.0b	77.0b	80.0a	82.0a	6.9
NFE	69.0c	76.0b	83.0a	84.0a	8.8
ADF	70.0	75.0	79.0	83.0	7.9
NDF	69.0d	78.0b	77.0c	81.0a	6.8
Digestible energy	75.0b	78.8b	80.0a	82.4a	9.0

Abcd Rows of different superscripts are significantly different ($P<0.05$).

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