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EFFECT OF DIETARY CONCENTRATE TO ROUGHAGE RATIO ON NUTRIENT DIGESTIBILITY, RUMEN FERMENTATION, GROWTH PERFORMANCE AND SERUM ACUTE PHASE PROTEIN IN GROWING BUFFALO CALVES

S.M. Abdel Raheem[1], E.H. Hassan[2] and M.M. Farghaly [3]

[1]Department of Animal Nutrition and Clinical Nutrition, Faculty of Veterinary Medicine, Assiut University, Assiut, Egypt, 71526.
[2] Department of Animal Production, Faculty of Agriculture, Al-Azhar University, Assiut, Egypt.
[3]Department of Animal Production, Faculty of Agriculture, Assiut University, Assiut, Egypt, 71516.

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SUMMARY

This study was accomplished to designed to assess the appropriate concentrate: roughage ratio (C:R) ratio for better nutrient digestibility, rumen fermentation patterns, healthy and economic beef production in Egyptian buffalo calves. Sixteen buffalo calves aged about 18-20 months of 292.5±4.7 kg average body weight were randomly assigned into four groups of 4 animals each. The treatment diets were composed of four concentrate: roughage (C:R) ratios (80:20, A; 75:25, B; 60:40, C; and 55:45, D). The results revealed that increasing in the proportion of concentrate in the diet significantly (p <0.05) increased the digestibility of dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE), nitrogen free extract (NFE) and the total digestible nutrients (TDN). Ruminal concentration of both volatile fatty acids (VFA) and ammonia nitrogen were increased linearly with increasing the dietary concentrate portion (60, 75 and 80), however the rumen pH were decreased (P<0.01) with increasing the concentrate level in the diet. In addition, increasing the concentrate proportion increased the dry matter intake of feed, average daily gain, final body weight; and feed cost per kg body weight. Serum, glucose, and acute phase protein were increased by increasing the dietary concentrate portion. Feeding diet containing 60% concentrate showed better performance and economic efficiency per kg body weight gain when comparing with diet containing 75 % and 80 % concentrates levels. This study suggested that the diet consisting of 60: 40 concentrate: roughage ratio could be considered as the optimum diet for growing buffalo calves for better performance, efficient feed utilization, economic feed efficiency and low risk of sub-acute ruminal acidosis.

Keywords: *concentrate : roughage ratio, performance, subacut ruminal acidosis*

INTRODUCTION

Feedlot ration should be designed to give maximum weight gain and fattening rate at the lowest cost with minimum digestive upset. Modern beef feeding requires the manipulation of concentrate to roughage ratio (C:R) which affects gain and efficiency of gain. Since long time ago, there has been a tendency to fed high grain level in feedlot rations. Feeding high concentrate level improved ruminant production and decreased methan production which represent a daily feed energy losses and reduce profitability of beef production. High concentrate diet shift rumen fermentation to propionogenesis and reduce acetate and butyrate and methane production in comparison with high forage diet (Martin *et al*., 2010).

Many studies reported that feeding high concentrate diet to young calves with limited or no forage source (low NDF) or no optimum level of physically effective fiber could disturb rumen fermentation pattern, animal metabolism and health (Suárez *et al*., 2007). Concentrate diets improves animal performance, but increase the risk of rumen disorders and hepatic abscess when compared with diets with a fibre forage source due to the decrease in rumen pH caused by extreme consumption of fermentable carbohydrates (Nagaraja and Titgemeyer, 2007).

The dietary inclusion of concentrates for ruminant is planned to raise the energy, proteins, minerals, and vitamins content in animal diet and to improve feed utilization efficiency and productive efficiency (Morand-Fehr and Sauvant, 1987). On the other hand, long time feeding on high-concentrate diet predispose the animal to subacute ruminal acidosis (SARA) which described as decreased rumen pH under 5.6 or 5.8 as a result of excessive production of lactic acid and volatile fatty acids (VFA) (Zebeli *et al*., 2008 and Chen *et al*., 2012,). The symptoms of SARA are decreasing feed intake, decreasing rumination, and metabolic disorders and animals might live in a certain stress status (Jia *et al*., 2014). Subacute ruminal acidosis stimulate the release of ruminal lipopoly saccharide endotoxin and trigger an inflammatory response in steers (Gozho *et al*., 2005 and GonzaGonzlez *et al*., 2012). SARA produced by high grain diet lead to increasing the acute phase protein (APPs) in peripheral blood (Gozho *et al*., 2005; Khafipour *et al*., 2009 and Jia *et al*., 2014). The increased acute phase proteins (APPs) concentration is not specific for a particular disease but reflects the overall health of the animals. The information about the optimum levels of roughage in rations of fattening buffalo calves is lacking. Therefore, verifying the proper concentrate: roughage ratio is one of the most essential factors to guarantee the growth and health of buffalo calves. Consequently, the present study was designed to assess the appropriate C:R ratio for better nutrient digestibility, rumen fermentation patterns, healthy and economic beef production.

