



Effect of undegradable dietary protein levels and plane of nutrition on feed intake, water metabolism and blood-biochemical constituents in crossbred heifers

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ABSTRACT

An experiment was conducted on crossbred heifers (16), 15 to 19 months old, randomly divided into 4 groups of 4 each in a 2 × 2 factorial completely randomized design. The heifers were fed 4 dietary treatments for 116 days involving 2 levels of UDP (RDP: UDP ratio of 50: 50 and 60: 40) at 2 levels of feeding (100 and 115%, NRC 1989) through concentrate mixtures to assess their effect on feed intake, weight gain, water metabolism and certain blood biochemical parameters. The concentrate mixture containing 50: 50 RDP: UDP ratio (high UDP based on cotton seed cake/ linseed cake and maize) at normal (100%) and higher plane (115%) was fed to heifers in treatment groups 1 and 3, respectively, whereas concentrate mixture 2 containing 60: 40 RDP: UDP ratio (low UDP based on mustard cake and wheat grain) at normal (100%) and higher plane (115%, NRC) was fed to heifers in treatment groups 2 and 4, respectively. The mixed fodder (green oats + oats hay) served as sole roughage to all the animals. The average daily dry matter consumption in the heifers ranged from 2.72 to 2.78 kg per 100 kg body weight and 101.25 to 104.84 g per kg W^{0.75} and did not differ significantly among groups. The heifers in treatment group 3 fed high UDP ration at higher plane of feeding gained highest daily body weight (0.80 kg) followed by treatment groups 4 (0.75 kg), 1 (0.67 kg) and lowest in heifers in treatment group 2 fed low UDP ration at normal plane of feeding (0.59 kg). The daily body weight gain was improved by 10.45% due to high UDP ration and 23.8% due to higher plane of feeding. The daily water intake and water excretion did not differ significantly amongst the groups. However, water loss was more in faeces and less in urine due to high UDP ration but plane of feeding had no significant effect. The blood serum concentration of total protein, albumin, globulin, cholesterol, calcium and phosphorus and activities of SGOT, SGPT and serum alkaline phosphatase did not differ significantly among the treatment groups, however, there was higher concentration of serum total protein, calcium content and SGPT activity due to high UDP ration. The higher plane of feeding also increased serum albumin and phosphorus content and SGPT activities significantly. It is concluded that feeding high UDP ration (50: 50 RDP: UDP ratio) with 115% of nutrients as recommended in NRC (1989) feeding standard under Indian condition is advantageous in improving the weight gain in crossbred heifers at later stage of growth without affecting the feed and water intakes and with normal blood biochemical constituents.

Key words: Blood biochemical constituents, Crossbred heifers, Feed intake, Plane of nutrition, Undegradable dietary protein, Water metabolism

Protein requirements for ruminants emerged to meet the nitrogen requirements of rumen microorganisms as well as to meet their amino acid requirements. This led to fractionation of protein requirements of ruminants into rumen degradable protein (RDP) and undegradable dietary protein (UDP) (ARC 1980, NRC 1989). Feeding of diet containing high UDP content produced variable results in terms of dry matter intake, nutrient utilization, blood biochemical

constituents and performance of ruminant animals (Lee *et al.* 2001, Chaturvedi and Walli 2001, Wankhede and Kalbande 2001, Kumar *et al.* 2005, 2006). Moreover, feeding of 10–20% higher level of CP in crossbred heifers over NRC (1989) standards significantly improved daily weight gain (Malik *et al.* 1998, Sihag *et al.* 2008). Keeping in view, the present study was conducted to discern the effect of concentrate mixture containing 2 UDP levels from plant sources at two planes of feeding on feed intake, weight gain, water metabolism and certain haematobiochemical constituents in crossbred heifers.

