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The use of chromic oxide as an index for determining the digestibility of feed constituents in buffalo calves

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ABSTRACT : Six murrah buffalo calves divided into two groups were fed wheat straw and concentrates mixture along with green Lucerne. The average dry matter (DM) intake per 100 kg body weight (2.94 ± 0.36 kg) and g / unit metabolic size (g/$w^{0.75}$) (119.01 ± 7.54 g) were significantly higher (P < 0.05) in the animals of group II than the values obtained in the group I (2.25 ± 0.32 kg and 95.79 ± 10.03 g). The intake of digestible crude protein (DCP) g / unit metabolic size was lower (6.57 ± 0.57 g) in the males group than the females group (7.06 ± 0.71 g) whereas, the intake of total digestible nutrients (TDN) g / unit metabolic size was higher in the males group (77.79 ± 12.27) than the females group (68.02 ± 13.38). The differences in the intake and utilization of these nutrients between two groups of animals were statistically significant. The average digestibility co-efficients of DM, crude protein (CP), ether extract (EE), crude fibre (CF), nitrogen-free extract (NFE), total carbohydrates (TCHO), total ash, insoluble ash, neutral detergent fibre (NDF), acid detergent fibre (ADF) were 62.41 ± 1.13, 69.57 ± 0.89, 54.13 ± 1.81, 63.50 ± 0.86, 66.74 ± 2.79, 65.61 ± 3.29, 35.40 ± 2.08, 54.27 ± 1.38 and 74.73 ± 2.46 per cent in the animals of group I and 58.29 ± 1.44, 66.02 ± 0.36, 50.34 ± 0.49, 61.10 ± 0.79, 63.58 ± 1.80, 63.38 ± 2.41, 31.79 ± 1.39, 51.68 ± 0.71 and 68.64 ± 1.97 per cent in the animals of group II. Among the nutrients, the males digested more (P < 0.05) crude protein than the females.

KEY WORDS : Digestibility, Chromic oxide, Buffalo, Group, Faeces

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INTRODUCTION

A number of indicators have been employed in digestibility studies to avoid the necessity for the total collection of faecal material. The use of indigestible markers to determine nutrient digestibility is an attractive technique as it dispenses with the need to measure food intake and faeces output. Digestibility trails have provided a basis for acquiring much of our present knowledge of the nutritive value of the components of animal diets. Such trials are still of fundamental importance in nutrition research. One of the chief problems in this type of work has been to identify the faecal output resulting from a specific intake of feed. A number of workers have explored the possibility of including a known amount of a completely indigestible material in the feed and by determining its subsequent concentration in the faeces, allowing the material to serve as an index of digestibility of the feed. Diets based on crop residues are deficient in protein, energy, minerals and vitamins, restricts intake and digestibility of animals, can be improved by providing supplementary nutrients like leguminous and non-leguminous green forages, concentrates and specific nutrient supplements in the form of mineral mixtures. In conventional method digestibility, daily feed intake and faeces voided are quantitatively measured but this method is very laborious and time consuming. In this direction indicator method (Hill and Anderson, 1958) will be less time consuming and provide better result than the

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conventional method.

MATERIAL AND METHODS

Six murrah buffalo calves 3 males (group I) and 3 females (group II) were taken for entire investigation. The animals were selected on the basis of age, body weight and body confirmation and his age within 2 to 2½ years. Before the start of actual trial, all the calves were dewormed and cured from external parasite before putting them in the experimental shed. All the calves were weighed at the start of the preliminary experiment and at the culmination of the each digestibility trial using 'Avery made dial' balance (1000 kg capacity). Weighments were done consecutively for three days at the same time, *viz.*, 8.00 to 8.30 a.m. The body weight of individual animal and the group average were ascertained. At the end of each experiment body weight gain of individual animal was calculated. At the time of starting experiment the average body weight of male buffalo calves was 297.33 ±77.67 kg while the average body weight of female calves was 222.00 ±60.53 kg. The experimental buffalo calves were provided adequate feedstuffs containing nutrients computed on the basis of individual body weight (NRC, 1989). In this experiment, animals were offered concentrate mixture, green Lucerne along with wheat straw. The wheat straw was fed ad-libitum, after feeding the concentrate mixture daily morning and evening to all the animals. The digestible crude protein requirement of animals was met with concentrate mixture. The observations recorded during the course of these investigations were summarized in the form of table for the analysis of mean and standard error. To judge the differences in digestibility between male and female group, paired 't' test was applied. The significant differences between the average values were tested against critical difference CD at 5 and 1 per cent level of probability.

