http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 10 (9): 1398-1405, 2007
ISSN 1028-8880

Response of Male Buffalo Calves to Different Levels of Energy and Protein in Finishing Diets

[1]H. Mahmoudzadeh, [2]H. Fazaeli, [3]I. Kordnejad and [4]H.R. Mirzaei
[1]Department of Animal and Poultry Health and Nutrition, Faculty of Veterinary Medicine, University of Tehran, P.O. Box 14155-6453, Tehran, Iran
[2]Animal Science Research Institute, Karaj, Iran
[3]Agricultural and Natural Research Center, Khoozestan, Iran
[4]Department of Animal Science, Faculty of Agriculture, University of Zabol, Iran

Abstract: A factorial experiment with completely randomised design was conducted, using 27 heads of 15 month buffalo male calves with initial live weight of 287±15 kg. The animals were individually housed and randomly allocated into 9 treatment groups of three animals each. Three levels of energy (E_1, E_2, E_3) with three levels of crude protein (P_1, P_2, P_3) were formulated to provide 90, 100 and 110% requirement equivalents for 900 g, expected body weight gain of steers derived from NRC beef cattle requirements (1976). Live weight changes were obtained by direct weighing of the animals every month and ended by slaughtering the calves for carcass index measurements. Results indicated that Dry Matter Intake (DMI) was not significantly different between treatments. Average Daily Gain (ADG) ranged from 503 to 951 g/animal that was significantly varied among the diets ($p<0.05$). The significantly higher daily gain was obtained ($p<0.05$) when animals received medium energy diets that was similar to 100% beef cattle steer requirements. In addition the feed conversion ratio was significantly lower, when the animals received medium energy diets ($p<0.05$). The dressing yield as well as the meat %age was not affected by the type of the diet, but abdominal fat was significantly higher in medium energy diets ($p<0.05$). It can be concluded that the optimum fattening performance of 15 month old buffalo male calves may be obtained by providing around 10.42 MJ/kg of dietary metabolisable energy and about 10.22% of crude protein.

Key words: Buffalo male calves, fattening, energy, protein

INTRODUCTION

Buffaloes are known to be more efficient in utilizing fibre component of the coarse feed than cattle and they thrive well on grazing native ranges, crop residues and agricultural by-products (Devendra, 1980; Punia *et al*., 2001). Punia and Sharma (1990) who studied the influence of dietary energy on ruminal VFA production rate in buffaloes and cattle reported that, total volatile fatty acid production rate was higher and turnover time lower in buffaloes than in cattle ($p<0.05$). They concluded that feed degradability in the rumen was higher in buffaloes than in cattle. The more relaxed behavior of buffaloes is thought to be the reason for lower energy requirement for maintenance and growth of buffaloes when compared to cattle fed similar diets under the same conditions (Liang and Samiyah, 1989). Singh *et al*. (2003) reported that digestibility of DM, OM, CP, NFE and nitrogen balance were significantly higher in buffalo calves when compared with cross-bred cattle calves ($p<0.05$). Fattening practices of male buffalo calves are recognized in some countries (Bharadwaj and Sethi, 2000; Mandal *et al*., 2000; Yunus *et al*., 2004).

The prospects for meat production from buffalo husbandry have shown to be successful under local conditions. Buffaloes reared under feedlot management with suitable diets have shown to posess the potential for production of high quality carcass (Bharadwaj and Sethi, 2000; Udeybir and Mandal, 2001). Swamp buffaloes raised on feedlot using oil palm byproducts as their major feed ingredients can reach normal growth rate of about 0.59 kg per day (Sukri *et al*., 1987; Nordin and Ramakrishnan, 1989). Average daily gain in growing buffalo calves fed urea ammoniated wheat straw-based rations supplemented with concentrate mixtures (roughage: concentrate ratio 58:42) were, 484 g with feed conversion ratio of 11.0 (Tiwari *et al*., 2000).

It has been shown that dry mater intake and digestibility of DM, OM, NFE and CP were higher in buffalo calves than the crossbred (Holstein × Kankrej)

Corresponding Author: H. Mahmoudzadeh, Department of Animal and Poultry Health and Nutrition, Faculty of Veterinary Medicine, University of Tehran, P.O. Box 14155-6453 Tehran, Iran Fax: 0098-21-66933222

male calves when fed with chaffed fresh sugarcane tops. Udeybir *et al.* (2000) reported that dry matter intake is higher in growing cattle than in growing buffaloes but buffalo calves utilized dry matter, energy and protein more efficiently for growth and fattening than cattle calves.

Texeira *et al.* (1987) compared the net energy requirements for maintenance and weight gain of Holstein, Zebu cattle and buffalo calves. They found that buffaloes and Zebu cattle had significantly lower energy and protein requirements than Holstein cattle. Baruah *et al.* (1988) compared diets contained 100% protein and 110% energy for 0.5 kg daily gains of NRC requirements for beef cattle (1976) in Murrah and Desi buffalo male calves. They reported that ADG was 17.6% higher in Murrah calves, but DM intake per 100 kg body weight was higher in Desi calves. However some researchers believe that protein rich concentrate is required for optimum growth of both cattle and buffalo calves (Patil *et al.*, 1999).

