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Effect of varying levels of concentrate on growth performance and feed economics in Nili-Ravi buffalo heifer calves

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Abstract: An experiment was conducted to optimize the effect of concentrate levels on growth performance in Nili-Ravi buffalo heifers. These animals (n = 30), aged 4–6 months, were divided into three treatment groups (A, B, C) and were offered concentrate at the rate of 0.5%, 1.0%, and 1.5% of body weight for an 8-month period, respectively. The statistical data showed a significant ($P < 0.01$) effect on dry matter intake among all treatment groups. However, dietary treatments showed a nonsignificant effect on body weight gain. Treatment A showed a better ($P < 0.01$) feed conversion ratio (10.01 ± 0.55) compared to treatment B (11.75 ± 0.79) and C (12.85 ± 0.74). The average body condition score, body measurements, and blood profiles were not affected by varying levels of concentrate. However, total serum protein was found lower ($P < 0.01$) in treatment A compared with the other two treatment groups. The cost for production per kg gain was 80.8% higher in treatment C and 46.6% higher in treatment B compared to treatment A. It can be concluded that buffalo heifers can be reared cost-effectively on a minimum concentrate level (0.5% of body weight) along with ad libitum green fodder.

Key words: Body measurements, buffalo heifer, concentrate, growth performance

1. Introduction

In dairy farming, feeding costs account for 63% (1) to 84% (2) of total input cost and determine the economic viability of heifer production systems. Heifer production is the most expensive component of dairy farm operations because age at puberty is high (3). Improper feeding management at this stage affects the future profitability. In the life of a heifer, the first 9 months are most critical. Improper feeding during this phase leads to poor growth and increased risk of mortality (4). In Pakistan most of the buffalo heifers are reared conventionally on poor quality roughages characterized by low energy and high fiber contents (5), resulting in poor growth (6) and delayed age at puberty. The slow growth rate in buffalo heifers can be enhanced cost-effectively by feed plans including restricted concentrate with ad libitum roughages (7). The nutrient requirements of buffalo are different from dairy cattle due to differences in climatic adaptability and nutrient utilization (8). The digestibility of each nutrient in feed is 2%–5% higher in buffalo compared to cattle (9). The performance of buffalo heifers can further be improved through genetic selection and nutritional management. Feeding of buffalo heifers according to their protein and energy requirements is a key to enhance the profitability (10).

Limited information is available about the use of appropriate concentrate level in the diet of growing buffalo heifers. The present study was designed to investigate the growth performance of Nili-Ravi buffalo heifers at varying levels of concentrate along with ad libitum green fodder.

2. Materials and methods

2.1. Experimental treatment groups and feeding plans

The present study was carried out at the Livestock Experiment Station, Pattoki, district Kasur, in Pakistan and conducted according to the guidelines of the Committee on Use of Animals in Research and Experimentation. Thirty Nili-Ravi buffalo heifers of the same age (4–6 month) and body weight (93–94 kg) were randomly divided into three treatment groups (A, B, and C) having ten animals in each and were offered concentrate (dry matter (DM): 90.2%, crude protein (CP): 17%, ether extract (EE): 3.5%, and metabolizable energy (ME): 2.6 Mcal/kg) at the rate of 0.5%, 1.0%, or 1.5% of body weight, respectively. In addition to

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this heifers were offered green fodder (*Sorghum bicolor*: DM: 20.1%, CP: 7.7%, EE: 1.9%, ME: 1.7 Mcal/kg and *Zea mays*: DM: 23.5%, CP: 8.5%, EE: 2.3%, ME: 2.5 Mcal/kg) and fresh water ad libitum for an 8-month period. The animals were provided a 14-day adjustment period before the start of the experiment. Measured quantities of concentrate and chopped green fodder were offered twice a day (morning and evening) and orts were weighed the next day. The heifers were weighed at the beginning of the trial and then on a fortnightly basis until the completion of the trial.

2.2. Body condition score

Body condition score (BCS) was calculated on a monthly basis by observing eight locations on the animal's body. These locations were the area under the tail head to the pin bone, spinous processes of lumbar vertebrae, depression between spinous and transverse processes, transverse process of lumbar vertebrae, point between 12th and 13th ribs, sacral crest, depression between sacral crest and hook bone, and depression between hook and pin bones (11).

2.3. Blood and serum collection

Blood samples were collected from individual animals 2 h after morning feeding. Blood analysis was performed by using a blood chemistry analyzer (Abacus, Diatron) and serum samples were analyzed by using a serum chemistry analyzer (Microlab 300).

