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A FEEDING STRATEGY OF LAMBS TO INCREASE NUTRIENT UTILIZATION AND REDUCE FEED COST

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ABSTRACT

Five experimental rations were evaluated in this study of which 33% and 66% of concentrate feed mixture (CFM) was replaced by yellow corn grains (YCG) or crushed yellow corn ear (YCE) and their effects on lambs performance were also studied. These rations contained different levels of CFM (3%, 2%, or 1%), YCG (2%, or 1%), YCE (2%, or 1% of body weight), and rice straw *ad lib*. Forty Barki male lambs of average 25.85-Kg body weight were divided into five groups and assigned at random to the experimental rations for 140 days. Five metabolism trials were conducted during weeks 11 and 12.

Results obtained show that replacement of CFM with YCG or YCE increased digestibility coefficients, nutritive values, nitrogen balance, concentrations of plasma TP, albumin, glucose, and improved daily gain. It also gave the best feed conversion, economical efficiency and the lowest feed cost/Kg weight gain.

It is concluded that using local raw materials in formulating rations may reduce costs without adverse effects on animal performance.

Keywords: concentrates, lambs, digestibility, metabolism, growth, performance

INTRODUCTION

Feeding feed cubes to ruminants may result in variable performance of animals. Large variations are detectable in the chemical analysis and nutritive values due to the variations in feed cube components.

It is advisable to farmers to “dilute” the concentrated feeds or increase the concentrations of certain feed ingredients in order to obtain good profits

Feeding supplementary feed ingredients individually (the so called “straights”) is a good practice by farmers in some other countries (e.g Britain, Newman, 1989).

Rations based on such feeding strategies seem to be more consistent in their nutritive value (Wright, 1989).

The present study was conducted to evaluate the effect of “diluting” concentrates feed mixture (commonly available in local markets) which, usually, has no consistent components and, hence, variable chemical composition with some individual feed ingredients such as yellow corn grains or ears on lambs growth performance and nutritive values of rations.

MATERIALS AND METHODS

Animals and management

Forty male Barki lambs of average 25.85± 1.00-Kg live body weight (LBW) were used in this study during the period from autumn to the beginning of winter season (Sept. to Jan.). Therefore, the experimental period was 140 days. Lambs were divided into five similar groups of eight animals each and randomly assigned to the tested rations. Lambs were group fed. Different concentrates were offered to animals twice a day at 8 am and 3 pm, while rice straw was offered *ad. Lib*. Water was available for animals at all times. After the 10th week of the experiment, five metabolism trials were conducted to determine the digestion coefficients and feeding values of the four experimental rations. Three animals from each treatment were used. The preliminary and collection periods of the metabolism trial were 15 days.

Experimental rations

Feeding treatments were as follows:

1- Concentrates feed mixture (CFM) at 3% of LBW, and rice straw *ad. Lib.* (control ration, G1)
2- Concentrate feed mixture (CFM) at 2% of LBW, 1% of LBW as yellow corn grains (YCG), and rice straw *ad. Lib.* (G2)
3- Concentrate feed mixture (CFM) at 1% of LBW, 2% of LBW as yellow corn grains (YCG), and rice straw *ad. Lib*. (G3)
4- Concentrates feed mixture (CFM) at 2% of LBW, 1% of LBW as yellow corn ears (YCE), and rice straw *ad. Lib*. (G4)
5- Concentrate feed mixture (CFM) at 1% of LBW, 2% of LBW as yellow corn ears (YCE), and rice straw *ad. Lib*. (G5)

Corn grains and corn ears were ground coarsely. Feeds were offered twice daily and water was available for animals at all times. Feed and water intakes were recorded. Chemical composition of feed ingredients is presented in Table (1).

Table 1.Chemical analysis of ingredients of the experimental diets.

Item	DM	OM	CP	CF	EE	Ash	NFE
		--------------DM, %-----------------					
CFM*	86.36	93.89	14.21	12.11	2.81	6.11	64.76
Rice straw	86.71	84.36	4.11	37.02	1.21	15.64	42.02
Yellow corn grains	86.64	98.71	9.04	1.81	3.71	1.29	84.14
Yellow corn ears	86.26	98.41	8.50	7.93	2.94	1.59	79.04

***Concentrate feed mixture contains: 37% wheat bran, 27% undecrticated cotton seed cake, 25% extracted rice bran, 5% molasses, 3% limestone, corn, 2% and 1% mineral salt.**

Sampling techniques and analytical methods

Samples of feeds, feces, and urine were analyzed according to A.O.A.C. (1990). Blood samples withdrawn from the jugular vein were let to flow into heparinized tubes. Blood samples were immediately centrifuged at 4000 rpm for 20 minutes and frozen at –20 ^{o}C till time of analysis according to A.O.A.C. (1990). Samples of rumen fluid were collected using stomach tube. Rumen liquor was sampled at the middle of the experimental period. The samples were withdrawn just before morning feeding, 3 and 6 hrs post feeding. Samples were filtered through double layer cheesecloth and pH values were immediately recorded (Beckman pH meter). Few drops of saturated solution of mercuric chloride were used to stop microbial activity. The samples were frozen for TVFA's determination (Kromann *et al*, 1967).

