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Effect of plane of nutrition on blood biochemical parameters and attainment of sexual maturity in growing yaks

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ABSTRACT

Four divergent rations namely low protein-low energy (LP-LE), low protein-high energy (LP-HE), high protein-low energy (HP-LE) and high protein-high energy (HP-HE) were formulated to supply two levels of digestible crude protein (DCP) (100 and 75%) and 2 levels of energy (TDN) (100 and 75%) for twenty four growing yaks (12 male and 12 female) of uniform age and body weights randomly divided into 4 groups of 6 animals (3 male and 3 female) in each. At random one dietary treatment was allotted to each group for a period of one year. At the end of feeding trial, average daily gain and feed conversion efficiency were highest in HE-HP group followed by HP-LE, LP-HE and LP-LE groups though their differences were statistically non-significant. The blood glucose level was highest in HP-HE group in comparison to the other groups; but the trends of plasma protein, albumin and urea levels were similar among the groups. The study also revealed that high protein-high energy ration is the suitable dietary combination for growing yak calves to support an average body weight gain of 371.8 g/day during 250 to 300 kg of body weight and could advance their sexual maturity.

Key words: Feed efficiency, Growth performance, Nutrient digestibility, Plane of nutrition, Yak

The yak (*Poephagus grunniens* or *Bos grunniens*), the hairy bovine of snow-covered high altitude has a long linkage with the mankind inhabiting in the remote mountainous regions of India, Bhutan, China, Mongolia, Nepal and other parts of central Asia. Yak herdsmen usually do not feed any supplementary feed except some salts at regular interval. Generally milch and pregnant animals are fed small amounts of concentrates in the form of wheat flour or maize flour to support optimum milk production and normal foetal development. Scientific feeding of yaks is generally not followed. The information on nutrient requirement of yaks till date is very scanty and based on the available information on limited studies carried out under free-range conditions in China and stall-fed conditions in India. Hence, the study was conducted for 360 days in growing yaks to determine their nutrient requirement for growth based on NRC (1989) for dairy cattle and buffaloes.

MATERIALS AND METHODS

Four divergent rations were formulated to supply two levels i.e. 75 and 100% of digestible crude protein (DCP) and two levels i.e. 75 and 100% of energy, i.e. total digestible nutrients (TDN) requirement for 500g daily body weight gain as recommended by NRC (1989) for daily cattle and buffaloes. Four rations, viz. (i) low protein-low energy (LP-LE), (ii) low protein-high energy (LP-HE), (iii) high protein-low energy (HP-LE) and (iv) high protein-high energy (HP-HE) were prepared for conducting the animal growth trial. Twenty four yak calves (12 male and 12 female) of about one year of age with an average body weight of 90.3±1.19 kg, were randomly divided into four groups of six animals (3 male and 3 female) in each. All the experimental animals were fed individually under stall feeding for 360 days on mixed rations containing both concentrate mixtures and paddy straw. Green grasses (*Dactylus glomerata*) were offered to the all the experimental animals at the rate of 1 kg/animal/day to meet out their Vitamin A requirements. At random one dietary treatment was allotted to each group. Three digestion trials were conducted on all the experimental yaks at their three different body weights e.g. 100–150, 150–200 and 250–300 kg during 120, 240 and 360 days of experimental periods. Blood samples were collected from all the experimental animals to determine the concentration of blood metabolites on the initial and closing date of the feeding trial. Besides, blood samples were also collected from all the experimental females at 4 days interval for a period of 40 days starting at 40th days prior to closing of the feeding trial, i.e. 321st days of experimental feeding to

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Table 1. Composition of the experimental ration

Attribute	Experimental ration				Paddy straw	*Dactylus glomerata*
	LP-LE	LP-HE	HP-LE	HP-HE		
Physical composition						
Maize grain	19	72	15	52		
Wheat bran	68	-	44	-		
Goundnut cake	9	24	37	44		
Urea	1	1	1	1		
Mineral mixture	2	2	2	2		
Common salt	1	1	1	1		
Chemical Composition						
OM	93.3	94.2	95.7	95.3	85.6	90.2
CP	15.2	15.4	20.1	19.8	3.4	13.4
EE	1.3	1.5	1.8	1.9	1.4	3.3
NFE	66.3	70.6	64.6	66.1	50.3	52.4
CF	10.5	6.8	9.3	7.6	30.7	20.9

LP-LE, Low Protein Low Energy**;** LP-HE, Low Protein High Energy; HP-LE, High Protein Low Energy; HP-HE, High Protein High Energy.

observe their plasma progesterone concentration and they were also subjected to ultra-sonographic examination to see their cyclicity of oestrous. Again, the experimental males under study were subjected to training for collection of semen for a period of two months at the end of the feeding trial to know their attainment of sexual maturity. The samples of feed, faeces and residue left were analyzed for proximate composition according to AOAC (1990). The data were subjected to statistical analysis (2×2 factorial designs) as per the methods described by Snedecor and Cochran (1986).