2.4. Body measurements

Linear body measurements were taken using tailor's tape (cm) after restraining the animals in an unforced position. Three body measurements were taken: height at wither (distance between the highest position at wither to the surface of floor/platform), heart girth (circumference of the body of the animal just behind the forelegs), and body length (distance between the point of shoulder and pin bone) (12).

2.5. Feeding cost

The economic aspect of heifer rearing was calculated on the basis of feeding cost/kg live weight gain (13) (1 USD = 104.75 Rupees) and mostly depended on the cost of feed ingredients and their digestibility. Feeding cost comprised concentrate and forage costs.

2.6. Statistical analysis

The data were analyzed through analysis of variance (ANOVA) with a general linear model procedure in SAS 9.1 software. The differences among treatment means were compared through least significant difference tests (14).

3. Results and discussion

3.1. Dry matter intake

Dry matter intake (DMI) from forage was found nonsignificant, while a significant ($P < 0.01$) effect was observed in the average daily DMI from concentrate and average daily total DMI (Table 1). The difference in DMI was due to varying levels of concentrate. This result is similar to the results of different studies carried out on Nili-Ravi heifers (15) that observed significant effects on daily DMI in growing Nili-Ravi heifers on 2 and 4 kg concentrate diets. Similar findings were observed in a previous study where a linear increase in DMI occurred with increasing dietary protein levels (16). Many scientists also found an increase in dry matter intake due to high energy rations (7,17).

3.2. Body weight gain

A nonsignificant effect of different concentrate levels was observed on body weight gain (Table 1). These results coincide with the findings of various scientists (15) who offered 2 and 4 kg concentrate with green fodder to Nili-Ravi heifers and found a nonsignificant ($P < 0.05$) effect on weight gain. Similarly, the same findings in weight gain of crossbred calves at different dietary protein levels were reported (16). This may be due to efficient utilization of

Table 1. Average daily dry matter intake and weight gain.

Parameters	Treatments*			
	A	B	C	P-value
Forage DMI, kg	3.27 ± 0.09	3.19 ± 0.09	3.23 ± 0.10	0.651
Concentrate DMI, kg	0.65 ± 0.01^{c}	1.29 ± 0.03^{b}	1.91 ± 0.05^{a}	0.001
Total DMI, kg	3.92 ± 0.11^{c}	4.48 ± 0.12^{b}	5.14 ± 0.14^{a}	0.001
Total weight gain, kg	111.20 ± 4.18	112.80 ± 6.13	117.84 ± 9.00	0.769
FCR	10.01 ± 0.55^{a}	11.75 ± 0.79^{ab}	12.85 ± 0.74^{b}	0.009

*Treatments: A: Low concentrate level, B: medium concentrate level, C: high concentrate level. DMI: Dry matter intake, FCR: feed conversion ratio. Values with different superscripts within rows are significantly different ($P < 0.05$).

dry matter (low protein and energy) by buffalo heifers. In contrary, Brosh et al. (18) reported higher body weight gain in Friesian calves raised on high protein (146 g/kg) compared to medium (126 g/kg) and low (106 g/kg) protein diets. This difference in weight gain might be due to genetic variation. Body weight gain is affected by many factors, like genetic resources, age, initial body weight, and nutritional management (19).

3.3. Feed conversion ratio

Treatment A showed a significantly better ($P < 0.01$) feed conversion ratio (FCR) compared to treatments B and C (Table 1). This might be due to better efficiency of nutrient utilization in Nili-Ravi buffalo heifers. The results match the findings of Tiwari et al. (20), who offered wheat straw-based rations at 58%, supplemented with 42% concentrate mixture, to buffalo calves and reported FCR of 11.0. Mahmoudzadeh and Fazaeli (21) raised buffalo calves on diets with three different energy levels (90%, 100%, and 110% of 2001 National Research Council recommendations) (22) and reported significantly better FCR (6.53, 5.41, and 5.80) at the 100% NRC recommended level. In contrast, Lohakare et al. (16) offered diets with three different protein levels to thirty crossbred calves and reported a nonsignificant ($P > 0.05$) FCR. The contrary results may be due to differences of species as FCR is influenced by variations of breed, age, feeding systems, and farm management conditions (23).

3.4. Body condition score

The different dietary treatments showed nonsignificant effects on BCS at the completion of the experiment (Table 2). The current results are substantiated by the findings of Gasparrini et al. (24), who raised Murrah buffalo heifers on two different energy levels and found equivalent ($P > 0.05$) BCS values for the treatment groups. Hill et al. (25) reported similar BCS values in Holstein calves raised on different protein diets.