MATERIALS AND METHODS

Sixteen crossbred (Jersey × Sahiwal × Holstein friesian)

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heifers in the age group of 15 to 19 months were selected from dairy farm of the university and divided into 4 groups of 4 animals each in such a way that their average body weights were almost similar. The heifers were fed concentrate mixtures having RDP: UDP ratios 50: 50 and 60: 40 at 2 planes of nutrition i.e. 100 and 115% of NRC (1989) requirements. The 4 groups of heifers were allotted randomly 4 dietary treatments to assess the effects on feed intake, weight gain, water metabolism and certain blood biochemical parameters during feeding trial of 116 days. The heifers in treatment groups 1 and 3 were fed concentrate mixture 1 having 50: 50 RDP: UDP ratio (high UDP) at normal plane (100% of NRC) and higher plane (115% of NRC), respectively, whereas heifers in treatment groups 2 and 4 were fed concentrate mixture 2 having 60:40 RDP: UDP ratio (low UDP) at normal plane (100% of NRC) and higher plane (115% of NRC), respectively. All the heifers were fed respective concentrate mixtures along with mixed fodder consisting of green oats with variable amounts of oat hay to meet their nutritional requirements as per NRC (1989). The concentrate mixture 1 containing 50: 50 RDP: UDP ratio consisted of cottonseed cake 18 parts, linseed cake 14 parts, maize grain 17 parts, rice polish 48 parts, mineral mixture 2 parts and common salt 1 part, whereas concentrate mixture 2 containing 60: 40 RDP: UDP ratio consisted of mustard cake 26 parts, wheat grain 31 parts, rice polish 40 parts, mineral mixture 2 parts and common salt 1 part, based on RDP and UDP values as reported by Kumar and Tiwari (2003). The allowance of concentrate mixture was calculated for each heifer for a daily gain of 500 g and given for a fortnight and thereafter adjusted according to changes in body weights. All the animals were provided weighed quantity of roughage (green oats mixed with oat hay) once in a day at 9:00 a.m. *ad lib.* while the weighed amount of concentrate mixture was offered twice a day in equal installments at 9:30 a.m. and 4:00 p.m. Clean and fresh drinking water was provided *ad lib.* to all animals thrice a day at 8:00 am, 12 noon and 5:30 pm. Daily records of the feed offered and residue left of individual animals were maintained. The representative samples of concentrate mixtures and mixed roughage (oats green + oat hay) were analyzed for their chemical composition as per AOAC (1990). A metabolism trial for 5 days was conducted in the middle of feeding trial (89th to 110th day of experimental period) to record the water excretion through faeces and urine. The water loss through vapourization was arrived at by difference. The body weight of all the animals was recorded for 3 consecutive days at the start and termination of feeding trial before morning feeding and watering.

Blood samples were collected from jugular vein of each heifer on 68th and 116th day of the experimental feeding trial at 8.00 AM prior to morning feeding and watering and serum samples were harvested. The serum samples were analyzed in blood analyzer using ready-to-analyze kits

provided for alkaline phosphatase, serum glutamate oxaloacetate transaminase (SGOT) and serum glutamate pyruvate transaminase (SGPT) activities and serum concentrations of calcium, phosphorus, total protein, albumin and cholesterol. Pooled data were used for statistical analysis.

The statistical analysis of the data was done in 2×2 factorial completely randomized design in accordance with Snedecor and Cochran (1980) and using the general linear model procedure of SPSS (1996).

RESULTS AND DISCUSSION

The concentrate mixture 1 contained 17.35% CP, 7.49% EE, 4.30% CF, 58.58% NFE and 12.28% ash on dry matter basis, whereas the corresponding values in concentrate mixture 2 were 19.51, 8.00, 2.76, 57.62 and 12.11%, respectively.