Improvement of growing and fattening performance of buffalo male calves could be achieved through nutritional and management manipulations. In an experiment buffalo male calves, from 80-90 to 300 kg live weight, were given diets low, medium or high-energy diets contained 90, 100 and 110% of requirements suggested for beef cattle NRC (1976) (Baruah *et al.*, 1988). Results showed that the average daily gain was 516, 559 and 607 g, respectively, which was significantly affected by the energy levels. Devendra (1984) fed diets with constant metabolisable energy, about 10.5 MJ/kg and Crude Protein (CP) of 6, 8, 10, 12, 14, 16, 18, 20 or 22% of DM to buffalo bulls, with live weight of 415-521 kg. Average daily gin was maximum with the 10% CP diet. Nitrogen balance was negative with 6% protein but increased to a maximum positive with 14% CP in the diet. Meanwhile, limited work has been reported on nutrient requirements of growing and fattening buffalo calves. The objective of this study was to study the effect of different levels of energy and protein on the fattening performance and slaughtering characteristics of Iranian regional buffalo male calves.

MATERIALS AND METHODS

Animals: Twenty seven yearling buffalo male calves with initial live weight of 287±15 were selected from the buffalo holders in a limited area of Khoozestan province in south west of Iran and transferred to the research station in Dezfool. The animals were housed individually and randomly allocated into one of the 9 treatment (diets) groups of three animals each. The calves were given an adaptation period of 3 weeks in a trial of 3 months, where individual live weight changes were obtained by direct weighing of the animals every month and ended by slaughtering the calves for carcass measurements.

Diet and Management: Since most of the reported requirements for buffalo (Sengar *et al.*, 1986; Udeybir and Mandal, 2001; Basra *et al.*, 2003), are estimated from beef cattle requirements (NRC, 1976) it was decided to use these data as the nutritional requirements for calves in this experiment. Nine experimental diets contained three levels of energy (E_1, E_2, E_3) each with three levels of crude protein (P_1, P_2, P_3) were formulated to provide 90, 100 and 110% of energy and protein requirements equivalent for 900 g, expected daily body weight gain of steers. Diets were consisted of alfalfa hay and wheat straw as roughage components and barley grain, wheat bran, sugar beet pulp, sugar cane molasses, urea and mineral supplements were used as concentrate part of the rations. Concentrate ingredients for each experimental period, were prepared and combined prior to the start of the period. Roughage and concentrate were mixed daily and offered ad libitum as Total Mixed Ration (TMR) three times daily. These ingredients were mixed in different proportions to yield the desired ME and CP values shown in Table 1.

Measurements: Voluntary Feed Intake (VFI) for each animal was recorded individually and dry matter intake (DMI) was estimated from VFI × %age of DM. Samples of concentrate and roughage were taken from daily rations. Feed residues were collected, weighed and sampled every morning before feeding. Feed and residue samples were air dried and weekly pooled proportionately to individual daily consumption. Pooled feed and residues samples were ground through a 1 mm-screen hammer mill separately and analysed to control and adjust the CP levels and ME concentrations of the experimental diets.

Experimental design: A 3×3 factorial experiment with completely randomized design was conducted with 27 buffalo male calves individually housed and randomly allocated into 9 treatment groups of three animals each. Data obtained were analysed for parametric statistics, including analyses of variance by GLM procedure of SAS software (1992), using the following model:

$$Y_{ijk} = \mu + S_i + P_j + (EP)_{ijk} + e_{ij} + E_{ijk}.$$

Y_{ijk} = Responses of animal k in treatment (Energy level I of protein level j,
μ = Overall sample mean,
S_i = Energy level I effect,
P_j = Protein level j effect,
$(EP)_{ijk}$ = Interaction of Energy level I and protein level j,
e_{jk} = Energy I and protein j error,
E_{ijk} = Ordinary least squares residual error.

Table 1: Formulation and composition of the experimental diets (DM basis)

Parameters	Diets 1	2	3	4	5	6	7	8	9
Feed ingredients									
	$E_1 P_1$	$E_1 P_2$	$E_1 P_3$	$E_2 P_1$	$E_2 P_2$	$E_2 P_3$	$E_3 P_1$	$E_3 P_2$	$E_3 P_3$
Alfalfa hay	38.52	44.40	39.20	20.73	27.42	26.30	11.33	13.12	13.59
Wheat straw	22.79	16.67	20.43	19.92	12.60	13.50	11.21	9.10	8.28
Roughage	61.31	61.07	59.63	40.65	40.02	39.80	22.54	22.22	21.87
Barley grain	10.11	10.31	10.72	24.20	20.68	21.25	33.40	33.36	32.98
Wheat bran	8.05	15.80	13.82	9.44	17.20	14.50	3.14	3.33	3.96
Sugar beet pulp	16.14	8.61	11.06	21.43	17.89	19.77	36.33	36.21	35.99
Sugar cane molasses	3.91	3.96	3.96	3.96	3.96	3.96	3.96	3.95	3.96
Urea	0.00	0.00	0.56	0.00	0.00	0.47	0.00	0.31	0.66
Di-calcium phosphate	0.22	0.00	0.00	0.08	0.00	0.00	0.38	0.36	0.33
Sodium chloride	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Concentrate	38.69	38.93	40.37	59.35	59.98	60.20	77.46	77.78	78.13
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Composition									
ME (MJ/kg DM)	9.38	9.38	9.38	10.42	10.42	10.42	11.18	11.18	11.18
Crude Protein (g/100 g DM)	9.20	10.22	11.24	9.20	10.22	11.24	9.20	10.22	11.24