3.5. Blood and serum chemistry

The blood profile (WBCs, RBCs, and hemoglobin) was not affected ($P > 0.05$) by dietary treatments (Table 3). Jabbar et al. (26) and Lohakare et al. (16) reported that concentrate supplementation levels had no influence on hematocrit and hemoglobin values in growing buffalo heifers (1 year of age) and crossbred calves (3–5 months of age). These nonsignificant results of blood parameters suggest adequate availability of nutrients (16) among all three treatments. The concentrations of serum glucose and total protein match the findings of Ahmed et al. (27), who reported values of blood glucose and total serum protein as 65.59 ± 1.23 mg/dL and 5.33 ± 0.09 g/dL in Egyptian buffalo heifers. The serum glucose concentration remained unaffected among all three treatment groups; however, total protein was found significantly ($P < 0.01$) lower in treatment A compared to treatments B and C. The decrease in total serum protein concentration might be due to low protein in the diet of heifers belonging to treatment A. The current findings are in line with those of Jabbar (28), who reared buffalo heifers on different dietary energy levels and reported high serum protein with the high energy density diet.

3.6. Body measurements

The average height at withers, body length, and heart girth were found to be the same ($P > 0.05$) among all three treatment groups (Table 4). Toker and Ozkaya (29) studied the effect of different dietary protein levels (18% vs. 22%) on the growth performance of twenty Holstein calves during the postweaning period. They found the same body length (100.65 ± 2.62 and 102.40 ± 2.62 cm), chest girth (115.90 ± 3.55 and 121.55 ± 3.55 cm), and wither height (101.45 ± 2.71 and 105.60 ± 2.71 cm) with varying protein levels in diets. Lammers and Heinrichs (30) studied the response of different dietary protein to energy ratios on structural growth in growing Holstein heifers and reported nonsignificant effects on wither height and heart girth. Zanton and Heinrichs (31) raised Holstein dairy heifers on high-forage (75%) and high-concentrate rations (75%) and also reported that gain in structural measurements (wither height, body length, and heart girth) were not affected by dietary treatments. In another study, Fiaz et al.

Table 2. Body condition scores of Nili-Ravi buffalo heifers,

Parameters	Treatments*			
	A	B	C	P-value
BCS at the start of trial	3.41 ± 0.03	3.43 ± 0.03	3.44 ± 0.04	0.759
BCS at the end of trial	3.79 ± 0.04	3.84 ± 0.03	3.90 ± 0.05	0.160
Change in BCS	0.38 ± 0.03	0.42 ± 0.04	0.46 ± 0.03	0.227
Average BCS during trial	3.62 ± 0.02	3.65 ± 0.02	3.71 ± 0.02	0.097

*Treatments: A: Low concentrate level, B: Medium concentrate level, C: High concentrate level.
BCS: Body condition score.

(3) also found nonsignificant (P > 0.05) effects of different energy levels (100% and 112%) in diets on body length of Sahiwal heifers. The current findings might be due to the same age, physical body appearance, and body weight of all the treated heifers during the experimental period.

3.7. Feeding cost

The average daily DMI cost was 84% and 30% higher in treatment C compared with treatments A and B, respectively (Table 5). The feeding cost per kg gain was 80.8% higher in treatment C compared to treatment A and it was 23.2% higher in treatment C compared with treatment B. The average daily DMI cost (1 USD = 104.75 Rupees) and cost per kg gain were 41.8% and 46.8% higher for treatment B compared with treatment A, respectively. The mean FCR and cost per kg gain were lower in treatment A compared with the other two treatments. This might be due to efficient digestibility of carbohydrate and protein (13) in buffalo heifers. Restricted feeding leads to significant feed economics. These findings are in line with the findings of Rafiq et

Table 3. Blood profile and serum chemistry analysis of Nili-Ravi buffalo heifers.

Parameters	Treatments*			
	A	B	C	P-value
WBC count, $\times 10^9$/L	25.65 ± 1.33	23.47 ±1.26	26.55 ± 1.13	0.167
RBC count, $\times 10^{12}$/L	9.39 ± 0.17	9.49 ± 0.15	9.53 ± 0.25	0.864
Hemoglobin, g/dL	12.55 ± 0.22	12.38 ± 0.20	12.73 ± 0.26	0.445
Glucose, mg/dL	85.88 ± 1.92	85.02 ± 2.67	83.36 ± 2.23	0.532
Total protein, g/dL	6.12 ± 0.17^b	6.65 ± 0.23^a	6.79 ± 0.23^a	0.007

*Treatments: A: Low concentrate level, B: Medium concentrate level, C: High concentrate level. Values with different superscripts within rows are significantly different (P < 0.05). WBC: White blood cells, RBC: red blood cells.