Feed intake and weight gain: The daily total dry matter (DM) intake, roughage DM intake, DM intake per 100 kg body weight and DM intake per kg $W^{0.75}$ did not differ significantly among the groups (Table 1), however, concentrate DM intakes were significantly ($P < 0.01$) higher in heifers of groups T_3 and T_4 than those in groups T_1 and T_2 which is as per objective to provide higher plane of nutrition. The daily total DM intake and DM intake per 100 kg body weight and per kg $W^{0.75}$ were not significantly influenced either due to high UDP level due to higher plane of nutrition. Similarly, Sampath *et al.* (2005) and Kumar *et al.* (2005) reported no change in DM intake and feed conversion efficiency in crossbred cows due to feeding bypass protein containing ration, however, the decrease in DM intake per kg metabolic body size with an increase in the UDP content has also been reported by Tomlinson *et al.* (1997) in Holstein heifers.

The daily body weight gains were 0.67, 0.59, 0.80 and 0.75 kg in heifers of treatment groups 1, 2, 3 and 4, respectively and differed significantly ($P < 0.05$) amongst groups. The heifers in treatment group 3 fed high UDP ration at higher plane of feeding gained highest ($P < 0.05$) daily body weight followed by treatment group 4, 1 and lowest ($P < 0.05$) in heifers of treatment group 2 fed low UDP ration at normal plane of feeding (Table 1). The daily body weight was improved by 10.45% due to high UDP ration and 23.80% ($P < 0.01$) due to higher plane of nutrition. Malik *et al.* (1998) and Sihag *et al.* (2008) also observed improvement in daily body weight gain in crossbred heifers fed 10–20% higher CP than that recommended by NRC (1989).

Water metabolism: Daily total water intake and water excretion did not differ significantly among groups (Table 1). However, daily water intake through roughage was higher ($P < 0.01$) in heifers fed high UDP ration, whereas it was lower ($P < 0.01$) through concentrate. The water intake was also higher ($P < 0.01$) through concentrates in heifers fed at high plane of nutrition. There was significantly ($P < 0.05$) higher drinking water intake due to low UDP ration as well as due

Table 1. Average daily dry matter intake and water metabolism in growing crossbred heifers fed ration containing different RDP: UDP ratios and plane of nutrition

Particulars	Groups/Treatments				UDP levels		Level of feeding	
	1 (HUDDP+NP)	2 (LUDP+NP)	3 (HUDDP+HP)	4 (LUDP+HP)	LUDP (RDP:UDP, 60:40)	HUDDP (RDP:UDP, 50:50)	NP (100% of NRC)	HP (115% of NRC)
Average body weight (kg)	198.45±19.79	194±14.22	206.16±7.23	202.8±7.28	198.40±7.58	202.31±9.86	196.23±11.31	204.48±4.79
Total body weight gain (kg) ^{*,**}	78.10 ^{ab} ±5.78	68.85 ^b ±3.41	92.88 ^a ±3.53	87.15 ^a ±6.63	78.00±4.88	85.49±4.20	73.48 ^b ±3.57	90.08 ^a ±3.64
Body weight gain (kg/d) ^{*,**}	0.67 ^{ab} ±0.05	0.59 ^b ±0.03	0.80 ^a ±0.03	0.75 ^a ±0.06	0.67±0.04	0.74±0.04	0.63 ^b ±0.02	0.78 ^a ±0.03
DM intake (kg/d)								
Roughage	3.47±0.34	3.34±0.22	3.30±0.06	3.36±0.08	3.35±0.11	3.39±0.16	3.41±0.19	3.33±0.05
Concentrate ^{**}	1.91 ^b ±0.08	1.91 ^b ±0.07	2.29 ^a ±0.04	2.27 ^a ±0.04	2.09±0.08	2.10±0.08	1.91 ^b ±0.05	2.28 ^a ±0.03
Total	5.39±0.42	5.26±0.29	5.59±0.09	5.63±0.12	5.44±0.16	5.49±0.20	5.32±0.24	5.61±0.07
DM intake/100 kg BW (kg)	2.73±0.07	2.72±0.05	2.72±0.06	2.78±0.04	2.75±0.03	2.72±0.04	2.73±0.04	2.75±0.04
DM intake/kg W ^{0.75} (g)	102.06±1.51	101.25±0.55	102.84±1.61	104.84±0.72	103.04±0.80	102.45±1.03	101.66±0.76	103.84±0.90
Daily water intake (litre)								
From roughage ^{**}	5.79±0.49	5.26±0.46	5.55±0.23	5.63±0.38	5.44 ^b ±0.28	5.67 ^a ±0.26	5.53±1.95	5.59±1.97
From concentrate ^{**}	0.18±0.01	0.21±0.02	0.22±0.01	0.25±0.03	0.29 ^a ±0.02	0.20 ^b ±0.01	0.19 ^b ±0.07	0.24 ^a ±0.08
Through drinking water ^{**}	19.58±2.49	19.83±3.24	19.54±1.80	20.79±2.77	20.31 ^a ±1.98	19.56 ^b ±1.42	19.71 ^b ±6.97	20.16 ^a ±7.13
Total water intake	25.55±2.78	25.30±3.19	25.30±1.79	26.67±2.53	25.98±1.90	25.43±1.53	25.42±1.96	25.99±1.46
Daily water excreted (litre)								
In faeces ^{**}	11.16±1.34	9.42±0.48	10.51±0.13	9.93±0.24	9.68 ^b ±0.27	10.83 ^a ±0.64	10.29±3.64	10.22±3.61
In urine ^{**}	4.68±1.21	4.17±0.85	3.40±0.39	5.48±2.15	4.82 ^a ±1.10	4.04 ^b ±0.64	4.42±1.56	4.43±1.57
Vapourized ^{**}	9.71±1.48	11.71±2.19	11.40±1.50	11.26±1.47	11.48 ^a ±1.22	10.56 ^b ±1.03	10.71 ^b ±1.28	11.33 ^a ±0.97
Drinking water intake/kg DM intake (litre)	3.65±0.40	3.75±0.52	3.49±0.27	3.71±0.55	3.73±0.35	3.57±0.22	3.70±1.31	3.60±1.27