E_1 = Low energy; E_2 = Medium energy; E_3 = High energy; P_1 = Low protein; P_2 = Medium protein; P_3 = High protein

RESULTS AND DISCUSSION

Body weight changes and daily gain: As it is shown in Table 2, there were no significant differences among the animals on different diets for the final body weight. No significant interaction effect of energy and protein was observed on the final body weight of the animals. When the data obtained from body weight were statistically analysed for the effect of energy or protein, it was shown that the final body weight was significantly affected by the energy levels ($p<0.05$), but the protein levels did not significantly affect the final body weight (Table 2). The calves received medium level energy diet, had significantly higher final weight ($p<0.05$) than those received lower or higher energy diets (378.7 vs. 336.7 or 335.7 kg). The initial body weight of the calves were between 271.5 to 303.2 kg at the start of the experiment, when they were 15 months old and their final weights were from 327.2 to 389.7 kg at 18 month of age by the end of this experiment. These results are in accordance with the results reported by the researchers who worked on the Egyptian buffalo calves, where they found that the body weight of buffalo calves were between 350-400 kg, at 16-20 months of ages at the end of the finishing period (Afifi, 1977; El-Serafy and El-Ashry, 1989). It has been reported that in a short fattening period of about 4 months, the river buffalo male calves may reach to 350 kg of body weight when with initial weight of 200 kg (EL-Serafy, 1988). The live weight of buffalo male calves may be affected by the type and breed of the animal, environmental factors and feeding management system (Mandal *et al*., 2000; Thevamanoharan *et al*., 2000; Ahmad *et al*., 2002; Seth, 2005).

As it is shown in Table 3, the interaction of energy and protein levels significantly affected the average daily gain of the animals ($p<0.05$). The highest amount (951) of daily gain was obtained in calves received diets containing medium energy level (standard level) with low protein levels, whereas the animals received the diets contained the high energy and low protein had the lowest (503 g/d) average daily gain. Despite the protein levels, the energy level itself significantly affected the average daily gain ($p<0.05$), whereas the medium energy diet caused higher daily gain than that of the other energy diets (Table 4). These results are different than those reported by Baruah *et al*. (1988), when they conducted an experiment on buffalo male calves, from 80-90 kg to 300 kg live weight fed low, medium or high-energy diets contained 90, 100 and 110% of NRC (1976) suggested for beef cattle requirements. They found that the average daily gain was 516, 559 and 607 g respectively, which was significantly influenced by the energy levels. But similar daily gain data were reported by Yunus *et al*. (2004) where they found a daily weight gain of 980 g for yearling buffalo calves. The average daily gain could be affected by genetic resources, initial body weight, age and nutritional management (Keshab *et al*., 2002). Although the energy levels in this experiment are similar to those used by Baruah *et al*. (1988) but the bioavailability of the energy and other nutrients as well as the age of the animal and its initial live weight also could affect the body weight gain. Regarding the protein levels, it was shown in our experiment that 10.22% CP could be sufficient for optimum growth rate of buffalo male calves. Such a results are in accordance with the findings of Devendra (1984), when fed diet with constant metabolisable energy about 10.5

Table 2: Average body weight of the animals at start and the end of experiment

	Treatments									
Weight	E_1P_1	E_1P_2	E_1P_3	E_2P_1	E_2P_2	E_2P_3	E_3P_1	E_3P_2	E_3P_3	SEM
IBW (kg)	271.5	292.3	272.9	303.2	296.6	291.2	302.2	279.5	274.3	3.1
FBW(kg)	327.2	362.6	319.7	389.7	370.3	376.0	348.0	331.0	328.3	9.91
		Energy level					Protein Level			
FBW(kg)		336.7^{b}	378.7^{a}	335.7^{b}			355.7^{a}	354.7^{a}	341.3^{a}	

Means with the different superscripts within a row are significantly ($p<0.05$) dfferent; IBW = Initial Body Weight; FBW = Final Body Weight; SEM = Standard Error of Means

Table 3: Effects of treatments on DMI, BWG and feed efficiency during the experiment

