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Comparing Chopped Barley Straw with Alfalfa Hay in Fattening Shami Goat Kids

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ABSTRACT

The experiment was conducted in the Agricultural Research Station in the Jordan Valley to study the effect of replacing alfalfa hay by barley straw in Total Mixed Rations (TMR) for fattening Shami kids. Thirty two Shami goat kids with an average initial live weight ranging from 25 to 25.75 kg were used. The experiments lasted for 56 days. Animals were allocated randomly to four isocaloric and isonitrogenous total mixed ration treatments (T1, T2, T3 and T4) contained different levels of alfalfa hay and barley straw. Rations were formulated to meet the animal requirements and fed on *ad libitum* basis. In the first treatment, alfalfa hay was the main source of roughage while in the second and third treatments, alfalfa hay was replaced partially by barley straw. In the fourth treatment, barley straw was the main source of roughage and alfalfa hay was not used. Feed intake was measured daily while kids were weighed every two weeks. At the end of the two experiments, four kids from each treatment were assigned at random and slaughtered to measure the carcass characteristics.

Results showed that Voluntary Feed Intake (VFI) was numerically increased by low partial replacement of alfalfa hay but decreased with increased level of replacement of alfalfa hay in the diet with lowest value with complete replacement of alfalfa hay with barley straw (T4). No significant (P>0.05) differences were observed among treatments in average daily weight gains. Cold dressing percent ranged from 48.7 to 50.8% and the *M. Longissimus* area ranging from 101.6 to 134.9 mm, with no significant differences (P>0.05) between treatments.

Present findings indicate that alfalfa hay could be replaced successfully with wheat straw in the diets of finishing Shami kids without adversely affecting their growth performance or carcass characteristics.

Keywords: Shami Kids, Alfalfa Hay, Straw, Carcass, M. Longissimus.

INTRODUCTION

Sheep and goat production plays a major role in the agriculture of Jordan being considered the main source of red meat. Nutrition is the main problem facing livestock production in Jordan and the knowledge of the available methods for using the national feed resource especially straw which is still strongly needed and it is one of the national recommendations (MOA, 2005).

Roughage quality greatly affects feed intake (Skjevdal *et al.*, 1981). Galyean *et al.* (2003) suggested that the intake of dry matter is affected by changes in the roughage source and level. Straw is bulky, low in

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nitrogen and minerals and high in fiber content (Schiere *et al.,* 1995). Some researches found that using straw decreased feed intake (Economides *et al.,* 1981; Okine *et al.,* 1993; Dewhurst *et al.,* 2000; Haddad and Husien, 2001). The mixing of straw with different roughage source gave a different effect on voluntary intake. Okine *et al.* (1993) found that dry matter and organic matter intake of steers fed diets containing different combinations of alfalfa hay and barley straw decreased linearly with increased dietary straw. Also, Haddad and Husein (2001) found that the dry matter intake for lambs fed alfalfa hay was higher than those fed wheat straw diet. Using straw and alfalfa hay as a combination maintained the level of intake (Bahman *et al.,* 1997; Theurer *et al.,* 1999) and better than using barley straw alone (Haddad, 2000).

Comparing straws with alfalfa hay, Shain *et al.* (1999) found that alfalfa hay fed steers gained faster and were more efficient than those fed wheat straw. Also, Haddad and Husein (2001) found that ewe lambs fed alfalfa hay as roughage source gained more than those fed wheat straw. Carcass characteristics were also affected. Shain *et al.* (1999) found that steers fed diets containing alfalfa hay resulted in heavier hot carcass weight than for those fed wheat straw diets, while fat depth, measured at 12^{th} rib, was not affected. Meanwhile, Theurer *et al.* (1999) found no differences in carcass measurements when comparing alfalfa hay and wheat straw as roughage sources in steers finishing diets.

According to the MOA (2005), the use of alfalfa hay in Jordan decreased linearly during the period of 1996-2005 while the use of straw increased during the same period. This makes studying the effect of replacing alfalfa hay by straw in the diets of local small ruminants is needed and recommended. Therefore, the objective of this research was to compare the effects of adding straw at different levels instead of alfalfa hay in a total mixed ration in fattening Shami kids.