RESULTS AND DISCUSSION

The compositions of different experimental rations are presented in Table 1. It was observed the per cent daily dry matter intake (DMI) of the animals under low protein-low energy (LP-LE) group was significantly higher in comparison to high energy-high protein (HE-HP) fed group (Table 2). With higher level of protein and energy with better utilization could meet their requirements with lesser quantity of feed might be the reason for low intake in HE-HP group. However, daily dry matter intake per unit body weight in male and female yak calves was almost similar and the values were in the same trend as reported by Liu *et al*. (1997) and Medhi *et al.* (2016). Studies undertaken by Han *et al*. (1990a) in 2 to 3 year old castrated yaks under stall-fed condition observed, the dry matter intake varied from 1.38 to 2.34 kg/100 kg body weight when the animals were maintained on green forages, dry roughages, or on diets based on dry roughages and concentrates. They also observed the values increased at lower temperature both under stall fed and grazing conditions. The faster rate of passage of feed at lower temperature might be the reason for higher intake. However, in grazing yaks, the dry matter intake (DMI) was 3.01 and 3.38 kg/100 kg body weight, when they were maintained on mature and premature forages respectively (Liu *et al*. 1997). The DMI was two per cent of the body weight in adult yaks maintained under grazing at an altitude of 4,242 metre above sea level (Basu *et al*. 2005). It has been observed that yaks graze comfortably at a temperature as low as -30°C to -40°C or even lower. In contrast, at higher temperature, their grazing activity is reduced resulting in lower feed intake.

The dry matter as well as the organic matter digestibility were similar among all the four experimental groups except the crude fibre digestibility which was significantly higher (P>0.01) in LP-LE group in comparison to HP-HE group. The digestibility of dry matters and all the organic nutrients were also similar irrespective of different sexes of the experimental animals.

The experimental rations contained 6.2, 6.3, 8.6 and 9.0% digestible crude protein (DCP) and 57.8, 60.3, 59.0 and 60.8% total digestible nutrients (TDN) on dry matter basis

Table 2. Growth performance, nutritive values and plane of nutrition of the experimental yaks

Attribute	Experimental group			
	LP-LE	LP-HE	HP-LE	HP-HE
Dry matter intake				
kg/day	4.4^{a}	4.6^{a}	4.5^{a}	5.0^{b}
kg/100 kg BW/day	2.5^{a}	2.4^{ab}	2.3^{ab}	2.2^{b}
g/kg$W^{0.75}$/day	79.90	78.38	78.64	82.50
Growth performance				
Initial body weight (kg)	90.7	90.3	90.1	90.0
Final body weight (kg)	209.5	228.1	220.5	238.1
Total body weight gain (kg)	118.8^{a}	137.8^{b}	130.4^{a}	148.1^{b}
Average daily gain (g)	330.1^{a}	383.3^{c}	362.5^{b}	411.4^{d}
Feed efficiency				
DMI (kg)/kg BW gain	9.9^{b}	8.4^{a}	8.6^{a}	7.9^{a}

LP-LE, Low Protein Low Energy; LP-HE, Low Protein High Energy; HP-LE, High Protein Low Energy; HP-HE, High Protein High Energy. Means bearing different superscripts within the same column differ significantly.

Table 3. Average values of different blood biochemical constituents of the animals in different experimental groups