	Items						
	Dry mater intake			BWG		Feed efficiency	
Diets	kg/day	% of BW	g/kg $BW^{0.75}$	g/day	FCR	MECR	CPCR
E_1 P_1	5.67^{b}	1.90^{b}	78.8^{b}	612^{c}	9.3^{a}	87.07^{b}	0.85^{b}
E_1 P_2	6.71^{a}	2.05^{a}	87.1^{a}	773^{b}	8.7^{ab}	81.21^{bc}	0.89^{b}
E_1 P_3	5.22^{b}	1.76^{b}	73.1^{b}	514^{d}	10.2^{a}	95.02^{ab}	1.14^{a}
E_2 P_1	6.95^{a}	2.01^{a}	86.6^{a}	951^{a}	7.3^{b}	76.19^{c}	0.67^{c}
E_2 P_2	6.18^{ab}	1.85^{ab}	79.2^{ab}	810^{ab}	7.6^{b}	79.53^{bc}	0.78^{bc}
E_2 P_3	6.45^{a}	1.93^{a}	82.7^{a}	932^{a}	6.9^{b}	72.0^{c}	0.78^{bc}
E_3 P_1	4.81^{c}	1.48^{c}	62.9^{c}	503^{d}	9.6^{a}	106.74^{a}	0.88^{b}
E_3 P_2	4.57^{c}	1.50^{c}	62.5^{c}	566^{cd}	8.1^{b}	90.42^{b}	0.83^{b}
E_3 P_3	4.56^{c}	1.51^{c}	63.1^{c}	593^{c}	7.7^{b}	85.81^{b}	0.86^{b}
SEM	0.64	0.14	6.47	139	0.71	3.73	0.57
SOL	*	*	*	*	*	*	*

Means with the different superscripts within a column are significantly ($p<0.05$) different; FCR = Feed Conversion Ratio = kg of DMI per kg of weight gain; MECR = Metabolisable Energy Conversion Ratio = MJ ME consumed per kg of weight gain; CPCR = Crude Protein Conversion Ratio = kg of crude protein intake per kg weight gain; SEM = Standard Error of Mean; BWG = Body Weight Gain; SOL = Significant Observed Level * = ($p<0.05$)

MJ/kg, but crude protein levels of 6, 8, 10, 12, 14, 16, 18, 20 or 22% of DM to buffalo bulls, with live weight of 415-521 kg and reported that the average daily gain was maximum with 10% CP in the diet. However, the growth rate of growing buffalo calves is affected by the composition and degradability of the protein when the CP level of the diet is in marginal amount (Chatterjee and Walli, 2003). Yunus *et al.* (2004) studied the effects of substituting cottonseed meal with sunflower meal in isonitrogenous rations for growing buffalo calves and reported that daily feed consumption as well as the daily gain was increased when the cottonseed meal was substituted by sunflower meal.

Some reports showed that the average daily gain of buffalo calves was between 800 to 900 g/d, during fattening period, depending on the level of concentrates (Afifi, 1977; Metry, 1999). In feedlot fattening operations (Shehata *et al.*, 1973), ADG was 800 to 1000 g when the concentrate portion of the ration was 75% and 1.0 kg of concentrates was offered for each 50 kg live body weight. Daily weight gains of over 1.0 kg have been reported under proper nutritional management in feedlot system (Seth, 2005).

Feed intake: As it is indicated in the Table 3, there was significant variation among the treatments for dry mater intake ($p<0.05$), which were between 4.56 to 6.95 kg per animal per day. When the dry mater intake was calculated based on the %age of live weight or g per kg of metabolic body weight, there were also significant differences between the treatments. Therefore the interaction of energy and protein levels did significantly affected the voluntary intake. According to the Table 4, when the effect of protein levels was estimated from the voluntary intake, no significantly variation was observed among the diets but the energy levels significantly affected the dry mater intake ($p<0.05$), where the highest amount of intake was for the standard energy levels (6.52 kg day^{-1}), but the animals on higher energy diets had consumed significantly lower DM intake ($p<0.05$). Beside the physical and chemical characteristics of the ration (Keshab *et al.*, 2002), the feed and dry mater intake is mostly affected by the energy concentration in the diet (Baruah *et al.*, 1988; Nair *et al.*, 2004; Puri *et al.*, 2004). The results of DMI are lower to those reported by Udeybir *et al.*, (2000) where they found that DMI was between 2.1 to 2.4% of body weight or 89 to 94 g per kg of metabolic body weight for growing buffalo, weighing between 200 to 320 kg. Similar works was done to estimate the dry matter requirement of growing Indian buffalo calves fed concentrate and wheat straw to supply two levels (75 and 100%) of protein and three levels (90, 100 and 110%) of energy as NRC (1976) for 500 g daily gain (Baruah, 1990) which they found that DMI is depended on the body weight, daily gain and energy levels of the diet. Singh *et al.* (2003) who studied nutrient utilization and