Materials and Methods

This experiment was carried out in the Agricultural Research Station of the University of Jordan at the Jordan Valley. Thirty two Shami goat kids were used in an experiment which lasted for 80 days to determine the effect of replacing alfalfa hay by barley straw in the fattening diets of goat kids on their growth performance.

Kids were divided randomly into 4 groups, 8 in each group, taking into consideration body weight, and housed in a sheltered, cemented floor, open front barns. Barns were ventilated and equipped with adequate feeding and water facilities. Four approximately isocaloric and isonitrogenous rations were formulated to meet the requirements containing different levels of Alfalfa Hay (AH) and Barley Straw (BS). In the first treatment, alfalfa hay was the only source of roughage (T1) at level of 25% DMB (25/0) while in the second (T2) and third (T3) treatments alfalfa hay was replaced partially by barley straw (20/10 and 10/20 DMB for AH and BS in both diets, respectively). In the fourth treatment (T4), barley straw was the sole source of roughage and alfalfa was not used (0/30).

Sunflower meal and urea were used as sources of protein. Ingredient composition and chemical analysis of these rations are listed in Table (1). Samples of the experimental diets were taken and stored for chemical analysis according to the Proximate and Van Soest analyses (AOAC, 1990).

Measuring of Fattening (Growth) Performance:

Kids were adapted to their rations for 7 days before starting the experiment. Feed was offered on *ad lib* basis and was supplied daily in the morning. The amounts offered per pen were recorded daily and adjusted according to feed refusals which were around 10%. Fresh and clean water were available all the time. Feed intake was measured daily for each group together while

the body weight was measured individually every 14 days. The groups stayed on the fattening rations for 56 days then the ration was removed for 24 hours and fasting weight for kids were taken and they were prepared for slaughtering.

By the end of the fattening period, 4 kids from each treatment were assigned at random and fasted for 24 hours. Fasted kids were weighed and sent to be slaughtered at the abattoir. Slaughtering and dressing were carried out according to the normal slaughtering procedure followed usually at Amman slaughter house. Carcass and non-carcass component measurements were taken after slaughtering for all carcasses. Carcass measurements included hot and cold carcass weights and dressing percentage. Dressed carcass weight was recorded after chilling for 24 hours at 4°C. Hot and cold dressing percentages were calculated based on hot and cold carcass weights, respectively. Non-carcass components were Heart, Liver, Lungs and Trachea together (HLLT), spleen weight, kidneys weight, and kidney fat weight.

Carcass Characteristics Measurements

Loin Measurements

After completing the above measurements, carcasses were cut into two halves along midline. The 13th rib (Loin) from each half of the carcass was separated to measure loin characteristics (Figure 1) and Table (4), and the following loin measurements were taken: *M. Longissimus* (loin eye) muscle width (A), *M. Longissimus* muscle depth (B), *M. Longissimus* width: depth ratio (A:B), *M. Longissimus* muscle area, fat thickness over *M. Longissimus* muscle (C), loin tissue depth (GR), and tissue fat thickness (J).

The *M. Longissimus* muscle width and depth, fat thickness over *M. Longissimus* muscle, loin tissue depth, and tissue fat thickness was measured by using a millimeter grading ruler while the area of *M. Longissimus* muscle (loin eye area) was measured by using a plastic grid which was designed for measuring loin eye. The area surrounding each dot in the plastic grid is equal to 1/20 (0.05) of one square inch (20 dots equal one square inch) then it was converted to square millimeter (mm^2) by the equation: 1 in^2 = 64.516 mm^2.

Statistical Analysis

Individual animals data were collected except for feed intake which was measured on group basis, were analyzed using General Linear Model (GLM) procedure of the Statistical Analysis Systems (SAS, 2000). Initial live weights were used as a covariate in the model utilized. Pen was also in the model as the experimental unit for DM intake. Carcass data were adjusted for fasting weight and cold carcass weight. Furthermore, week (period) was utilized in the model with a repeated measure design to study the effects of replacing on growth parameters throughout the experiment. LSD was used for testing means among treatments.