Data were statistically analyzed using GLM procedures of SAS (1992).

RESULTS

Results in Table (2) indicate that the replacement of different proportions of CFM with either crushed YCG or crushed YCE resulted in better ration digestibility coefficients. While the control ration showed the lowest DM, OM, EE, and NFE digestion coefficients, the dilution of CFM recorded 5% or more increments.

Table 2. Digestibility coefficients, nutritive values of the experimental rations as fed to sheep

Item	G1	G2	G3	G4	G5
Digestion coefficients, %					
DM	64.91^{b}	72.07^{a}	72.93^{a}	69.60^{ab}	70.73^{ab}
OM	68.78^{b}	74.34^{a}	75.10^{a}	71.43^{ab}	73.88^{a}
CP	62.94^{a}	62.89^{a}	61.74^{b}	62.70^{a}	61.35^{b}
CF	53.32^{a}	52.47^{ab}	50.99^{c}	53.01^{a}	51.99^{b}
EE	71.65^{b}	74.30^{a}	75.89^{a}	73.71^{ab}	71.26^{b}
NFE	74.25^{c}	80.84^{a}	81.09^{a}	77.47^{b}	80.93^{a}
Nutritive value, %					
TDN	66.15^{c}	72.55^{ab}	73.37^{a}	69.62^{b}	72.38^{ab}
DCP	7.07^{a}	6.15^{b}	5.57^{c}	6.33^{b}	5.04^{c}

a,b,c, and means with different superscripts in the same row differ significantly (P<0.05)

As was the case with nutrient digestibilities, the total digestible nutrients (TDN) were high for higher YCG and YCE percentages in rations G2 through G5 than the control ration G1 (Table 2).

Table 3. Effect of type of concentrates on nitrogen utilization and water intake

Item	G1	G2	G3	G4	G5
N intake, g/h/d	22.10	20.83	17.56	20.13	15.14
Fecal N, g/h/d	8.19	7.73	6.72	7.31	5.86
Digested N, g/h/d	13.91	13.10	10.84	12.82	9.28
Urinary N, g/h/d	8.80	7.64	5.12	7.64	3.91
N retention, g/h/d	5.11b	5.46a	5.72a	5.18b	5.37a
Retained/digested N,%	36.74b	41.68b	52.77a	40.41b	57.87a
Retained/ intake, %	23.12b	26.21b	32.57ab	25.73b	35.47a
Water intake, l/h/d	2.442c	2.580b	2.802a	2.650b	2.773a
Water intake/Kg DMI	2.11c	2.20b	2.45a	2.21b	2.56a

a,b,c, and means with different superscripts in the same row differ significantly (P<0.05)

On the other hand, results presented in Table (3) revealed that nitrogen balance, nitrogen balance as percent of digested nitrogen, and nitrogen intake increased significantly ($P<0.05$) with each increment in the level of replacement (G2 to G5).

Lambs of the control group (Table 3) drank less water on average than did other groups.

Rumen liquor parameters and blood plasma metabolites

Table (4) shows the average values of some rumen liquor parameters (pH values and TVFA's concentrations) at different times (0, 3, and 6 hrs post feeding). Some variations in pH values took place. Groups (3 and 5) had lower pH values, while G1 (control) showed higher values. The mean pH values of the five rations exhibited similar trend. They showed higher values at zero time, then decreased at 3 hrs and raised again after 6 hrs post feeding. Overall average of ruminal pH decreased with increasing proportions of YCG or YCE in rations.