Table 4: Effect of levels of E and P on the dry mater intake and efficiency

	Treatments							
	Energy level				Protein level			
Parameters	E_1	E_2	E_3	MSE	P_1	P_2	P_3	MSE
DMI(kg)	5.87^b	6.52^a	4.66^b	0.31	5.83	5.80	5.41	0.21
ADG (g)	633.00^b	898.00^a	554.00^b	68.50	688.70	716.30	679.70	38.00
FCR	9.40^a	7.27^c	8.47^b	0.36	8.73	8.13	8.27	0.35
MECR	87.91^b	85.77^c	94.19^a	3.10	90.0	83.72	84.56	2.80
CPCR	1.0^a	0.7^c	0.9^b	0.036	0.8^b	0.80^b	0.9^a	0.019

Means with the different superscripts within a row for energy level are significantly ($p<0.05$) different; Means with the different superscripts within a row for protein level are significantly ($p<0.05$) different; DMI = Dry Mater Intake; ADG = Average Daily Gain

growth rate of buffalo calves reported that the average daily dry matter intake, based on the kg/100 kg body weight, was 2.47 that are higher than the results of this experiment (1.5 to 2.05). Such differences could be related to the age and size of the animals as well as the nutrition management and environment conditions (Jasiorowski, 1988; Thevamanoharan *et al*., 2001; Ahmad *et al*., 2002).

Feed efficiency: As it is shown in Table 3, the FCR were from 6.9 to 10.2 that were significantly different among the treatments ($p<0.05$). A 5.2 FCR with 980 g/d of live weight gain in buffalo calves reported by Yunus *et al*. (2004) when the animals received standard diet. However, The FCR was more than 6 for all of the diets used in this experiment but it was between 6.9 to 7.6 for the diets contained standard energy level that are in accordance to the 7.01±0.38 which reported by Boujarpoor (1989) when he studied fattening performance of buffalo male calves in the same area of Iran. Higher FCR was reported by Tiwari *et al*. (2000) when they fed urea treated straw based diet with roughage: Concentrate ratio of 58:42 to growing buffalo calves and found average daily gain of 437 to 482 g and FCR of 10.4 to 11.6.

In general, various results of daily gain and FCR reported for buffalo male calves are due to variation in breed, age, environment conditions, feeding systems and management (Sikka *et al*., 1996; Punia *et al*., 2001; Thevamanoharan *et al*., 2001). However, estimation of feed efficiency based on the energy and protein consumed per unit of live weight gain may give comparable results for growing animals, including buffalo calves.

The interaction of energy and protein significantly affected the feed efficiency including: FCR, MECR and CPCR ($p<0.05$). The highest MECR was for the E_3P_1 and E_1P_3 but the lowest amount shown in E_2P_1 and E_2P_3. This is because of higher amount of energy received by the calves when they fed with high energy diets. It has been reported that crude protein and metabolisable energy intakes increased with increasing level of crude protein and metabolisable energy contents in the diet of Nili-Ravi buffalo calves (Basra *et al*., 2003).

Regarding the CPCR, as it is shown the in the Table 3, diets contained medium levels of ME with low level of protein had the lowest, but the diet E_1 P_3, showed the highest amount of the CPCR ($p<0.05$).

As oppose to the protein levels, the energy levels significantly affected the FCR, MECR and CPCR ($p<0.05$) (Table 4). The diet with low level energy, had the highest amounts of FCR and CPCR, but the MECR was highest for the high energy level and the lowest for standard energy level. When the data were analysed for protein levels, it was indicated that there were no significantly variation among the diets for the FCR and MECR. Regarding the levels of energy, it has been shown that the standard level (10.42 MJ ME/kg DM) resulted the lowest (7.27) of FCR which was lower than the other reports (Tiwari *et al*., 2000) where they found 10.46 to 11.10 for the buffalo calves fed urea ammoniated wheat straw based rations supplemented with concentrate mixtures (roughage: concentrate ratio 58:42). Feed efficiency is affected by the age, breed, body weight, fattening period and nutrient concentration of the diet. As it was found in this experiment, feeding diets with the medium energy levels resulted a better efficiency in yearling buffalo calves.

In spite of the energy, protein levels did not affect the FCR and MECR but the CPCR was significantly higher in high CP diet ($p>0.05$) which indicated that CP requirement is not high in buffalo calves and the animal can not convert high protein levels to the body weight gain. Beside the CP, the protein degradability also can have effect on feed and protein efficiency in buffalo calves (Patil *et al*., 1999; Moniello *et al*., 1994). Chatterjee and Walli (2003) studied economics of feeding formaldehyde treated mustard cake as bypass protein to growing buffalo calves and reported that average daily body weight gain (g/d) was increased from 386 to 600 and the dry matter required to achieve one unit gain (kg/kg body weight