MATERIALS AND METHODS

Animals, diets and management

This study was conducted following the procedures officially approved by the Ethics Committee on Animal Experimentation of Assiut University, Faculty of veterinary medicine. This study was performed out at Research Farm of Faculty of Agriculture, Al-Azhar University Assiut, Egypt. Sixteen buffalo calves aged about 18-20 months of 292.5±4.7 kg average body weight were randomly assigned into 4 groups of 4 animals each for six month fattening period. The treatment diets were composed of basal diet with four concentrate to roughage ratios (80:20, A; 75:25, B; 60:40, C and 55:45, D), respectively. The experimental diet consists of concentrate mixture, wheat straw and berseem hay. The concentrates level was 2 % of body weight, while roughage level was 1% of body weight. The ingredients composition and chemical analysis of experimental diets are displayed in Tables (1 and 2).

Table (1): Ingredient composition of the experimental diets.

Item	A	B	C	D
Concentrate mixture (%)	80	75	60	55
Roughage (%)	20	25	40	45
Total	100	100	100	100
Concentrate mixture				
Ground corn	17	10.50	3.50	3
Ground sorghum	51.5	62.00	78.00	75.5
Wheat bran	16	12.00	2.00	2.00
Soybean meal	12	12.00	14	17
Vitamin and mineral Premix*	1	1	1	1
Limestone	2	2	1	1
Salt	0.5	0.5	0.5	0.5
Total	100	100	100	100

**Vitamin and mineral premix each 3 kg contain: 1,250,000 IU, Vit A; 2,500,000 IU, Vit D3; 1000 mg, Vit E; 80,000 mg, Mn; 60,000 mg, Zn; 50,000 mg, iron, 20,000 mg, copper, 5000 mg, iodine, 250 mg, Se, 1000 mg, Co mg tell 3 kg CaCO3*

Preparing and mixing of diet performed daily and diets offered twice a day. Daily feed intake was noted and representative samples from feed were taken for chemical analysis. Separate pens with concrete floor equipped with locally manufactured feed manger were used for keeping each calf. Body weight of the calves were recorded initially and every month thereafter. Clean and fresh water was available *ad libitum.* Deworming of calves were carried out before the beginning of the experiment.

Digestibility trials

Digestibility of feed nutrients was performed by the use of chromic oxide as indicator. The digestion trial lasted for 14 days, 7-days as preliminary period and 7 days as collection period. Exactly 10 grams of Cr2O3 were hand mixed into the concentrate portion of each calf for 14 days. Orts were weighed daily, and collected before feedings of days 7-14.

Table (2): Chemical analysis and nutrient composition of experimental diets (% on DM basis).

Item	A	B	C	D	Berseem hay	Wheat straw
Dry matter	89.79	90.01	90.52	90.45	88.6	91.5
ME Mcal/kg	2.85	2.84	2.76	2.72	2.45	1.62
Crude protein	16.89	16.86	16.83	16.85	19.75	4.81
Crude fiber	10.69	11.86	15.70	17.29	30.36	40.87
Ether extract	3.17	3.06	2.85	2.80	2.71	2.19
NFE	59.36	62.62	57.71	55.55	31.72	43.72
Ash	9.90	5.60	6.91	7.51	15.46	8.42
Organic matter	90.10	94.40	93.09	92.49	84.54	91.58
Calcium	1.06	1.10	0.97	1.04	2.47	0.19
Phosphorus	0.50	0.45	0.35	0.34	0.29	0.05

Diet A with C: R=80:20; diet B with C: R= 75:25; diet C with C:R= 60:40; diet D with C:R= 55:45
NFE= Nitrogen free extract, ME= Metabolizable energy