Table 4: Effect of type of concentrates on some rumen liquor parameters

Item	Time after feeding (hr)	G1	G2	G3	G4	G5
PH	0	6.87	6.80	6.75	6.84	6.80
	3	6.19^{a}	6.17^{a}	6.10^{b}	6.18^{a}	6.11^{b}
	6	6.50	6.43	6.42	6.47	6.44
	Ave.	6.52^{a}	6.47^{ab}	6.42^{b}	6.50^{a}	6.45^{ab}
TVFA's	0	5.70^{c}	6.07^{b}	6.24^{a}	5.82^{bc}	5.97^{b}
	3	9.42^{c}	9.55^{b}	9.82^{a}	9.51^{b}	9.73^{a}
	6	7.84	8.10	8.03	7.95	8.07
	Ave.	7.65^{b}	7.91^{ab}	8.03^{a}	7.76^{ab}	7.92^{ab}

a,b,c, and means with different superscripts in the same row differ significantly ($P<0.05$)

Concentrations of TVFA's in rumen liquor samples of the five lamb groups were significantly different at zero, 3, and 6 hrs post feeding, and so were the overall averages. The values of TVFA's concentrations at 3, and 6-hrs post feeding were higher than those recorded before feeding for all groups. Replacement of CFM with YCG or YCE had affected TVFA's concentrations at different time intervals.

Plasma total protein, albumin and globulin concentrations (Table 5) were slightly higher for YCG (G2 and G3) and YCE (G4 and G5) than control group. Albumin/globulin ratios were similar among rations. Plasma glucose content was significantly lower in animals of the control group than other groups.

Table 5: Effect of type of concentrates on some plasma contents

Item	G1	G2	G3	G4	G5
TP, g%	7.20	7.23	7.29	7.22	7.26
Albumin, g%	3.94	3.96	4.02	3.95	3.96
Globulin, g%	3.26	3.27	3.27	3.27	3.30
A/L ratio	1.21	1.21	1.23	1.21	1.20
Glucose, mg%	55.14^{b}	58.19^{a}	59.11^{a}	57.92^{a}	58.82^{a}

a, and b, means with different superscripts in the same row differ significantly (P<0.05)

Growth performance

Results in Table (6) indicate higher daily weight gain in lambs fed YCG or YCE rations as separate ingredients compared with CFM ration (G1). Highest average daily gain was recorded for G3 (140.07 g/h/d) followed by G2 (132.64 g/h/d). Replacement of CFM with YCG or YCE had higher total DMI (non-significant) and daily TDN intake (P<0.05) than G1 (control). Control group had higher DCP intake (P<0.05) than other groups.

Table 6: Performance of lambs fed different experimental rations

Item	G1	G2	G3	G4	G5
Initial weight, Kg	25.75	25.88	25.88	25.75	26.00
Final weight, Kg	43.25	44.45	45.49	43.47	44.31
Total gain, Kg	17.50	18.57	19.61	17.72	18.31
Daily gain, g/h/d	125.00b	132.64b	140.07a	12657b	130.79b
Daily feed intake, g/h/d					
CFM	880.99	610.69	309.82	594.47	303.52
Rice straw	339.53	332.99	327.96	335.93	330.49
Yellow corn grains	--	306.33	621.65	--	--
Yellow corn ears	--	--	--	296.89	606.32
TDMI	1220.52a	1250.01a	1259.43a	1227.29a	1240.33a
TDNI	807.37c	906.88ab	949.23a	854.44b	897.75ab
DCPI	86.29a	76.88ab	70.15ab	77.69ab	62.51b
Feed conversion					
Kg DM/Kg gain	9.76a	9.42a	8.99a	9.70a	9.48a
Kg TDN/Kg gain	6.46a	6.84b	6.78b	6.75b	6.86b
Kg DCP/Kg gain	0.69a	0.58ab	0.50b	0.61b	0.48b
Feed cost*/Kg gain, LE	5.21	4.90	4.52	4.94	4.62
Economic efficiency**	1.80	1.93	2.11	1.90	2.07

a, and b, means with different superscripts in the same column differ significantly (P<0.05)

*** based on the assumption that the price of one ton of CFM, rice straw, yellow corn ears were 600, 100, 530, 505 LE, respectively. The price of one Kg live body weight gain was 9.5 LE.**

**** Economical efficiency as ratio between price of the weight gain and cost of feed consumed.**

Feed conversion as Kg DM/Kg gain and as Kg DCP/Kg gain was better for rations including separate feed ingredients than control. On the other hand, results showed that feed conversion as Kg DCP/Kg gain was better for ration (5) than others.

Feed cost/Kg weight gain (L.E.) and economic efficiency were in favor of feeding feed ingredients as separate components than CFM (G1).