Table 5: Effect of treatments on the slaughtering traits

	Treatments								
Parameters	E_1P_1	E_1P_2	E_1P_3	E_2P_1	E_2P_2	E_2P_3	E_3P_1	E_3P_2	E_3P_3
Live weight (kg)	327.7	362.70	319.70	389.70	370.30	376.00	348.00	331.00	328.30
Warm carcass weight (kg)	161.0	185.00	160.30	192.30	187.90	192.10	175.10	165.00	163.20
Cool carcass weight (kg)	156.9	181.20	156.20	187.70	183.70	187.30	171.00	160.20	158.70
Dressing %age									
1	49.14	51.01	50.14	49.35	50.73	51.10	50.30	49.85	49.70
2	47.88	49.96	48.86	48.17	49.60	49.81	49.15	48.38	48.33
3	54.27	55.45	54.46	53.72	54.81	54.92	54.38	52.87	53.43
Abdominal fat (%)	12.10^b	14.70^{ab}	12.70^b	17.40^a	15.50^{ab}	13.30^{ab}	14.10^{ab}	12.30^b	14.20^{ab}
Meat (%)	67.30	66.90	67.70	64.40	65.60	67.30	68.10	68.10	66.40
Bone (%)	18.40	17.10	19.10	16.90	17.90	17.20	16.90	18.70	19.70

1-Based on: (warm carcass weight /body weight before slaughtering) ×100, 2-Based on: (cool carcass weight body weight before slaughtering) ×100, 3-Based on: (cool carcass weight /empty body weight before slaughtering) ×100

Table 6: Effect of the energy and protein levels on the slaughtering rates

	Treatments					
	Energy levels			Protein levels		
Parameters	E_1	E_2	E_3	P_1	P_2	P_3
Live weight (kg)	336.70^b	378.70^a	335.80^b	355.10	354.70	341.30
Warm carcass weight (kg)	168.80	190.80	167.70	176.10	179.30	171.90
Cool carcass weight (kg)	164.80	186.20	163.30	17.90	175.00	167.40
Dressing %age						
1	50.13	25.83	49.96	49.60	50.55	50.36
2	48.94	25.21	48.63	5.04	49.34	49.04
3	54.73	54.53	53.56	54.17	54.38	54.27
Abdominal fat (%)	13.10^b	15.40^a	13.20^b	13.00	14.20	14.50
Meat (%)	67.50	65.80	67.30	67.20	66.90	66.60
Bone (%)	18.40	17.40	18.20	18.60	17.90	17.40

Means with the different superscripts within a row are significantly ($p<0.05$) different

gain) was significantly decreased from 8.68 to 5.93 when the protein supplement was protected from rumen degradation. It has also been reported that the digestibility of CP and nitrogen balance were higher in buffalo when compared with cross-bred cattle calves (Singh *et al*., 2003).

Slaughtering characteristics: There were no significantly interaction effects of energy and protein on the carcass characteristics except for the abdominal fat %age that was significantly different among the diets (Table 5). Considering the effect of energy, it was found that there were no significantly differences between the treatments for the carcass traits with exception for the abdominal fat that was significantly affected by the energy levels but protein levels did not affect the carcass traits (Table 6). Little information reported regarding the carcass characteristics of buffalo calves; however these results are in agreement with Sengar *et al*. (1986), where they found that there were no significant differences in carcass quality of male buffalo calves fed with fed diets contained different protein levels and slaughtered at 24 month of age. Marcos *et al*. (2003) reported that hot and cold dressing %age where between 50.3 to 51.2 and 48.8 to 49.5, respectively for the buffalo calves fed with different roughage: concentrate diets and slaughtered when they were around 500 kg of live weight which are in accordance with our results. The %age of meat to carcass weight in this study was between 64.4 to 68.1, that was higher than those (59 to 61%) reported by Marcos *et al*. (2003) but the bone %age was from 16.9 to 19.7 which was similar to those (16 to 17.3) reported by the above authors.

According to the data from Guangxi Buffalo Research Institute, triple crossbred buffalo calves at 18 months of age, had dressing %age of 59.9, net meat of 42.1% and bone to meat ratio of 1.4:4.0 (Bingzhuang *et al*., 2004). Carcass characteristics could be affected by the breed, nutritional management, age and live weight in buffalo calves (Bharadwaj and Sethi, 2000; Naik *et al*., 2003; Sharma *et al*., 2003).

CONCLUSIONS

From the results obtained in this study, it can be concluded that the optimum growth rate and the feed efficiency of 15 month buffalo male calves may be obtained by providing around 10.42 MJ/kg of dietary metabolisable energy and about 10.22% of crude protein. However, further research is needed for the validation of nutrient requirements (especially protein and energy) for different physiological stages of buffalo calves. A system to monitor the nutritional status of buffaloes would be beneficial to reduce losses and maximize efficiency of nutrient utilization. To optimize energy and protein efficiency and reduce nitrogen wastage, diets need to be formulated to provide optimum fermentable energy sources and nitrogen concentration for maximum rumen microbial yield and growth. Evaluation of complete rations based on local feedstuffs for buffalo production is needed especially in the case of buffalo beef production in Iran.

REFERENCES

Afifi, Y.A., 1977. The effect of using different sources of roughages on carcass traits of buffalo calves. Egyptian J. Anim. Prod., 17: 165-171.