Sampling and measurements

Feed was dried at 60°C in a forced-air oven for 72 hours. By the end of the collection period, an equal quantity of sample was taken from each daily collection, and composited per calf to create a single sample representative of that calf's feed. About 200 g of fresh feces was collected by fecal grab from 7-14 days twice / 24-hr and stored in refrigerator. At the end of each period, fecal samples were thawed, composited in equal amounts by calves, and dried at 60°C. Samples were milled to pass through a 1 mm screen and sealed in plastic bags. Samples were assayed for dry matter (DM), organic matter (OM), and crude protein, crude fiber (CF), ether extract (EE) and ash according to methods defined by AOAC (1999). Chromium content of feed feces was determined by atomic absorption spectrophotometer by the methods described by Williams *et al*. (1962). Digestibility of nutrients were estimated according to Maynard and Loosli (1969) by the following equation:

$$Digestibility\ of\ nutrient\ (\%) = 100 - (100 \times (\%\ marker\ in\ feed) / (\%\ marker\ in\ feces) \times (\%\ nutrient\ in\ feces) / (\%\ nutrient\ in\ feed).$$

Blood sampling

Blood samples were collected by jugular vein-puncture into two tubes containing either 0.1% EDTA for plasma collection or in a tube with no anticoagulant for obtaining the serum at the end of the experiment 6 h after the a.m. feeding. After that blood samples were centrifuged at 3000 rpm for 20 min for harvesting serum and plasma and then stored at −20 ◦C till analyzed for blood metabolites and plasma acute phase protein. Blood metabolites (glucose, total protein, albumin, AST, ALT and blood urea nitrogen) were analyzed by spectrophotometer (Unico, USA) using commercial test kits according to manufacturer company.

Determination of acute phase proteins

Serum haptoglobin (Hp) concentration was determined using a commercial sandwich ELISA (GenWay Biotech Inc. San Diego, CA). Samples were diluted (50-time dilution). Intra and inter-assay CV were 3.3% and 11%, respectively. Serum amyloid A was determined by the use of commercial multispecies ELISA (Tridelta Development Ltd, Kildare, Ireland) explained by McDonald *et al*. (1991).

Rumen liquor parameters

In the last day of collection period at 3 h post morning feeding rumen liquor was taken from each calf by stomach tube. A double layer of cheesecloth was used for filtration of rumen liquor into plastic tubes (50 ml). A portable pH meter (Beckman, model 45, USA) was used for determination of pH immediately after sampling. Rumen liquor was used to determine total volatile fatly acids (VFA) concentration according to method described by Cannon *et al*. (2010). Rumen fluid samples was mixed with oxalic acid (0.1 mol/l), sodium azide (40 mmol/l) and capronic acid (0.1 mmol/l) as internal standard, centrifuged and the supernatant was analyzed for short chain fatty acids (SCFAs) by gas chromatography (Agilent 6890 N GC) equipped with a 30 m x 530µm x 0.1 µm capillary column with flame ionization detector according to the method. While rumen ammonia nitrogen (NH3-N) concentration mg /100 ml was analyzed according to (method 973.49, AOAC International, 2000).

Statistical analysis

SPSS program version 16.0 software (SPSS, 2008) was used for analysis of raw data, Differences between groups in nutrient digestibility, rumen fermentation, blood metabolites; serum acute phase protein and performance were estimated by one-way ANOVA. Duncan's multiple range tests (Duncan, 1955) was used to detect the differences between means. The data were tabulated in mean ± S.E.M. Level of significance was set at P<0.05.

RESULTS AND DISCUSSION

Nutrients digestibility

The data in Table (3) indicated that increasing the proportion of concentrate in the diet significantly (p <0.05) increased the digestibility of DM, OM, CP, CF, EE and NFE. Similarly, the percentage of digestible crude protein (DCP), and total digestible nutrients (TDN) were significantly increased in high concentrate diets (A, B and C) in comparison with diet D. This result was coincided with the findings observed by previous investigation carried out by Cantalapiedra-Hijar *et al*. (2009), Saini *et al*., (2012), Kumari *et al*., (2012), Ma *et al*. (2014) and Malisetty *et al*. (2014). The decrease in nutrient digestion at 80 % concentrate level may be produced by the inhibition of cellulolytic bacteria growth caused by decreasing the rumen pH under 6.2 (Grant and Mertens, 1992).

Table (3): Effect of concentrate to roughage ratio on nutrient apparent digestibility, %.