DISCUSSION

Results in Table (2) show that feeding coarsely ground corn grains or ears increased DM, OM, EE, and NFE digestibilities and, therefore, TDN values. Digestion coefficients of CP and CF and, hence, digestible CP decreased. This might be due to the higher contents of OM, EE, and NFE and lower contents of CP in YCG, and YCE (Table 1). These results are in accordance with Abou-Raya *et al*., (1980) and Fahmy *et al.* (1995). Singh *et al.* (1980) and El-Sayes and Gaafar, (1998), found that grains supplementation increased DM, OM, EE and NFE digestion coefficients, and decreased CF digestibility. Mehrez, (1995) reported that the addition of quantities of readily available substrates (in the form of cereals) to poor quality roughage increased its rate of fermentation in the rumen through more colonization of rumen bacteria. Kennedy and Milligan (1980) suggested that grains could be used to increase nutrient utilization. However, this might be due to the variation in the availability of energy from corn grains or ears compared to CFM ration. Aly *et al.* (1982) reported that increased digestibilities of nutrients may be due to increased energy utilization.

Linden *et al*. (1984), Van Gylswyk and Schwartz, (1984), and Gihad *et al.* (1994) observed that the digestibility of CF declined linearly as the proportion of grains increased in the diet. The lower CF digestibility associated with feeding corn grains or ears might due to their contents of high readily fermentable carbohydrates. This slightly increased rumen TVFA's concentrations and decreased pH values (Table 5), resulting in lower cellulolytic activity, thus reducing the fermentation of fiber (Chase and Hibberd, 1989).

On the other hand, Iwuanyanwu *et al* (1990) reported that low protein content in rations caused CP digestibility to decrease. Hanafy *et al.* (1998) found that the low DCP value of corn grains included in rations could be related to its low CP contents compared with CFM.

The results in Table (3) indicated that increasing coarsely ground corn grains or ears from zero to one or two percent of LBW (high energy diet) decreased nitrogen intake, nitrogen in feces and urine, and increased nitrogen retention calculated as gram N/h/d or as percentage of digested nitrogen or nitrogen intake. This increase in N utilization in these groups maybe due to the lower dietary fiber content (Taie, 1998). Higher nutrient digestibilities, therefore, could be attributed to better fermentation rate and NH_3-N concentration leading to higher microbial protein synthesis (El-Bedawy *et al.*, 1993). This protein has more balanced amino acid pattern than that of CFM as suggested by El-Ayek, (1999). Angami *et al.* (1992), Sultan and Loerch, (1992), and Taie *et al.* (1998) found that N retention was higher with high-energy diets. Similar improvement was obtained in N retention as percentage of N digested and N intake. Lower CP concentration reduced N waste, particularly in the form of urinary N. Susmel *et al.* (1995) and Wright *et al.* (1997) supported this suggestion.

In Table (3), water intake (l/h/d) and water intake/Kg DM intake increased with increasing level of energy in the rations. These results agree with Shafie *et al.* (1994) and Solouma, (1999). They found that high energy level in the ration increased drinking water more than the low level of energy.

Rumen pH is one of the most important factors affecting the fermentation in the rumen and influences its function. Overall average of ruminal pH values (Table 4) ranged from 6.42 to 6.52 indicating optimum rumen environment for degradation of straw (Bhargava and Orskov, 1987). The trend of pH values might reflect the increase in TVFA's production in the rumen through the first 3 hrs post feeding. This may due to fermentation process of non structural carbohydrates causing pH to decrease until relatively absorbed from the rumen wall resulting in an increase in pH value (6 hrs post feeding) (El-Sayed *et al.*, 1997). Ashmawy (1998) stated that rumen pH was closely related to VFA levels in the rumen. Average ruminal pH values decreased and total VFA's increased with increasing corn grains or ears in rations (Table 4). Ørskov, (1973) reported that grain diets decreased rumen pH. Lower pH values (G2 to G5) may be due to relatively more fermentation of NFE (Gihad *et al.*, 1989). On the other hand, the higher TVFA's concentrations may be associated with increased NFE intake (Table 1) (Fouad *et al*., 1997). Haaland *et al* (1992) and Das, (1996) attributed that to the availability of essential nutrients required for microbial activity. Moreover, Van't Klooster, (1986), reported that intake of large quantities of fast fermentable carbohydrate cause a disturbance in the rumen ecosystem. The rate of VFA production may in this situation exceed the rate of VFA absorption through rumen epithelium and, therefore, VFA concentrations increase in rumen juice.