Blood constituent	Experimental group											
	LP-LE			LP-HE			HP-LE			HP-HE		
	Male	Female	Overall Mean± SE	Male	Female	Overall Mean± SE	Male	Female	Overall Mean± SE	Male	Female	Overall Mean± SE
Hb (g/dl)												
Initial^{NS}	11.57±0.17	10.23±0.45	10.9±0.67	11.62±0.24	10.83±0.42	11.23±0.40	11.24±0.22	10.95±0.62	11.10±0.15	11.97±0.18	1.17±0.47	11.45±0.52
Post feeding^{NS}	11.62±0.53	10.57±0.27	11.10±0.53	11.87±0.35	10.97±0.47	11.42±0.45	11.81±0.45	11.24±0.33	11.53±0.29	12.02±0.41	10.93±0.321	11.60±0.43
Blood glucose (g/dl)												
Initial^{NS}	61.67±1.41	59.47±1.32	60.57±1.10	62.96±1.22	62.22±1.44	62.59±0.37	61.62±2.02	60.59±1.44	61.11±0.52	63.06±1.28	62.03±1.48	62.55±0.52
Post feeding^{NS}	64.47±1.82	63.23±1.66	63.85±0.62	66.23±1.07	65.76±1.08	66.00±0.24	64.24±1.28	64.14±1.45	64.19±0.11	67.57±1.36	65.26±1.25	66.42±1.16
Total serum protein (g/dl)												
Initial^{NS}	7.22±0.14	7.42±0.28	7.32±0.10	7.22±0.14	7.42±0.28	7.32±0.10	7.22±0.14	7.42±0.28	7.32±0.10	7.22±0.14	7.42±0.28	7.32±0.10
Post feeding^{NS}	7.32±0.38	7.54±0.17	7.43±0.11	7.32±0.38	7.54±0.17	7.43±0.11	7.32±0.38	7.54±0.17	7.43±0.11	7.32±0.38	7.54±0.17	7.43±0.11
Blood urea nitrogen (g/dl)												
Initial^{NS}	20.46±0.19	19.42±0.33	19.94±0.52	20.12±0.27	19.04±0.27	19.58±0.54	20.86±0.42	20.14±0.47	20.50±0.36	20.95±0.27	21.04±0.43	21.00±0.05
Post feeding^{NS}	22.03±0.11	21.75±0.41	21.89±0.14	21.24±0.41	20.89±0.75	21.07±0.18	22.61±0.24	21.95±1.11	22.28±0.41	22.98±0.34	23.06±0.27	23.02±0.04
Alkaline phosphatase (IU/l)												
Initial^{NS}	184.23±0.17	188.45±2.04	186.34±2.11	180.04±1.24	180.00±1.42	180.02±0.02	181.62±0.28	180.02±1.41	180.82±0.80	183.75±0.17	182.11±1.42	182.93±0.82
Post feeding^{NS}	186.44±1.47	9.75±1.98	188.10±1.66	184.25±1.27	185.06±1.22	184.66±0.41	184.07±1.22	183.24±1.42	183.66±0.41	187.12±1.31	185.75±1.18	186.44±0.69
SGOT (U/l)												
Initial^{NS}	34.14±0.57	31.89±1.45	33.02±1.13	34.74±0.65	32.03±1.15	33.39±1.36	34.98±1.02	32.03±1.26	33.51±1.48	35.18±0.62	32.53±1.25	33.86±1.32
Post feeding^{NS}	37.22±1.25	35.41±1.10	36.32±0.91	38.42±1.33	35.88±1.24	37.15±1.27	38.65±1.66	36.07±1.24	37.36±1.29	39.23±1.07	37.14±1.04	38.19±1.04
SGPT (U/l)												
Initial^{NS}	23.62± 2.11	18.56±2.04	21.09±2.53	23.77±1.04	18.16±1.14	20.97±2.81	24.05±1.42	18.89±1.21	21.47±2.58	25.22±1.12	19.24±0.78	22.23±2.99
Post feeding^{NS}	27.06±0.48	22.13±0.72	24.60±2.47	26.12±0.68	23.02±0.44	24.57±1.55	27.92±0.43	24.25±0.62	26.09±1.84	28.56±0.47	23.95±0.41	26.26±2.31

NS, Non significant; LP-LE, Low Protein Low Energy; LP-HE, Low Protein High Energy; HP-LE, High Protein Low Energy; HP-HE, High Protein High Energy.

in LP-LE, LP-HE, HP-LE and HP-HE groups, respectively. It was also observed at the end of 360 days of feeding trial that the average daily gain (ADG) in body weights and feed conversion efficiencies (FCE) of the yak calves were significantly better in HE-HP group followed by HP-LE, LP-HE and LP-LE groups.

The intake of the crude protein (CP) in terms of g per day, g per 100kg body weight and per kg metabolic body weight differ significantly among the groups and the values were within the same line as reported by Xue *et al*. (1994) in China. However, the total digestible nutrients intake in terms of g per day, g per cent and per kg metabolic body weights were similar among the groups indicating no effect of the experimental diets in utilization of energy in growing yaks. Similarity was also observed in both CP and TDN intakes in male and female experimental calves.

Study undertaken on different blood biochemical profiles also indicated higher blood glucose level in HP-HE group in comparison to other experimental groups; however, the values of plasma protein, albumin and urea levels were similar among all the four groups with no statistical variations irrespective of the sexes of the animals (Table 3). Blood samples were also collected from all the experimental females at 4 days interval for a period of 40 days to observe plasma concentration of progesterone. The experimental females were also subjected to ultra-sonographic examination to see their cyclicity of oestrous. The blood progesterone concentration and ultra-sonographic detection of the experimental animals revealed the animals under HP-HE had normal cycle of oestrous, whereas the animals under other groups showed non-cyclicity with worst findings in group LP-LE. Hence, it could be concluded that diet with high protein high energy could have better effect in advancement of cyclicity in yak heifers. The milk progesterone (P_4) levels in yak cows showed 80% cyclic ovarian activity with 70% occurrence of oestrus with supplementation of oats hay; however, only 25% had been observed in occurrence of oestrus without any supplementation (Long 1999).

Again, the experimental males under study were subjected to training for collection of semen indicated that out of 12 male animals, only two animals one each from group (HP-HE and HP-LE) satisfactorily ejaculated semen at an age of approximately 2.5 years, whereas the animals under other experimental groups failed to ejaculate during the period. Their ejaculation volume and the semen quality was evaluated for its mass activity, progressive motility, concentration, live and deal spermatozoa along with their morphology and it revealed that the collected semen were of good quality with almost all parameters were within the normal range indicating the diets containing high protein-high energy and high protein-low energy could have beneficial effects in advancement of sexual maturity in growing yaks. The study also revealed that high protein-high energy ration is the suitable dietary combination for growing yak calves to support an average body weight gain of 371.8 g/day during 250 to 300 kg of body weight and could advance their sexual maturity.

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