Item	Treatment				*P*
	A	B	C	D	
		Diet digestibility			
DM	$69.86^{b} \pm 0.35$	$73.2^{a} \pm 0.43$	$73.47^{a} \pm 0.31$	$68.54^{b} \pm 0.68$	<0.001
OM	$71.42^{c} \pm 0.14$	$75.44^{b} \pm 0.21$	$76.03^{a} \pm 0.14$	$70.62^{d} \pm 0.12$	<0.001
CP	$71.31^{b} \pm 0.34$	$76.34^{a} \pm 0.7$	$76.11^{a} \pm 0.31$	$69.86^{c} \pm 0.44$	<0.001
CF	$65.66^{b} \pm 0.21$	$68.28^{a} \pm 0.25$	$68.42^{a} \pm 0.27$	$64.02^{c} \pm 0.6$	<0.001
EE	$68.59^{b} \pm 0.1$	$71.43^{a} \pm 0.29$	$71.64^{a} \pm 0.22$	$66.68^{c} \pm 0.27$	<0.001
NFE	$74.19^{b} \pm 0.15$	$76.87^{a} \pm 0.24$	$77.26^{a} \pm 0.08$	$73.32^{c} \pm 0.17$	<0.001
		Nutritive value			
DCP, %	$12.04^{b} \pm 0.06$	$12.87^{a} \pm 0.05$	$12.81^{a} \pm 0.05$	$11.77^{c} \pm 0.07$	<0.001
TDN, %	$67.99^{c} \pm 0.1$	$74.02^{a} \pm 1.9$	$72.73^{b} \pm 0.08$	$67.77^{c} \pm 0.13$	<0.001

Means within row bearing different superscripts differ significantly (p< 0.05).
Diet A with C: R=80:20; diet B with C: R= 75:25; diet C with C:R= 60:40 and diet D with C:R= 55:45
DM dry matter, OM organic matter, CP crude protein, EE ether extract, NFE, nitrogen free extract, DCP digestible crude protein, TDN total digestible nutrients and SE starch equivalent.

Rumen properties

The rumen fermentation parameters were exhibited in Table (4). The C:R ratio affected (P < 0.05) ruminal pH, VFA and ammonia-N concentration. There was a significant (P<0.05) decrease in the rumen pH in the buffalo calves by increasing the level of concentrate from 55 to 80 %. In the current study increasing concentrate in diets was increased (p<0.01) rumen total volatile fatty acids and ammonia nitrogen concentration. This result support the finding of previous studies performed by Cantalapiedra-Hijar *et al*. (2009), Agle *et al*. (2010) and Van Dung *et al*. (2014). The higher rumen volatile fatty acid produced from feeding high concentrate diet decreased (P<0.01) rumen pH as compared with high roughage diet. This observation supports the finding of Cantalapiedra-Hijar *et al*. (2009). The greater lactic acid produced from the greater amount of starch present in high concentrate diet was the main reason for the reduction in rumen pH (Slyter, 1976). The higher rumen ammonia N in high concentrate diet may be caused by the higher digestibility of crude protein in high concentrate diet because the rumen ammonia nitrogen depend up on the protein content in the diet and the digestibility of protein (Cantalapiedra-Hijar *et al*., 2009).

Table (4): Effect of concentrate to roughage ratio on rumen fermentation parameters.

Item	Treatment A	B	C	D	*P*
pH	$6.08^{b} \pm 0.07$	$6.31^{a} \pm 0.1$	$6.44^{a} \pm 0.03$	$6.49^{a} \pm 0.03$	0.009
NH3-N, mg/dl	$14.72^{a} \pm 0.14$	$13.08^{b} \pm 0.22$	$11.17^{c} \pm 0.04$	$11.46^{c} \pm 0.05$	<0.001
Acetate, m*M*	$52.23^{a} \pm 0.32$	$50.01^{b} \pm 0.62$	$47.74^{c} \pm 0.32$	$45.91^{d} \pm 0.07$	<0.001
Propionate, m*M*	$6.04^{b} \pm 0.05$	$6.13^{a} \pm 0.01$	$6.05^{b} \pm 0.01$	$5.85^{c} \pm 0.02$	<0.001
Iso butyrate, m*M*	$5.00^{c} \pm 0.11$	$5.84^{b} \pm 0.07$	$5.74^{b} \pm 0.13$	$6.38^{a} \pm 0.02$	<0.001
Butyrate, m*M*	$4.8^{c} \pm 0.03$	$5.83^{b} \pm 0.53$	$7.53^{a} \pm 0.31$	$6.01^{b} \pm 0.02$	<0.001
Isovalerate, m*M*	$4.76^{a} \pm 0.01$	$4.58^{b} \pm 0.07$	$4.06^{d} \pm 0.01$	$4.37^{c} \pm 0.02$	<0.001
Valerate, mM	$3.09^{a} \pm 0.02$	$2.87^{b} \pm 0.05$	$2.55^{d} \pm 0.01$	$2.78^{c} \pm 0.01$	<0.001
Total VFAs , m*M*	$75.94^{a} \pm 0.29$	$75.29^{ab} \pm 0.22$	$73.68^{b} \pm 0.51$	$70.32^{c} \pm 0.97$	<0.001
A:P	$8.65^{a} \pm 0.08$	$8.23^{b} \pm 0.11$	$7.79^{c} \pm 0.04$	$7.84^{c} \pm 0.02$	<0.001