RESULTS AND DISCUSSION

In this experiment six buffalo calves (3 males and 3 females) were fed on wheat straw and green Lucerne along with concentrate mixture. Chromic oxide (external indicator) was fed to the animals with concentrate mixture.

Intake and utilization of feed constituents :

The data presented in Table 1 clearly depict that the dry matter intake ranged from 2.00 to 2.62 kg with an average of 2.25 ± 0.32 kg per 100 kg body weight in the males (group I) whereas, the intake values varied from 2.57 to 3.30 kg with an average of 2.94 ± 0.36 kg per 100 kg body weight in case of females (group II). The dry matter intake by the animals as well as their variation within the groups was the highest in females than the males.

The difference in the average dry matter intake per 100 kg body weight was significantly higher ($P < 0.05$) in the females than the average value found in the males. The overall group (male and female) average of dry matter intake was 2.59 ± 0.48 kg per 100 g body weight. The higher dry matter intake per 100 kg body weight in case of females could be due to lower live weight g / unit of metabolic size ($g/w^{0.75}$) than the value found in the males group. Singh (1980) and Goswami *et al.* (1997) have reported that animals having higher body weight consume lesser feed as compared to the animals having lower body weight. This finding is directly corroborated with the results found in the present investigation. Virk and Pradhan (1992), reported higher dry matter intake per 100 kg body weight in case of female than the value

Table 1: The DCP contents of the feed, their availability and utilization

Groups of animals	DCP in feed (%)	DM intake $g/w^{0.75}$	DM intake / 100 kg body weight (kg)	DCP intake $g/w^{0.75}$	TDN intake $g/w^{0.75}$
A	6.55	90.22	2.00	5.91	91.77
B	7.75	89.78	2.15	6.95	72.80
C	6.40	107.38	2.62	6.87	68.80
Average ± S.E.	6.90 ± 0.73	95.79 ± 10.03	2.25 ± 0.32	6.57 ± 0.57	77.79 ± 12.27
D	5.96	110.35	2.57	6.58	79.18
E	5.94	122.59	2.95	6.73	71.71
F	6.36	124.10	3.30	7.89	53.18
Average ± S.E.	6.08 ± 0.23	119.01* ± 7.54	2.94* ± 0.36	7.06 ± 0.71	68.02 ± 13.38
Overall average ± S.E.	6.49 ± 0.64	107.40 ± 14.99	2.59 ± 0.48	6.82 ± 0.64	72.90 ± 12.66

* indicates significance of value at P=0.05

found in male buffalo calves. Several research workers (Gill and Gill, 1979; Mehra *et al*., 1990; Virk *et al*., 1993; Chauhan *et al*., 1997 and Teli *et al.*, 1999) have also reported similar dry matter intake when male and female buffalo calves were maintained on different farm rations. In contrast to these results lower values (1.4 to 1.84 kg per 100 body weights) were recorded by Mondal *et al*., 1997, when cows/buffaloes were maintained on the different feeds.

When the dry matter intake per unit metabolic size ($g/w^{0.75}$) was calculated, it was found that male buffaloes consumed ration from 89.78 to 107.38g per head per day whereas, the dry matter intake values from 110.35 to 124.10g per head per day ($g/w^{0.75}$) were recorded in the female. The variations in the intake per unit metabolic size between two categories of the animals were higher in the males than the females. The average dry matter intake per unit metabolic size ($g/w^{0.75}$) was significant ($P<0.05$) higher in females than males. The overall (groups) average of dry matter intake ($g/w^{0.75}$) was recorded to be 107.40 ± 14.99g per head per day. Similar dry matter intake (88.00 to 120.00$g/w^{0.75}$) also reported by Gill and Gill (1979) and Mudgal *et al.* (1981) when buffaloes were maintained on various ration schedules. Mehra *et al*. (1991); Mondal *et al*. (1996) and Sastry *et al.* (1999) showed lower (70.4 to 87.18g) dry matter intake ($g/w^{0.75}$) as against to the values found in the present investigation.