Table 4. Body measurements of Nili-Ravi buffalo heifers.

Parameters	Treatments*			
	A	B	C	P-value
Height at wither, cm	103.31 ± 0.57	103.43 ± 0.54	104.04 ± 0.55	0.301
Body length, cm	98.27 ± 0.60	97.86 ± 0.59	98.71 ± 0.68	0.366
Heart girth, cm	120.43 ± 0.92	120.61 ± 0.90	121.59 ± 0.98	0.316

*Treatments: A: Low concentrate level, B: Medium concentrate level, C: High concentrate level.

Table 5. Feeding costs for live weight gain of Nili-Ravi buffalo heifers.

Parameters	Treatments*			
	A	B	C	P-value
Avg. daily dry matter intake cost form green fodder (PKR)	29.99	29.25	29.59	0.650
Avg. daily dry matter intake cost form concentrate (PKR)	22.94^c	45.77^b	67.78^a	<0.001
Total avg. daily dry matter intake cost (PKR)	52.92^c	75.03^b	97.37^a	<0.001
Feeding cost per kg gain (PKR)	136.09^c	199.71^b	246.07^a	<0.001

*Treatments: A: Low concentrate level, B: Medium concentrate level, C: High concentrate level.
Different superscripts indicate significant difference (P < 0.05).
PKR: Pakistani rupees.

al. (15), who raised growing buffalo heifers on different levels of concentrate supplementation (2 and 4 kg) along with ad libitum green fodder and reported that rearing of buffalo heifers is cost-effective on low quantity concentrate diet along with ad libitum green fodder. Helal et al. (7) offered three levels of concentrate ration (70%, 85%, and 100%) to buffalo calves and found better economic efficiency in the group with the lower concentrate level. In another study Anjum et al. (32) reported reduced cost per kg live weight gain by 13.34% in the restricted feeding group compared to the control group.

3.8. Conclusion

It can be concluded that provision of concentrate ration of the given composition at the rate of 0.5% of body weight is economical for optimum growth performance and FCR in Nili-Ravi heifer calves.