Data given in Table (5) revealed that levels of total protein, albumin and globulin slightly increased (non significantly) and glucose increased ($P<0.05$) with each increment in the level of replacement. These results were within the normal ranges recorded by Varley, (1969). The increased plasma total protein and its fractions may be due to stimulation of protein synthesis and as a response to the increase in regulators of growth hormone synthesis (Wood *et al.*, 1987). Growth hormone has a major role in the movement of amino acids and peptide transport and subsequently blood protein anabolism (Hussein, 1986). The increase in plasma glucose may be attributed to the increase of carbohydrate metabolism and the increase in the rate of intestinal glucose absorption (Harper *et al.*, 1979).

Barki breed sheep is one of the subtropical breeds that are raised mostly under unfavorable conditions of management and environment including less availability and seasonal fluctuations in feed supply (Aboul-Naga and Aboul-Ela, 1987). Results indicated that slightly decreased DM intake of rice straw corresponded with increasing levels of corn grains or ears. Mehrez, (1995) reported that if the diet contains grains at relatively high proportions then fermentation of the roughage part will be depressed mainly because of lowered rumen pH (Table 4) as a result of acids produced and less saliva secreted during chewing and rumination and decreased the straw intake.

Barki lambs performance (Table 6) indicated that partial replacement of CFM with corn grains or ears had slightly decreased roughage intake, increased total DM and average daily gain as well. O'Ferall and Keane (1990) reported that increasing the dietary energy level increased the daily gain. The higher daily gain for lambs fed the diets containing corn grains or ears (G2 to G5) was associated with a high energy availability of grains, mainly because of the greater ruminal degradation of starch (Oliveria *et al.*, 1995). Higher production of total VFA's (Table 4) and greater ruminal bacterial yields (Poore *et al.*, 1993) as well as increased ruminal propionate concentration and decreased molar proportions of acetate to propionate when starch availability in the rumen increased (Overton *et al.*, 1995), increased starch fermentation in the rumen and resulted in increased microbial protein synthesis. Subsequently, increased daily gain (Chen *et al.*, 1994) and to the associative effect of using the two kinds of concentrates (Yu, *et al.,* 1998). There was appreciable improvement in total MDI, daily TDN intake, average daily gain and feed efficiency as Kg DM/Kg gain and reduction in feed cost/Kg weight gain and increases in economical efficiency for group (3) than other groups

CONCLUSION

The concentrate feed mixture (CFM) is one of the important feeds for ruminants. But due to the continuous lack of local production (leading to a decreased productivity of the animals), it maybe safely recommend to use the raw materials such as corn grains or ears as a substitute for the CFM in lamb rations without having a negative effect on its health. It caused a reduction of production cost of one Kg of meat and increased the growth rate, hence, reducing time required for marketing.

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نظام لتغذية الحملان لزيادة الاستفادة من العناصر الغذائية وتقليل تكاليف التغذية

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استخدمت فى هذه الدراسة خمسة أنواع من العلائق تم بها استبدال جزء من العلف المركز بمثيله وزنا من حبوب الذرة الصفراء أو مجروش كيزان الذرة الصفراء لمعرفة اثر ذلك على القيم الغذائية واداء الحملان وكانت العلائق كالتالى:

1- علف مركز بنسبة ٣% من وزن الجسم
2- علف مركز بنسبة ٢% من وزن الجسم مع حبوب ذرة صفراء (١%)
3- علف مركز بنسبة ١% من وزن الجسم مع حبوب ذرة صفراء (٢%)
4- علف مركز بنسبة ٢% من وزن الجسم مع مجروش كيزان الذرة (١%)
5- علف مركز بنسبة ١% من وزن الجسم مع مجروش كيزان الذرة (٢%)

وقدم قش الأرز كمادة مالئة لحد الشبع فى العلائق الخمسة

استخدم فى هذه التجربة أربعون حولى برقى بمتوسط وزن ٢٥,٨٥ كجم قسمت الى خمس مجموعات بالتساوى واستمرت تجربة التغذية ١٤٠ يوما تم خلالها اجراء خمس تجارب تمثيل غذائى وجمع سائل الكرش وعينات دم.

اوضحت النتائج أن الاستبدال ادى الى زيادة معاملات الهضم والقيم الهضمية وميزان الازوت مع ارتفاع البروتين الكلى والالبيومين وجلوكوز الدم مع تحسن معدلات النمو وارتفاع الكفاءة التحويلية والاقتصادية وانخفاض تكلفة كيلو النمو وان لم تتأثر كثيرا قيم الاس الهيدروجينى ومجموع الاحماض الدهنية الطيارة لسائل الكرش

ويستنتج من ذلك ان استخدام المواد الخام المحلية فى تصنيع الاعلاف يمكن ان يخفض تكاليف تصنيع العلائق دون اى تاثير على اداء الحيوان