A perusal of the data presented in Table 1 clearly indicates that the per cent DCP in the feed recorded was 6.90 ± 0.73 per cent with the minimum and the maximum limit of 6.40 and 7.75 per cent, respectively, in group I animals. In case of group II animals, the DCP on average was 6.08 ± 0.23 per cent with the minimum and the maximum value of 5.94 and 6.36 per cent, respectively. The average of DCP in the feed was apparently higher (13.48%) in group I animals than the value obtained in the group II animals. The difference in DCP (%) in the feed between the feed to the two groups of animals did not show any statistical significance. The overall (groups) average of DCP in the feed recorded was 6.49 ± 0.66 per cent. The variation in the DCP found in the present study falls within the range (6.3 to 7.89%) reported by Virk *et al.* (1993); Chaudhary and Gupta (1999 and 2000). The variation in the DCP values in the feed reported by Goswami *et al*. (1997) and Sastry *et al.* (1999) were high (7.9 to 10.35%) as compared to the values obtained in the present study.

The DCP intake per unit metabolic size varied from 5.91 to 6.95 g, the average value being 6.57 ± 0.57 g in the group I animals. In the case of group II animals, the DCP intake values varied from 6.58 to 7.89 $g/w^{0.75}$ was apparently higher (7.29%) in group II animals, than the average values between the two groups of animals was statistically not significant. The overall (groups) average of DCP intake was recorded to be 6.82 ± 0.64 $g/w^{0.75}$, which falls within the same limit as reported by Singh (1980) but the DCP intake values were comparatively higher (7.1 to 11.80 $g/w^{0.75}$), than the DCP intake value reported by Chaudhary and Gupta (1999 and 2000).

Digestibility co-efficient of feed constituents :

Dry matter :

When the dry matter digestibility values presented in Table 2 were critically examined, it was found that the highest and the lowest values were recorded table 63.23 and 61.11 per cent, respectively with an average of 62.41 ± 1.13 per cent in the group I animals. In case of group II animals, the highest and the lowest digestibility values obtained were 59.86 and 57.01 per cent, respectively with an average of 58.29 ± 1.44 per cent. The range of variations in the dry matter digestibility was higher in the group II animals than the dry matter digestibility value found in group I animals. The average dry matter digestibility value was apparently higher (7.06%) in case of animals of group I category than the value obtained in the animals of group II category. The difference in the average dry matter digestibility between the two groups of animals was not significant. The overall (groups) average of dry matter digestibility was found to be 60.35 ± 2.53 per cent. Sankhyan *et al.* (1997) reported slightly lower digestibility (44.8 ± 0.79%) in the sheep than the value found in the present study. The range of variations for the dry matter digestibility obtained in the present study were similar (57.68 to 63.41%) to the earlier findings reported by Mudgal *et al.* (1993) when buffaloes were used as experimental animals. However, contradictory views to the present findings have been reported by Gill and Gill (1979) and Goswami *et al.* (1997) who found 63.5 to 68.18 per cent dry matter digestibility when buffaloes were maintained on the stall and fed conditions.

Crude protein :

It appears from the data presented in Table 2 that

the crude protein digestibility was the highest 70.56 per cent and the lowest 68.82 per cent and the mean value was 69.57 ± 0.89 per cent in the group I animals. In the group B category of animals, the highest crude protein digestibility was 66.43 and the lowest was 65.75 per cent with an average value of 66.02 ±0.36 per cent.

The range of variations recorded in the crude protein digestibility values between the two groups was higher in the males than the values found in the females which indicate significantly ($P < 0.05$) higher crude protein digestibility in the male calves than the female calves. The overall (groups) average of crude protein digestibility was 67.79 ± 2.04 per cent. Sankhyan *et al.* (1997) showed comparatively lower crude protein digestibility value (49.2 ±2.07%) in the sheep than the values found in the present investigation. The present findings are in agreement with the results reported by Gill and Gill (1979); Goswami *et al*. (1997) and Mehra *et al*. (1991) who recorded crude protein digestibility from 65.22 to 70.44 per cent in buffaloes. Some of the Indian Scientists (Mudgal *et al*., 1981; Chopra and Kurar, 1983; Mehra *et al.*, 1990 and Teli *et al*., 1999) have reported lower crude protein digestibility (44.90 to 58.76%) than the values obtained in the present investigation.