Means within row bearing different superscripts differ significantly (p< 0.05).
Diet A with C: R=80:20; diet B with C: R= 75:25; diet C with C:R= 60:40; and diet D with C:R= 55:45
mM millimolar or mmol/L.

Blood metabolites

The blood metabolites were displayed in Table (5). Blood metabolites are crucial tools for general health state and vitality. In this study, we noticed that increasing the proportion of concentrate from 55 % to 80 % in diets increased blood glucose, total protein and globulin concentration in buffalo calves. The increase in plasma glucose concentration reflects higher hepatic glucogenesis (Bobe *et al*., 2004), associated with the higher propionate proportion observed in our study. This result support the previous report of Serment *et al*. (2011). Abonyi *et al*. (2013), Chen *et al*. (2015) and Dong *et al*. (2017) who revealed that the high concentrate diet probably improved energy balance, protein synthesis and humoral immunity of the animal. Blood urea nitrogen (BUN) concentration was used as indicator of nitrogen utilization efficiency by ruminants (Lewis, 1957). Blood urea nitrogen (BUN) was not affected (P > 0.05) by different concentrate to roughage ratio in this study. The urea N produced from protein and amino acid catabolism in the body. That implies decreasing protein utilization, increasing blood urea N content (Ponnampalam *et al*., 2005). Experimental diets with different C: R ratios failed to induce any impact on liver enzymes (ALT and AST).

Table (5): Effect of concentrate to roughage ratio on blood metabolites.

Item	Treatment A	B	C	D	*P*
Glucose (mg/dl)	$64.10^{a} \pm 0.41$	$62.26^{b} \pm 0.28$	$59.95^{c} \pm 0.14$	$58.04^{d} \pm 0.21$	<0.001
Total protein, g/dl	$7.52^{a} \pm 0.09$	$7.44^{a} \pm 0.04$	$7.01^{b} \pm 0.01$	$6.99^{b} \pm 0.09$	<0.001
Albumin (g/dl)	$4.44^{ab} \pm 0.04$	$4.52^{a} \pm 0.02$	$4.51^{a} \pm 0.02$	$4.42^{b} \pm 0.01$	0.04
Globulin (g/ dl)	$3.08^{a} \pm 0.07$	$2.92^{a} \pm 0.05$	$2.49^{b} \pm 0.11$	$2.57^{b} \pm 0.09$	<0.001
Al/Glo ratio	$1.44^{b} \pm 0.03$	$1.54^{b} \pm 0.02$	$1.83^{a} \pm 0.09$	$1.74^{a} \pm 0.07$	<0.001
ALT (U/l)	30.1 ± 1.9	25.21 ± 0.94	30.77 ± 1.38	28.11 ± 2.44	0.11
AST (U/l)	78.16 ± 0.17	78.2 ± 0.18	78.32 ± 0.05	78.36 ± 0.04	0.69
Cholesterol (mg/dl)	$89.32^{ab} \pm 0.29$	$88.48^{ab} \pm 0.42$	$94.1^{b} \pm 0.91$	$99.19^{a} \pm 0.99$	<0.001
BUN (mg/dl)	25.82 ± 0.09	25.78 ± 0.04	25.76 ± .08	25.56 ± 0.14	0.291

Means within row bearing different superscripts differ significantly (p< 0.05).
BUN= Blood urea nitrogen.
Diet A with C: R=80:20; diet B with C: R= 75:25; diet C with C:R= 60:40 and diet D with C:R= 55:45.