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References

1. Moore R, Beiler J, Schnitkey G. The Economics of Heifer Contracting. Ohio State University Fact Sheet. Columbus, OH, USA: Ohio State University; 2009.
2. Razzaque MA, Mohammed SA, Al-Mutawa T. Dairy heifer rearing in hot arid zone: an economic assessment. Am J Appl Sci 2010; 7: 466-472.
3. Fiaz M, Abdullah M, Pasha TN, Jabbar MA, Babar ME, Bhatti JA, Nasir M. Evaluating varying dietary energy levels for optimum growth and early puberty in Sahiwal heifers. Pak J Zool 2012; 44: 625-634.
4. The Government of Queensland. The Economics of Heifer Rearing. Brisbane, Australia: Queensland Department of Agriculture, Fisheries and Forestry; 2009.
5. Sarwar M, Khan MA, Iqbal Z. Feed resources for livestock in Pakistan. Int J Agri Biol 2002; 4: 186-192.
6. Jabbar MA, Anjum MI, Rehman S, Shahzad W. Comparative efficiency of sunflower meal and cotton seed cake in the feed of crossbred calves for meat production. Pak Vet J 2006; 26: 126-128.
7. Helal FI, Abdel Rahman KM, Ahmed BM, Omar SS. Effect of feeding different levels of concentrates on buffalo calves performance, digestibility and carcass traits. Am Eurasian J Agric Environ Sci 2011; 10: 186-192.
8. Pasha TN. Prospect of nutrition and feeding for sustainable buffalo production. Buffalo Bull 2013; 32: 91-110.
9. Franzolin R. Feed efficiency: a comparison between cattle and buffalo. Buffalo J 1994; 2: 39-50.
10. Tauqir NA, Shahzad MA, Nisa M, Sarwar M, Fayyaz M, Tipu MA. Response of growing buffalo calves to various energy and protein concentrations. Livest Sci 2011; 137: 66-72.
11. Anitha A, Rao KS, Suresh J, Moorthy PS, Reddy YK. A body condition score (BCS) system in Murrah buffaloes. Buffalo Bull 2011; 30: 79-96.
12. Iqbal ZM, Javed K, Abdullah M, Ahmad N, Ali A, Khalique A, Aslam N, Younas U. Estimation of body weight from different morphometric measurements in Kajli lambs. J Anim Plant Sci 2014; 24: 700-703.
13. Venkata S, Jagadeeswara RS, Kishan KM, Harikrishna C. Effect of feeding processed sweet Sorghum (*Sorghum bicolour* (L.) Moench) bagasse based total mixed ration on growth and chewing behaviour in graded Murrah buffalo calves. J Anim Sci Adv 2012; 2: 835-840.
14. Steel RGD, Torrie JH, Dickey DA. Principles and Procedures of Statistics, A Biometrical Approach. 3rd ed. New York, NY, USA: McGraw-Hill Book Co. Inc.; 1997.
15. Rafiq M, Chaudhry MA, Jabbar MA. Effect of level of concentrate supplementation on growth rate and age at maturity in growing buffalo heifers. Pak Vet J 2008; 28: 37-39.
16. Lohakare JD, Pattanaik AK, Khan SA. Effect of dietary protein levels on the performance, nutrient balances, metabolic profile and thyroid hormones of crossbred calves. Asian-Australas J Anim Sci 2006; 19: 1588.
17. Tomar SK, Patil LN, Singh P, Kundu SS. Effect of feeding various energy levels on nutrient utilization and growth in male buffalo calves. J Anim Plant Sci 2014; 24: 33-35.
18. Brosh A, Aharoni Y, Levy D, Holzer Z. Effect of dietary protein concentration and source on the growth rate and on body composition of Holstein-Friesian male calves. Anim Sci 2000; 70: 527-536.
19. Nair PV, Verma AK, Dass RS, Mehra UR. Growth and nutrient utilization in buffalo calves fed ammoniated wheat straw supplemented with sodium sulphate. Asian-Australas J Anim Sci 2004; 17: 325-329.
20. Tiwari CM, Jadhao SB, Khan MY. 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-Australas J Anim Sci 2000; 13: 761-773.
21. Mahmoudzadeh H, Fazaeli H. Growth response of yearling buffalo male calves to different dietary energy levels. Turk J Vet Anim Sci 2009; 33: 447-454.
22. NRC. Nutrient Requirements of Dairy Cattle. 7th ed. Washington, DC, USA: National Academy Press; 2001.

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

24. Gasparrini B, Rendina M, Vecchio D, Baruselli PS, Gazaneo MP, Marchiello M, Balestrieri A, Campanile G. Effect of diet with different energy content in growing Murrah buffalo heifers. Ital J Anim Sci 2007; 6: 540-543.

25. Hill TM, Bateman HG, Aldrich JM, Schlotterbeck RL. Effect of consistency of nutrient intake from milk and milk replacer on dairy calf performance. Prof Anim Sci 2009; 25: 85-92.

26. Jabbar L, Cheema AM, Jabbar MA, Riffat S. Effect of different dietary energy levels, season and age on hematological indices and serum electrolytes in growing buffalo heifers. J Anim Plant Sci 2012; 22: 279-283.

27. Ahmed WM, Bashandy MM, Ibrahim AK, Shalaby SIA, El-Moez SIA, El-Moghazy FM, Ibrahim SRE. Investigations on delayed puberty in Egyptian buffalo-heifers with emphasis on clinicopathological changes and treatment using GnRH (Receptal®). Glob Vet 2010; 4: 78-85.

28. Jabbar L. Effect of different dietary energy levels on some growth and reproductive aspects and their relation with age of maturity in growing buffalo heifers. PhD, University of the Punjab, Lahore, Pakistan, 2004.

29. Toker MT, Ozkaya S. The effect of dietary protein levels on growth performance of female Holstein calves during the post-weaning period. Turk J Agric Nat Sci 2014; 7: 1642-1645.

30. Lammers BP, Heinrichs AJ. The response of altering the ratio of dietary protein to energy on growth, feed efficiency, and mammary development in rapidly growing prepubertal heifers. J Dairy Sci 2000; 83: 977-983.

31. Zanton GI, Heinrichs AJ. The effects of controlled feeding of a high-forage or high-concentrate ration on heifer growth and first-lactation milk production. J Dairy Sci 2007; 90: 3388-3396.

32. Anjum MI, Azim A, Jabbar MA, Anwar M, Mirza IH. Age and weight at puberty in Nili-Ravi buffalo heifers reared on three dietary energy restriction periods followed by compensatory growth. Pak Vet J 2012; 32: 367-371.