Ether extract :

The ether extract digestibility average in the males group (I) was 54.13 ± 1.81 per cent (52.09 to 55.56%), whereas, in the females group (II) the average ether extract digestibility was 50.34 ± 0.49 per cent (49.77 to 50.65%). The ether extract digestibility co-efficient was apparently higher (7.52%) in group I animals than in the group II. The difference in the ether extract digestibility between the two groups was statistically not significant. The overall (groups) average of ether extract digestibility was recorded to be 52.24 ± 2.39 per cent. The ether extract digestibility in the present study was in conformity with the results (51.42 to 55.35%) reported by Mudgal *et al.* (1981); Mehra *et al*. (1990 and 1991) and Mondal *et al.* (1996) but the lower values (60.70 to 84.95%) were recorded by Gill and Gill (1979) and Sastry *et al*. (1999) were reported on buffalo calves.

Crude fibre :

The crude fibre digestibility ranged from 62.68 to 64.40 per cent and the average value being 63.50 ± 0.86 per cent in male calves. In the female calves the crude fibre digestibility values ranged from 60.35 to 61.93 per cent with an average value of 61.10 ± 0.79 per cent (Table 2). The average crude fibre digestibility was apparently higher (3.92%) in the male group than the female group. The difference in the crude fibre digestibility between the two groups did not show any statistical significance. The overall (groups) average of crude fibre digestibility was found to be 62.22 ± 1.67 per cent. Almost similar results (61.91 to 64.13%) of crude fibre digestibility have also been reported by Virk *et al*. (1993) and Goswami *et al.* (1997) when buffaloes were fed on general farm ration. The higher digestibility values (65.59 to 79.59%) has been reported by Mudgal *et al*. (1981); Mehra *et al*.

Table 2 : Digestibility co-efficient of feed components estimated by chromic oxide method

Groups of animals	Dry matter	Crude protein	Ether extract	Crude fibre	Nitrogen-free extract	Total carbohydrates	Total ash	Acid detergent fibre	Neutral detergent fibre
A	62.89	69.35	54.76	63.42	66.97	64.27	35.95	54.89	75.62
B	61.11	89.82	52.09	62.68	63.85	63.20	33.10	52.69	71.95
C	63.23	70.56	55.56	64.40	69.42	69.37	37.16	55.24	76.64
Average ± S.E.	62.41	69.57*	54.13	63.50	66.74	65.71	35.40*	54.27*	74.73*
	±1.13	±0.89	±1.81	±0.86	±2.79	±3.29	±2.08	±1.38	±2.46
D	59.86	66.43	50.65	61.93	65.39	66.05	32.64	52.42	70.76
E	58.00	65.88	50.61	61.04	63.57	62.76	32.56	51.63	68.32
F	57.01	65.75	49.77	60.35	61.79	61.35	30.18	50.99	66.85
Average ± S.E.	58.29	66.02	50.34	61.10	63.58	63.38	31.79	51.68	68.64
	±1.44	±0.36	±0.49	±0.79	±1.80	±2.41	±1.39	±0.71	±1.97
Overall average ± S.E.	60.35	67.79	52.24	62.22	65.16	64.50	33.59	52.97	71.69
	±2.53	±2.04	±2.39	±1.67	±2.72	±2.85	±2.53	±1.72	±3.89

* indicates significance of value at P=0.05

(1990) and Chauhan *et al.* (1997) in case of buffaloes. Comparatively lower crude fibre digwstibility values (45.00 to 59.00%) reported by Gill and Gill (1979); Sharma *et al*. (1981); Mehra *et al*. (1991) and Sastry *et al*. (1999) when buffaloes were fed on different farm rations.

Nitrogen-free extract :

The values shown in Table 2 indicate that the highest and the lowest nitrogen-free extract digestibility were recorded to be 69.42 and 63.82 per cent, respectively, with an average digestibility being 66.74 ± 2.79 per cent in the group I category of animals. In case of group II animals, the highest and the lowest nitrogen-free extract digestibility values were found to be 65.39 and 61.79 per cent, respectively and the average value being 63.58 ± 1.80 per cent. The average nitrogen-free extract digestibility was apparently higher (4.97%) in case of the group I animals than the values found in group II animals. The difference in the nitrogen-free extract digestibility between the two groups of animals was not significant. The overall (groups) average of nitrogen-free extract digestibility was found to be 65.16 ± 2.72 per cent. The range of variations in nitrogen-free extract digestibility found in the present case were at par with the values (61.76 to 69.1%) reported by Gill and Gill (1979) and Mudgal *et al*. (1981) whereas, nitrogen-free extract digestibility (47.49 to 59.45%) were slightly lower than those reported by Sharma *et al*. (1981); Chopra and Kurar (1983); Mehra *et al.* (1990 and 1991) ; Virk *et al.* (1993) and Sastry *et al*. (1999) in case of buffaloes. However, other workers (Chauhan *et al*., 1997 and Goswami *et al*., 1997) reported higher (70.27 to 76.51%) nitrogen-free extract digestibility than the values recorded in the present study.