Ahmad, M., k. Javed and A. Rehman, 2002. Environmental factors affecting some growth traits in Nili Ravi buffalo calves. Proceeding of the 7th World Cong. Genet. Applied to Livestock Production. Montpellier, France. Session 7, pp: 0-4.

Baruah, K.K., S.K. Ranjhan and N.N. Pathak, 1988. Feed intake, nutrient utilization and growth in male buffalo calves fed different levels of protein and energy. Buff. J., 4: 131-138.

Baruah, K.K., 1990. Dry matter requirement of growing Indian buffaloes. Buff. Bull. Buffalo Information Center (Thailand), 9: 53-58.

Basra, M.J., M.A. Khan, M. Nisa, M. Riaz, N.A. Tuqeer and M.N. Saeed, 2003. Nili-Ravi buffalo I. Energy and protein requirements of 6-9 months old calves. Int. J. Agric. Biol., 5: 377-379.

Bharadwaj, A. and R.K. Sethi, 2000. Meat production potential in Murrah buffalo male calves under different systems of feeding management. Indian J. Anim. Sci., 70: 769-770.

Bingzhuang, Y., L. Zhongquan, L. Xianuei and Z. Caixia, 2004. Genetic improvement and the development of dairy industry in Chinese Water Buffalo. Asian Buff. Magaz., 1: 14-18.

Boujarpoor, M., 1989. Fattening performance of bufalo male calves of Khoozestan. MS. Theses. Tarbiat Modarres University. Iran.

Chatterjee, A. and T.K. Walli, 2003. Economics of feeding formaldehyde treated mustard cake as bypass protein to growing buffalo calves. Indian J. Dairy Sci., 56: 241-244.

Devendra, C., 1980. The potential value of grass and crop by-products for feeding buffaloes in Asia. Buffalo Production for small farms. Food and Fertilizer Technology Center (FFTC), Book Series No. 15: 141-160.

Devendra, C., 1984. Nitrogen utilisation and the requirements for maintenance of Malaysian swamp buffaloes. MARDI Res. Bull., 12: 248-258.

EL-Serafy, A.M., 1988. Feeding riverine buffaloes for milk/dual purpose production. Proceedings of II World Buffalo Congress. New Delhi, India Vol. II, Part II, pp: 537-547.

El-Serafy, A.M. and M.A. El-Ashry, 1989. The nutrition of Egyptian water buffaloes from birth to milk and meat production. Proceeding of the International Symposium On the Constraints of Ruminant Production in the Dry Subtropics, Cairo, Egypt, pp: 230-243.

Jasiorowski, H.A., 1988. Perspective and prospective of buffalo breeding for milk and meat production in the world. Proceeding of II World Buffalo Congress, New Delhi, India Vol. II, Part I, pp: 285-294.

Keshab, B., M. Mohini, K. Barman and M. Mohini, 2002. Nutrient utilization for growth and cost of feeding in buffalo calves as influence by rumensin supplementation. Buff. J., 18: 71-81.

Liang, J.B. and M.N. Samiyah, 1989. Comparative energy requirement of growing swamp and Murrah buffaloes. Buff. J., 2: 225-227.

Mandal, P., R.B. Sah, R.D. Pandit, B.P. Budhnagaria and R.S. Mandal, 2000. Studies on the effect of different feeding management on growth performance of Murrah buffalo heifers. Proceeding of the 4th National Workshop on Livestock and Fisheries Research in Nepal. Khumaltar, Lalitpur (Nepal). National Anim. Sci. Res. Inst., 276: 127-131.

Marcos, E., J.S. Fleming, J.L. Martinez, N. Waszczynskyj and C.R. Socol, 2003. Quantitative and qualitative buffalo carcass characteristics fed with different relationship of roughage and concentrate on a feedlot system in Brazil. Proceeding of the 4th Asian Buffalo Congress. New Delhi, India, pp: 30.

Metry, G.H., 1999. Studies on selenium and/or vitamin E administration to Egyptian buffalo calves. Effect on growth performance, feed efficiency and blood serum calcium and phosphorus. Mansoura University, J. Agric. Sci. (Egypt), 24: 1773-1785.

Moniello, G., A. Nizza, F. Infascelli and T. Lella, 1994. Nutritive value and truly digestible protein in the small intestine of diets with different NDF contents utilized by buffaloes and ovines. Proceeding 4th World Buffalo Congress, Sao Paulo, Brazil, pp: 233-235.

Naik, P.K., V. Lakshmanan, D.S. Sahu, S.K. Mendiratta, U.R. Mehra and R.S. Dass, 2003. Effect of feeding ammoniated and ammoniated plus hydrochloric acid treated wheat straw on carcass and slaughter characteristics of male buffalo calves. Proceeding of the 4th Asian buffalo congress, New Delhi, India, pp: 35.

Nair, P.V., A.K. Verma, R.S. Dass and U.R. Mehra, 2004. Growth and nutrient utilization in buffalo calves fed ammoniated wheat straw supplemented with sodium sulphate. Asian Aus. J. Anim. Sci., 17: 325-329.