UDP, Undegradable dietary protein; RDP, rumen undegradable protein; LUDP, low undegradable dietary protein; HUDDP, high undegradable dietary protein; NP, normal plane; HP, higher plane; sem, standard error of means; ^{a,b} values bearing different superscripts in a row differ significantly from each other; * P<0.05; ** P<0.01.

to higher plane of nutrition, however, total daily water intake was not influenced due to either UDP or plane of nutrition. The daily water excretion in faeces significantly (P<0.01) increased due to high UDP ration, whereas daily water excretion through urine was more (P<0.01) in heifers fed low UDP ration than in heifers fed high UDP ration, however, there was no significant influence on water excretion through faeces and urine due to plane of nutrition. The vapourized water was more in heifers fed low UDP ration and at higher plane of feeding. The higher intake of drinking water as well as urinary loss of water in heifers fed low UDP ration may probably be due to higher degradability of proteins and excretion of ammonia mainly through urinary system. There was no significant effect on drinking water intake/ kg DM intake due to either UDP or plane of nutrition.

Blood biochemical constituents: There was no significant difference in the serum total protein, albumin, globulin, cholesterol, calcium and phosphorus concentrations, albumin: globulin ratio and serum alkaline phosphatase, glutamate oxaloacetate transaminase (GOT) and glutamate pyruvate transaminase (GPT) activities among different groups of heifers (Table 2). However, concentration of protein, albumin, globulin and calcium in blood serum and SGPT activity increased (P<0.01) due to increased UDP levels in the ration of heifers. The higher UDP content

lowered the activities of alkaline phosphatase and SGOT reflecting a reduced burden on the liver. O'Mara *et al.* (2000) also reported higher concentrations of the total protein and albumin on increasing the dietary UDP in dairy cows. However, Kumar *et al.* (2006) did not record such observations on total serum protein concentration in lactating cows. On the contrary Lee *et al.* (2001) indicated significant lowering of total serum protein in lactating goats with an increase in UDP content of the ration. The other blood serum constituents were not affected significantly due to UDP levels.