Serum acute phase proteins

Variation in the ratio between concentrate to roughage induced significant (P<0.01) effects on serum acute phase proteins as clear in Table (6). There were significant increase (P<0.001) in serum haptoglobulin, serum amyloid A and serum C- reactive protein by increasing the dietary concentrate portion. These results in line with the results of Gozho *et al*. (2005), Khafipour *et al*. (2009) and Plaizier *et al*. (2009). Although serum acute phase protein increased with high concentrate diet and the risk of subclinical or subacute ruminal, acidosis was increased but the greater risk of acidosis did not impair growth performance in buffalo calves under present experimental station.

Table (6): Effect of concentrate to roughage ratio on levels of serum acute phase proteins.

Item	Treatment				P
	A	B	C	D	
Haptoglobulin, µg/ml	$41.66^{a} \pm 0.87$	$41.07^{a} \pm 0.25$	$39.52^{b} \pm 0.18$	$36.61^{c} \pm 0.27$	<0.0001
Serum amyloid A, µg/ml	$35.66^{a} \pm 0.87$	$35.07^{a} \pm 0.25$	$33.52^{b} \pm 0.18$	$30.61^{c} \pm 0.28$	<0.0001
C-reactive protein, mg/L	$38.65^{a} \pm 0.87$	$38.07^{a} \pm 0.25$	$32.52^{b} \pm 0.17$	$29.61^{c} \pm 0.28$	<0.0001

Means within row bearing different superscripts differ significantly (p< 0.05).
Diet A with C: R=80:20; diet B with C: R= 75:25; diet C with C:R= 60:40 and diet D with C:R= 55:45.

Growth performance

Performance of buffalo calves was presented in Table (7). Feeding high concentrate significantly increased final body weight, total and daily body weight gain and dry matter intake. In addition, feeding high concentrate diet to buffalo calves induced higher feed conversion rate diet (Diet A and B) when compared with low concentrate diet (C and D). Furthermore, low concentrate diets (60 and 55 %) are cheaper in cost in comparison with high concentrate diet (80 and 75 %). The improvement of growth performance with high concentrate diet was in agreement with previous work of Haddad, (2005), Papi *et al*. (2011), Chen *et al*. (2015) and Rashid *et al*. (2015). The increase in dry matter intake in high concentrate diet (A and B) could be ascribed to the higher palatability of high concentrate diet (Ma *et al*., 2014). Higher roughage diets reduced production costs in comparison with higher concentrate diets as well in our trial. In this respect Norris *et al*. (2002) mentioned that crossbred males fed with high concentrate diet had better (*P* <0.05) feed conversion rate than that of those fed with medium and low concentrate diets. From economical point of view, calves fed with diet C were economically efficient than that of those on diet A and B. The feed cost required for 1 kg LWG increased with the increase of concentrate level in diet. This is in line with results of Helal *et al*. (2011) who demonstrated that feed cost for one kg weight gain increased with the increase in concentrate level (15% to 100%) in buffalo and steers, respectively.

Table (7): Performance of buffalo calves fed experimental diets.

Item	Treatment				*P*
	A	B	C	D	
Initial weight, kg	292.75 ± 3.35	292.5 ± 4.69	296.0 ± 3.49	295.00 ± 2.16	0.87
Final weight, kg	$432.5^{a} \pm 1.04$	$430.25^{a} \pm 2.28$	$428.5^{a} \pm 0.64$	$419.75^{b} \pm 0.85$	<0.001
BWG gain, kg	$139.75^{a} \pm 3.71$	$137.75^{a} \pm 3.79$	$132.5^{ab} \pm 3.59$	$124.75^{b} \pm 2.78$	0.04
Daily gain, kg	$0.932^{a} \pm 0.03$	$0.918^{a} \pm 0.03$	$0.883^{ab} \pm 0.02$	$0.831^{b} \pm 0.01$	0.04
DMI of concentrate	$6.11^{a} \pm 0.01$	$5.28^{b} \pm 0.01$	$4.46^{c} \pm 0.03$	$4.00^{d} \pm 0.02$	<0.001
DMI of roughage	$1.53^{d} \pm 0.02$	$2.26^{c} \pm 0.004$	$2.97^{b} \pm 0.02$	$3.28^{a} \pm 0.02$	<0.001
Total DM intake kg/day¥	$7.64^{a} \pm 0.01$	$7.54^{a} \pm 0.01$	$7.44^{b} \pm 0.05$	$7.28^{c} \pm 0.04$	<0.001
*FC kg DM /kg gain	8.22 ± 0.22	8.24 ± 0.23	8.44 ± 0.27	8.77 ± 0.24	0.38
Feed cost/day E.P.**	$31.85^{a} \pm 0.03$	$29.09^{b} \pm 0.05$	$26.32^{c} \pm 0.17$	$24.62^{d} \pm 0.14$	<0.01
Feed cost/kg BWG***	$34.25^{a} \pm 0.95$	$31.75^{ab} \pm 0.90$	$29.88^{b} \pm 0.96$	$29.66^{b} \pm 0.81$	0.01