Results and Discussion

Chemical Composition of the Roughage Sources

Chemical analysis on dry matter basis of Alfalfa Hay (AH) and Barley Straw (BS) according to proximate and Van Soest analysis are shown in Table (2). Barley straw had higher crude fiber (43.3%) and acid detergent fiber (46%) contents, while alfalfa hay had higher crude protein content (12.9%). These results are in agreement with those reported in the Nutrient Requirement of goat (NRC, 1981) for the sun-cured mature alfalfa hay where CP and CF values were 12.9 and 37.7%, respectively while they were 4.8 and 42%, respectively for barley straw. Harb *et al.* (1996) found that barley straw analysis of DM, CP, EE and CF were 92, 4, 1.9 and 42%, respectively. Meanwhile, Madrid *et al.* (1997) found that alfalfa hay analysis of OM, CF, EE and ADF were 89.9, 38.1, 1.8 and 37.1%, respectively. Economides (1998) found that ADF in cereal straw was 46%.

The variation in nutrient composition for the two forage sources could be attributed to differences between legume hay and straw (Turgut and Yanar, 2004). However, the fattening diets utilized were formulated to be isocaloric and isonitrogenous (Table 1) and any differences in energy could be compensated by more intake of the ration. The deficiency in crude protein which is caused by the incorporation of barley straw instead of alfalfa hay was covered by increasing sun-flower meal in (T2) and by the addition of urea as in treatments 3 and 4, respectively. However, the analysis showed some variation. The calculated metabolizable energy ranged from 9.96 to 10.37 MJ/kg DM while CP ranged from 12.93 to 13.41% along the treatments.

The analysis also showed that the differences in crude fiber, neutral detergent fiber and acid detergent fiber contents between the treatment rations increased linearly with increasing the replacement level of alfalfa hay by barley straw which was adjusted to the differences in chemical composition between the two roughage sources.

Dry Matter Intake

It has to be said that Dry Matter Intakes (DMI) for kids were taken on a group basis and could not be analyzed statistically (Table 3). Results of fattening kids showed that the intake was numerically in T2 > T1 > T3 > T4. This might suggest that DMI was not decreased by the replacement of alfalfa hay at low level, but decreased with the increased level of replacement of alfalfa hay in the diet and had the lowest value at complete replacement of alfalfa hay when barley straw being the only source of roughage (T4).

Kids dry matter intake was not affected when small amount of alfalfa hay was replaced by barley straw (T2). However, intake was decreased at either large amount was replaced (T3), or at complete replacement as in (T4). This might indicate that intake was linearly depressed as the percent of the straw increased in the diets.

Similarly, dry matter intake decreased linearly with increased dietary barley straw fro steers fed diets with different combinations of alfalfa hay and barley straw (Okine *et al.,* 1993). Economides *et al.* (1981) reported that intake of forage sources like Lucerne hay was higher compared to that when barley straw was used.

Voluntary intake is the main determination of nutrient supply and is influenced primarily by dietary and animal factors (Sauvant *et al.,* 1991) and roughage quality can greatly affect feed intake and production (Skjevdal, 1981). The reasons for the decreased intake with increased percentage of straw in the diets may be associated with decreases in digestibility and duodenal flow of DM, OM and NDF as straw level increase (Okine *et al.,* 1993). Hadjigeorgiou *et al.* (2001) compared the different roughage sources to feed goats found that the highly digestible grass hay had the higher voluntary dry matter intake while barley straw was the lowest.

Body Weight, Average Daily Gain and Feed Conversion Ratio

The fattening measurements for kids are shown in Table (3). No differences were observed in average daily gain when alfalfa hay was replaced with barley straw in rations of fattening kids. However, results indicated that it was slightly better to use 2/3 of the roughage source as alfalfa hay (T3) and 1/3 as barley straw (T2) in kids fattening diets. Weight change followed daily gain and numerically showed to be nearly constant at T2 but then reached the lowest value at completely replacement without significant differences between treatments.