NRC., 1976. Nutrient requirements of beef cattle. National Academy Press, Washington, DC.

Nordin, Y. and P. Ramakrishnan, 1989. The Reproductive Performance of Murrah buffalo. International Symposium on milk buffalo reproduction, 16-19th March, Islamabad, Pakistan.

Patil, N.V., V.B. Kharadi and P.M. Desai, 1999. Feeding value of fresh sugarcane tops in growing crossbred cattle and buffalo calves. India. J. Dairy Sci., 52: 403-405.

Punia, B.S. and D.D. Sharma, 1990. Influence of dietary energy on ruminal VFA production rate in buffaloes and cattle. Indian J. Anim. Sci., 60: 888-892.

Punia, B.S., S. Singha and S. Singh, 2001. Buffalo calf feeding and management. Buffalo Bull., 20: 3-11.

Puri, J.P., S.S. Grewal, S. Sindhu and M.K. Rose, 2004. Effect of feeding protected protein supplemented with urea-treated straw on performance of buffalo calves. Indian J. Anim. Sci., 74: 319-320.

SAS Institute, 1992. SAS/STAT user's guide. SAS Institute Inc, Cary.

Seth, R.K., 2005. Improvement of buffalo for milk, meat and drought: A Review. Indian J. Anim. Sci., 75: 327-334.

Sengar, S.S., D.C. Joshi, V. Lakshmanan and A.S.R. Anjaneyulu, 1986. Effect of levels of dietary protein on growth, nutrient utilisation and carcass characteristics of male buffalo calves. Buff. Bull., 5: 80-85.

Seth, R.K., 2005. Improvement of buffalo for milk, meat and drought: A Review. Indian J. Anim. Sci., 75: 327-324.

Sharma, S.K., S.C. Gupta, M. Wandha and M.P.S. Bakshi, 2003. Effect of plane of nutrition on buffalo meat production. P roceeding of the 4th Asian buffalo congress. New Delhi, India, pp: 34.

Shehata, O., M.A. El-Ashry, M.S. Youssef and M.E. El-Kholy, 1973. Fattening buffalo calves on rations containing different sources of roughages. Agric. Res. Rev. Cairo, 51: 31-40.

Sikka, P., R.K. Sethi and V.N. Tripathi, 1996. Assessment of performance variabilities and their impact on growth in buffalo calves. Proceedings of the Second Asian Buffalo Association Congress. College, Laguna (Philippines), pp: 328-330.

Singh, R., S. Kishan and J., Jai Kishan, 2003. Comparative efficiency of nutrient utilization in buffalo, Hariana and cross-bred calves fed cereal free ration. Indian J. Anim. Nutr., 20: 6-10.

Sukri, I., M.N. Jariah and H. Rozali, 1987. Fattening of swamp buffalo in feedlot. In: Advances in Animal Feeds and Feeding in The Tropics. Proceeding of the 10th. MSAP conference. Genting Highland, Pahang, Malaysia, pp: 272-275.

Texeira, J.C., J.F.C. Silva, J.A. Garcia, M. Silva, W.R. Lorenzoni, E. Almeida, M, Silva and W. Lorenzoni, 1987. Energy and protein requirements, body composition and area and principal carcass cuts in 6 genetic groups of Bovidae. 2. Energy and protein requirements. Revista da Sociedade Brasileira de Zootecnia, 16: 181-192.

Thevamanoharan, K., W. Vandepitte, G. Mohiuddin, C. Chantalakhana and P. Bunyavejchewin, 2000. Genetic, phenotypic and residual correlations among various growth traits and between growth traits and body measurements of Swamp buffaloes. Buffalo Bull., 19: 55-60.

Thevamanoharan, K., W. Vandepitte, G. Mohiuddin and C. Chantalakhana, 2001. Environmental factors affecting various growth traits of swamp buffalo calves. Pak. J. Agric. Sci., 38: 5-10.

Tiwari, C.M., S.B. Jadhao, M. Chandramoni, M.Y. Khan, 2000. Comparative calorimetric evaluation of ammoniated straw-based rations supplemented with low levels of untreated and formaldehyde treated groundnut cake and fish meal with respect to growing buffalo calves. Asian Aus. J. Anim. Sci., 13: 761-773.

Udeybir, A., B. Mandal and P.S. Yadav, 2000. Comparative dry matter intake and nutrient utilization efficiency in growing cattle and buffaloes-an analysis of observed results. Indian J. Anim. Nutr., 17: 56-63.

Udeybir, A. and B. Mandal, 2001. Energy and protein requirements for growing buffaloes. Buff. J., 17: 163-178.

Yunus, A.W., A.G. Khan, Z. Alam, J.I. Sultan and M. Riaz, 2004. Effects of substituting cottonseed meal with sunflower meal in rations for growing buffalo calves. Asian Aus. J. Anim. Sci., 17: 659-662.