The serum total protein, albumin, calcium, phosphorus contents and GPT activity significantly (P<0.01) increased in heifers fed at higher plane of nutrition than heifers fed at normal plane, whereas serum globulin and cholesterol contents were higher in heifers fed at normal plane than in heifers fed at higher plane.

From the present studies, it was concluded that feeding of concentrate mixture having 50: 50 RDP: UDP ratio containing vegetable bypass protein sources and at 115% of NRC (1989) requirements under Indian conditions is beneficial in growing crossbred heifers at later stage of growth for improving the weight gain and in consistently maintaining the normal values of the serum biochemical constituents and enzymes activities without affecting the daily feed and total water intake.

Table 2. Average serum-biochemical constituents and enzyme activities in growing crossbred heifers fed ration containing different RDP: UDP ratios and plane of nutrition

Particulars	Groups/Treatments				SEM	UDP levels		Level of feeding	
	1 (HUDP+NP)	2 (LUDP+NP)	3 (HUDP +HP)	4 (LUDP +HP)		LUDP (RDP:UDP, 60:40)	HUDP (RDP:UDP, 50:50)	NP (100% of NRC)	HP (115% of NRC)
Total protein (g/dl)**	7.21±0.28	6.65±0.43	7.19±0.48	6.86±0.75	0.51	6.76 ^b ±0.40	7.20 ^a ±0.26	6.93±0.26	7.03±0.42
Albumin (g/dl) **	3.06±0.23	3.00±0.21	3.50±0.32	3.38±0.55	0.35	3.19±0.28	3.28±0.20	3.03 ^b ±0.15	3.44 ^a ±0.29
Globulin (g/dl) **	4.15±0.21	3.65±0.27	3.69±0.25	3.49±0.25	0.25	3.57 ^b ±0.17	3.92 ^a ±0.17	3.90±0.18	3.59±0.17
Albumin: globulin ratio **	0.74:1±0.07	0.83:1±0.05	0.96:1±0.08	0.96:1±0.13	0.09	0.89:1±0.07	0.85:1±0.06	0.79:1 ^b ±0.04	0.96:1 ^a ±0.07
Cholesterol (mg/dl)	106.88±5.37	104.25±3.09	102.63±3.16	101.25±2.98	3.78	102.75±2.06	104.75±3.00	105.56±2.91	101.94±2.03
Calcium (mg/dl) **	8.10±0.14	6.74±0.20	8.38±0.20	8.06±0.77	0.41	7.40 ^b ±0.44	8.24 ^a ±0.12	7.42 ^b ±0.28	8.22 ^a ±0.37
Phosphorus (mg/dl) **	3.88±0.13	4.09±0.21	4.29±0.51	4.30±0.54	0.39	4.19±0.27	4.08±0.26	3.98 ^b ±0.12	4.29 ^a ±0.34
Alkaline phosphatase (Unit/litre) **	361.75±24.77	358.75±27.82	360.75±28.38	371.00±31.39	25.38	364.88±19.55	361.25±17.51	360.25±17.35	365.88±19.68
Serum glutamate oxaloacetate transaminase, (Unit/litre)	83.50±2.90	81.25±6.41	83.25±4.63	89.50±15.16	8.67	85.38±7.78	83.38±2.53	82.38±3.28	86.38±7.43
Serum glutamate pyruvate transaminase (Unit/litre) **	30.75±0.95	26.75±0.63	33.25±2.56	30.00±1.91	1.70	28.38 ^b ±1.12	32.00 ^a ±1.35	28.75 ^b ±0.92	31.63 ^a ±1.60

UDP, Undegradable dietary protein; RDP, rumen undegradable protein; LUDP, low undegradable dietary protein; HUDP, high undegradable dietary protein; NP, normal plane; HP, higher plane; SEM, standard error of means; ^{a,b} Values bearing different superscripts in a row differ significantly from each other; **P<0.01.

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