The overall body weight change in kids was also not different. However, it was higher when alfalfa hay was highly used in rations. Feed conversion ratios were not different among treatments (Table 3). It took the same

trend for weight gain where numerically better ratios were observed with partial replacement of alfalfa hay at low level as in T2, while increasing the level of replacement had led to increase the feed needed for meat production.

These results are in agreement with that founded by O'Donovan (1983) who found that a ration contained 20% of wheat straw produced little or no decrease in the rate of gain. Also, Brown *et al.* (1990) found that steers body weight were not influenced when 50% of alfalfa hay was replaced by chopped barley straw. Moreover, Theurer *et al.* (1999) found that weight gain and final body weight gain of steers were maintained when fed wheat straw compared to those fed alfalfa hay in fattening rations.

Carcass Characteristics and Non-carcass Components

The results for kids carcass characteristics are shown in Table (4). Fasting weights ranged from 30 to 34 kg without any significant differences between treatments. There were no differences among treatments in carcass weight and dressing percent expressed on either cold or hot basis.

Differences in non-carcass components were also not evident. Such components included weights of spleen, kidneys fat, heart, liver, lungs and trachea. However, numerically, they appeared to increase by partial replacement of alfalfa hay by barley straw but began to depress with increasing the level of replacement (T3 and T4). Kidneys weight increased numerically when alfalfa hay was replaced and at all levels but without any significance.

Statistically, differences among treatments for all carcass and non carcass components were not significant. However, such components seemed to be slightly less in the last two treatments when high levels of alfalfa hay were replaced by barley straw (T3) and at complete replacement (T4). Therefore, it can be said that supplementing the concentrate rations with barley straw or mixture of both alfalfa hay and barley straw would not affect hot and cold carcass weight or dressing percentage compared with supplementing alfalfa hay alone. The same conclusions could be drawn out for the kidneys, spleen weights and other non-carcass components. Theurer *et al.* (1999) showed that the carcass measurements were not significantly affected when alfalfa hay was replaced by wheat straw in the diet of finishing steers diets. The same results were observed by Abdullah (2005) who found that the carcass and meat characteristics were not affected among treatment diets containing alfalfa hay or barley straw for Awassi lambs.

Data for kids' loin characteristics are reported in Table (5). There were no significant differences observed among treatments for loin (eye muscle) width, depth or area. However, it was numerically decreased when alfalfa hay was replaced by barley straw and the lowest values were for T3.

Eye muscle width and depth ratios (A:B) tended to increase ($P<0.06$) at partial or complete replacement of alfalfa hay which might indicate an adverse effect of straw inclusions on eye width and depth ratio.

Fat over the eye muscle, tissue thickness and fat tissue thickness were all not different among treatments. However, values of theses measurements were numerically increased at partial replacement in T2. In this study, the loin measurements at rib 13^{th} for kids showed the same trends for carcass characteristics and were in agreement with Shain *et al.* (1999) when comparing alfalfa hay with wheat straw as the source of roughage in steers' diets and showed that fat depth, measured at 12^{th} rib, was not significantly different between diets.

The ratio between width and depth of the loin eye muscle increased by 0.20 mm as barley straw was included to the rations instead of alfalfa hay. The ratio tended to

increase (P=0.07) when alfalfa hay was replaced by barley straw. The reasons for that may be related to the decreases in the depth being more than that in the width in the last three treatments which contained straw.

Conclusion and Recommendations

Straws are deficient in protein content but high in fiber more than green roughages. However, the substitution of green roughages by barley straw in the fattening total mixed rations had no effects on animal performance when both crude protein and metabolizable energy are approximately the same. The partial inclusions of straws with good quality green roughages in the diets may not cause any deterioration to the growth kids. If alfalfa hay is in short supply, there is no harm to mix it with barley straw in the kids fattening rations.