Means within row bearing different superscripts differ significantly (p< 0.05).
Diet A with C: R=80:20; diet B with C: R= 75:25; diet C with C:R= 60:40 and diet D with C:R= 55:45
**FC = Feed conversion ratio, ¥ DMI = Dry matter intake, ** E.P. =Egyptian pound, ** *BWG=Body weight gain.*

CONCLUSION

The optimum levels of concentrate to roughage ratio in rations of fattening buffalo calves is very important factor affecting feed utilization and the whole ruminant production capacity. This study suggested that the diet consisting of 60: 40 concentrate: roughage ratio could be considered as the optimum diet for growing buffalo calves for better performance, efficient feed utilization, economic feed efficiency and low risk of sub-acute ruminal acidosis.

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تأثير نسبة العلف المركز الي العلف الخشن في العليقة على الهضم وتخمر الكرش وأداء النمو وبروتينات المرحلة الحرجة في الدم في عجول التسمين الجاموسي

شريف محمد عبد الرحيم[1] و إكرامي حامد حسن[2] و محسن محمد فرغلي[3]

[1]قسم تغذية الحيوان والتغذية الإكلينيكية، كلية الطب البيطري، جامعة أسيوط

[2]قسم الإنتاج الحيواني، كلية الزراعة، جامعة الازهر فرع أسيوط

[3]قسم الإنتاج الحيواني، كلية الزراعة، جامعة أسيوط

صُممت هذه الدراسة لمعرفة تأثير نسبة العلف المركز الي العلف الخشن في العليقة على الهضم وتخمر الكرش وبروتينات المرحلة الحرجة في الدم وأداء عجول التسمين الجاموسي. اجريت الدراسة علس ستة عشر عجلا من عجول الجاموس بعمر 18-20 شهرا بلغ متوسط اوزانها 292.5 ±4.7 كجم وزعت عشوائيا على أربع مجموعات يحتوي كل منها على أربعة حيوانات. احتوت التجربة على أربع معاملات بأربع نسب مختلفة للعلف المركز الي العلف الخشن (20:80، 25:75 ،40:60، 45:55) على الترتيب لمدة ستة أشهر. اظهرت النتائج ان زيادة الغلف المركز يودي زيادة معدل الهضم للبروتين والالياف والدهون الخام وكذلك المادة العضوية والمادة الجافة بالإضافة الي زيادة معدل الاستفادة من كل من البروتين المهضوم ومجموع المركبات الغذائية المهضومة. ايضا احدثت زيادة نسبة العلف المركز زيادة في كمية المادة الجافة اليومية المأكولة، وفي متوسط زيادة الوزن اليومي، وفي وزن الجسم النهائي، وكذلك تكلفة العلف لكل كيلوغرام زيادة في وزن الجسم. ادت زيادة مستوي العلف المركز الى زيادة مستوي الجلوكوز، وبروتين المرحلة الحادة من خلال في مصل الدم. من خلال النتائج تبين ان مستوي 60 % من العلف المركز حقق أفضل النتائج من حيث أداء النمو واقل تكلفة اقتصادية لكل كيلوغرام زيادة في الوزن عند المقارنة بمستوي (75٪، 80٪) من العلف المركز. من نتائج الدراسة الحالية يمكن استنتاج أن العلف الذي يحتوي على 60: 40 من العلف المركز الي العلف الخشن يمكن استخدامه لتسمين العجول الجاموسي بأقل تكلفة ولتحقيق أفضل أداء تسمين واعلي زيادة في الوزن النهائي وأفضل من الناحية الصحية واقل عرضة لخطر حموضة الكرش تحت الحرجة الذي يصيب عجول التسمين.