Total carbohydrates :

The total carbohydrates digestibility obtained varies from 63.02 to 69.37 per cent with an average of 65.61 ± 3.29 per cent in case of group I category of animals (Table 2). In the case of group II animals the total carbohydrates digestibility varied from 61.35 to 66.05 per cent with an average of 63.38 ± 2.41 per cent. The average total carbohydrates digestibility was apparently higher (3.51%) in case of group I animals than the values obtained in the group II animals. The difference in the total carbohydrates digestibility between the two groups of animals did not show any statistical significance. The overall (groups) average of the total carbohydrates digestibility recorded was 64.50 ± 2.85 per cent. The total carbohydrate digestibility values found in the present study can directly be correlated with the values (62.96 to 67.50%) reported by some other workers (Singh, 1975-78; Mehra *et al.*, 1990 and Pathak *et al.*, 1997) engaged in bovine nutrition. Nooruddin and Roy (1985); Srivastava *et al.* (1985); Mehra *et al.* (1991) and Sastry *et al*. (1999) have reported comparatively lower total carbohydrates digestibility (53.30 to 60.09%) than the results obtained in the present investigation.

Total ash :

A perusal of the data presented in Table 2 depicts that the digestibility co-efficient of the total ash, in case of group 1 category of animals, ranged from 33.10 to 37.16 per cent with an average of 35.40 ± 2.08 per cent. In case of group II animals, the total ash, digestibility ranged between 30.18 and 32.64 per cent with a mean value of 31.79 ± 1.39 per cent. The average total ash digestibility recorded in group I animals was significantly higher ($P < 0.05$) than the values found in the group II animals. The overall (groups) average of total ash digestibility value found in the present case was within the range as reported by Singh, 1975-78 when cattle were fed on range and stall fed conditions. Srivastva *et al.* (1985) reported slightly higher (38.35 to 39.90%) total ash digestibility than the values obtained in the present investigation.

Acid detergent fibre (ADF) :

It is clear from the data presented in Table 2 that the acid detergent fibre digestibility varied from 52.69 and 55.24 per cent with an average of 54.27 ± 1.38 per cent in the group I category of animals whereas, the acid detergent fibre digestibility was ranged between 50.99 to 52.42 per cent with an average of 51.68 ±0.71 per cent in the group II category of animals. The range of variations in the acid detergent fibre digestibility as well as the average value were higher ($P < 0.05$) in case of group I animals than the value recorded in the group II animals. The overall (groups) average of acid detergent fibre digestibility was found to be 52.97 ± 1.72 per cent. Sankhyan *et al*. (1997) reported comparatively lower values in sheep (39.5 ± 1.10%) than the values obtained in the present investigation. The range of variation in the

acid detergent fibre digestibility observed in the present study were almost similar to the values (54.12 to 55.18%) reported by Virk *et al.* (1993) and Mondal *et al*. (1996). Srivastava *et al*. (1985) and Teli *et al*. (1999) reported acid detergent fibre digestibility value ranging from 39.70 to 49.10 per cent, which were slightly lower than the values obtained in the present study.

Neutral detergent fibre (NDF) :

A perusal of the data presented in Table 2 depicts that the average neutral detergent fibre digestibility was 74.73 ± 2.46 per cent which varied from 71.95 to 76.64 per cent in the group I animals. In case of group II animals, the neutral detergent fibre digestibility ranged between 66.85 and 70.76 per cent with an average of 68.64 ± 1.97 per cent. The mean value was significantly ($P < 0.05$) higher in the case of group I animals than the values recorded in the group II category of animals. The overall neutral detergent fibre digestibility irrespective of groups was 71.69 ± 3.89 per cent. Sankhyan (1997) reported comparatively lower neutral detergent fibre digestibility (37.2 ± 0.63) in the sheep than the results obtained in the present investigation. The neutral detergent fibre digestibility value found in the present study was similar to the findings (68.69 to 75.15%) of Mehra *et al*. (1990) and Virk *et al*. (1993) when buffaloes were the test case. Mondal *et al*. (1996) and Teli *et al*. (1999) reported comparatively higher neutral detergent fibre digestibility (43.30 to 54.71%) than the values recorded in the present study.

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