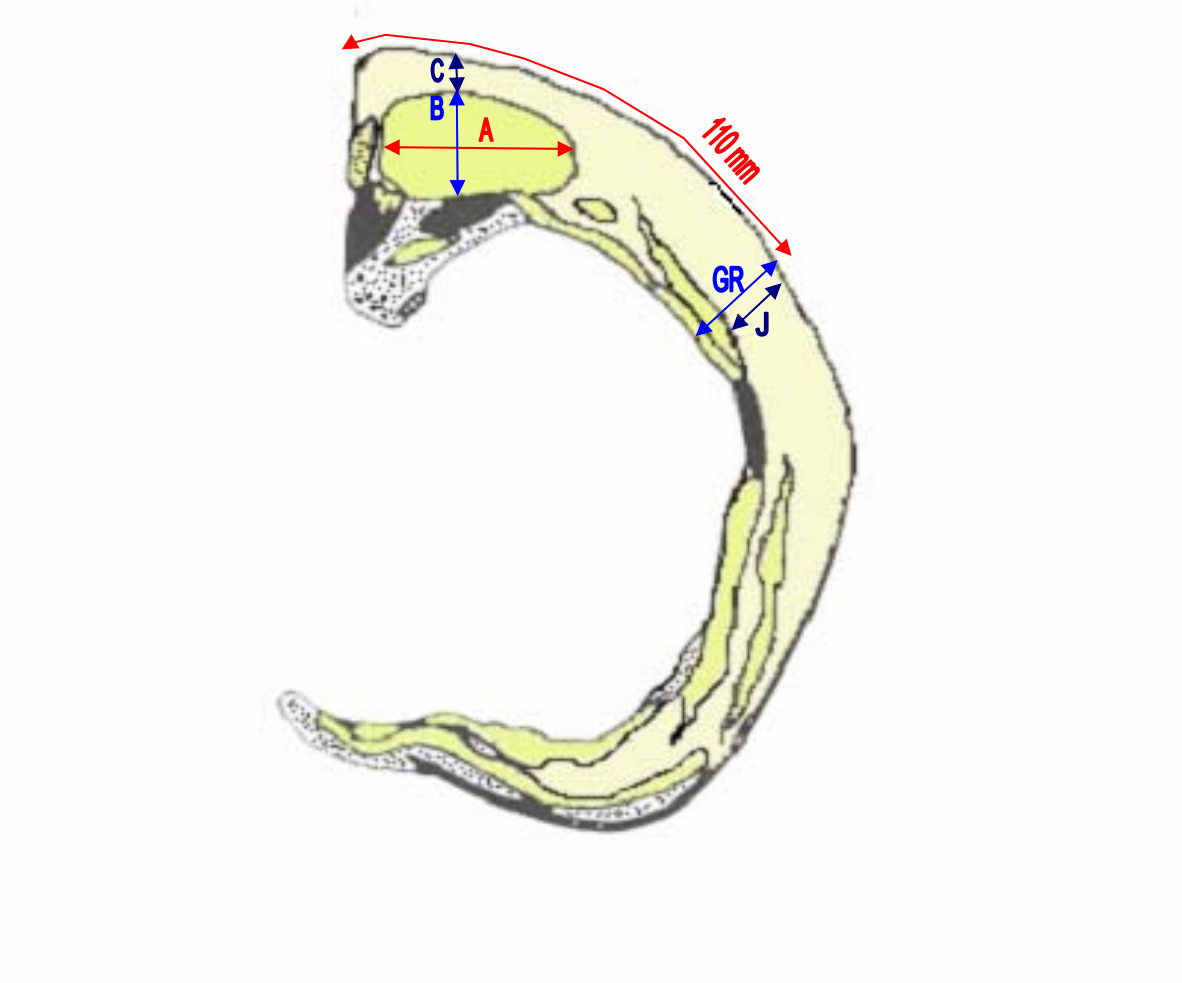

Figure (1): The loin cut was between the 12th and 13th ribs

Table 1. The ingredients composition and chemical analysis of the total mixed rations used in the experiment[1].

Ingredients	Treatment			
	T1	**T2**	**T3**	**T4**
Alfalfa Hay (AH)	25.00	20.00	10.00	0.00
Barley Straw (BS)	0.00	10.00	20.00	30.00
Sunflower meal	17.00	20.00	20.00	20.00
Barley grain	54.00	46.00	45.50	45.00
Urea	0.00	0.00	0.50	1.00
Soap fat[2]	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00
Dicalcium phosphate	0.50	0.50	0.50	0.50
Sodium bicarbonate	0.30	0.30	0.30	0.30
Minerals and vitamins[3]	0.20	0.20	0.20	0.20
Chemical composition (%)				
Dry matter	93.56	93.61	93.54	93.50
Organic matter	92.43	92.03	91.76	90.87
Crude protein	13.28	12.93	13.22	13.41
Ether extract	3.00	2.90	2.90	2.80
Ash	7.57	7.97	8.24	9.13
Neutral detergent fiber	26.98	30.67	32.17	33.67
Acid detergent fiber	17.05	21.07	22.23	23.15
ME[4] (MJ/kg DM)	10.37	10.25	10.12	9.96

[1] All data conducted on dry matter basis.

[2] TM: Feedaren, The Modern Establishment for Fats and Glycerin Manufacture, Amman, Jordan (Chemical composition %: Dry matter 96.70; Ether extract 89.80; Ca 9.20).

[3] Each 1 g contains 1500 I.U. Vitamin A; 150 I.U. Vitamin D3; 2 mg Vitamin E 50%; 300 µg Vitamin B1; 300 µg Vitamin B2; 300 µg Vitamin B6; 300 µg Vitamin K3 0%; 218 µg, 435 µg, 15.5 µg, 138.5 µg 2.2 µg KI, 0.9 µg, 0.43 µg, reach 1 g CaCO3.

[4] Calculated based on NRC (1981) values.

Table 2. Chemical composition of the alfalfa hay and barely straw used in the fattening experiment*.

%	Alfalfa Hay	Barley Straw
Dry matter	93.30	92.00
Organic matter	89.00	87.00
Crude protein	12.90	4.80
Crude fiber	38.30	43.30
Ether extract	2.00	1.80
Ash	11.00	13.00
Nitrogen free extract	35.80	37.10
Neutral detergent fiber	50.00	67.00
Acid detergent fiber	37.00	46.00

*All data conducted on dry matter basis.

Table 3. Dry matter intake and production response of Shami kids for the whole period.

Item	Treatment				Statistical significance	
	T1	T2	T3	T4	± SE	Treat.
Diet[1]	25/0	20/10	10/20	0/30		
Number of animals	8	8	8	8		
Average initial wt (kg)	25.75	25.25	25	25.37	1.31	NS
Average final wt (kg)	33.88	33.75	31.38	31.5	1.73	NS
Average dry matter intake (g/day)	1169	1173	956	914		
Weight change (kg)	8.13	8.50	6.38	6.13	1.03	NS
Average daily gain (g/day)	145	152	114	109	18.31	NS
Feed: gain ratio	8.06	7.72	8.39	8.38	1.42	NS

[1] Ratio of alfalfa hay: Barley straw in the diet (%).

kg = Kilograms.

g = Grams.

NS = Not significant (P>0.05).

SE = Standard error.

Table 4. Kids carcass characteristics and components.

Item	Treatment				Statistical significance	
	T1	T2	T3	T4	± SE	Treat.
Number of animals	4	4	4	4		
Fast wt (kg)	34.00	33.75	30.25	30.00	2.79	NS
Hot wt (kg)	17.88	17.79	15.61	16.00	1.64	NS
Cold wt (kg)	16.95	17.00	14.85	15.25	1.61	NS
Hot dressing %	52.20	52.80	51.30	53.40	1.28	NS
Cold dressing %	49.40	50.40	48.70	50.80	1.23	NS
HLLT wt (kg)	1.81	1.83	1.75	1.59	0.15	NS
Kidneys wt (g)	110.00	120.00	117.50	112.50	8.35	NS
Spleen wt (g)	70.00	70.00	62.50	55.00	6.40	NS
Kidney fat wt (g)	202.50	240.00	127.50	125.00	42.80	NS

Wt = Weight.

HLLT = Heart, Liver, Lungs and Trachea.

kg = kilograms.

g = grams.

NS = Not Significant (P>0.05).

SE = Standard Error.

Table 5. Kids loin characteristics.

Item	Treatment				Statistical significance	
	T1	T2	T3	T4	± SE	Treat.
Number of animals	4	4	4	4		
Eye muscle width A (mm)	46.80	46.30	43.00	44.50	2.55	NS
Eye muscle depth B (mm)	29.80	26.00	24.30	25.30	1.66	NS
A: B ratio	1.58 [b]	1.78 [a]	1.78 [a]	1.77 [a]	0.06	S*
Eye muscle area (mm^2)	134.90	125.10	101.60	117.00	11.42	NS
Fat depth over Eye muscle C (mm)	2.30	3.00	2.00	2.30	0.64	NS
Tissue depth GR (mm)	15.80	16.80	13.00	13.50	1.76	NS
Rib fat depth J (mm)	5.80	7.30	5.80	5.30	1.13	NS

mm = Millimeter.

NS = Not Significant (P>0.05).

S* = Significant at (P<0.1).

SE = Standard Error.

[a, b] Within the same raw with different superscript differ significantly (P<0.1)

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مقارنة تبن الشعير بدريس الفصة في تسمين الجديان الشامية

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ملخـص

أجريت التجربة في محطة البحوث الزراعية الواقعة في غور الأردن لدراسة تأثير استبدال دريس الفصة بتبن الشعير في خلطات تسمين الجديان الشامية. استخدم في التجربة 32 جدي شامي بمتوسط وزن ابتدائي تراوح من 25 إلى 25.75 كغم وسمنت 56 يوماً. تم تقسيم الحيوانات عشوائياً على أربع معاملات تغذوية بمحتوى متساو تقريباً من الطاقة والنيتروجين مع تغيير نسب دريس الفصة وتبن الشعير. بنيت الخلطات الأربعة حسب احتياجات الحيوانات وقدمت بشكل حر، وكانت على النحو التالي: في المعاملة الأولى استخدم دريس الفصة كمصدر وحيد للألياف في الخلطة، بينما في المعاملتين الثانية والثالثة تم استبدال دريس الفصة بتبن الشعير بشكل جزئي وبنسب مختلفة. أما في المعاملة الرابعة، فقد تم استخدام تبن الشعير كمصدر وحيد للألياف. تم أخذ معدل التناول الطوعي لكل مجموعة بشكل يومي بعد احتساب كمية العلف المتبقية، بينما أخذ معدل النمو لكل حيوان على حدة كل 14 يوماً، وفي نهاية التجربة اختير 4 جديان من كل معاملة، وأرسلت للذبح لقياس صفات الذبيحة.

دلت النتائج على أن معدل التناول الطوعي ارتفع بالاستبدال الجزئي المنخفض للدريس، بينما انخفض عند زيادة نسبة الاستبدال للدريس، وظهرت أقل قيمة عند الاستبدال الكلي للدريس في المعاملة الرابعة؛ حيث كان معدل التناول الطوعي 1173،1169، 956 و 914 غم مادة جافة/يوم للمعاملات الأربعة على التوالي. وكان معدل الزيادة في الوزن 145، 152، 114 و 109 غم/يوم للمعاملات الأربعة على التوالي ومن غير فروقات معنوية بين المعاملات الأربعة. أما نسبة التصافي فتراوحت من 48.7 إلى 50.8% وتراوحت مساحة العضلة العينية من 101.6 إلى 134.9 ملم ومن غير فروقات معنوية بين المعاملات الأربعة.

يتبين من الدراسة أنه يمكن استبدال دريس الفصة في خلطات التسمين للجديان الشامية بالتبن من غير أي تأثير سلبي في النمو أو صفات الذبيحة لدى هذه الجديان المسمنة.

الكلمات الدالة: جديان الماعز الشامي، دريس الفصة، التبن، الذبائح، العضلة العينية.

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