



## Comparison of nutrient intake and digestibility, rumen fermentation along with body weight gain in cattle and buffalo fed maintenance diet

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### ABSTRACT

In the present study, feed and nutrient intake, body weight changes, nutrient digestibility and rumen fermentation parameters were compared in cattle and buffaloes. Seven cattle (T<sub>1</sub>) and seven buffaloes (T<sub>2</sub>) were placed in two groups based on body weight employing completely randomized design. Experimental feeding in the form of total mixed ration (TMR) was carried out for 75 days having concentrate (C) and roughage (R) in 30C:70R. The daily intake of dry matter, crude protein, digestible crude protein and total digestible nutrients was non-significant between cattle and buffaloes. While in terms of percentage and metabolic body weight, the same parameters were significantly lower in cattle compared to buffalo. Digestibility of DM, OM, CP, EE, CF, NFE, NDF and ADF marginally differed between cattle and buffaloes. Rumen liquor pH, ammonia, non-protein and soluble nitrogen concentration was non-significantly different between cattle and buffaloes with significant lower value of total volatile fatty acids (12.25 vs. 14.19 mM/dl), total nitrogen (90.53 vs. 101.73 mg/dl) and TCA precipitable nitrogen (51.33 vs. 61.36 mg/dl) in cattle compared to buffaloes. Thus, from the study, it may be concluded that under similar feed and managemental conditions, intake of dry matter and nutrients per unit of body weight was lower, with non-significant difference in nutrients digestibility and inferior nitrogen fermentation as observed in cattle than buffaloes.

**Keywords:** Body weight, Buffaloes, Cattle, Nutrient intake, Nutrient digestibility, Rumen fermentation, TMR

The nutritional comparison of crossbred cattle and buffaloes under the similar feeding, management and environmental conditions is a challenging task as both are classified as ruminant ungulates. In both cattle and buffaloes, the rumen is the central to nutritional study owing to the fermentation of cellulosic material and producing fermentation end-products, i.e. volatile fatty acids (VFAs) and microbial proteins (Chanthakhoun *et al.* 2012, Lwin *et al.* 2012, Jabari *et al.* 2014, Franzolin and Wright 2016). Some differences in intake, digestibility, rumen microbiota population, behavioral, habit, conversion of feed to milk, meat and adaptation to the environment (Khejornart *et al.* 2011, Rafiei *et al.* 2013, Chanthakhoun *et al.* 2012, Iqbal *et al.* 2018, Singh *et al.* 2018, Malik *et al.* 2021) exist between cattle and buffaloes. The feed efficiency of the cattle and buffalo depends on the type of diet, ability to digest and utilize the end products keeping losses to a minimum (Chanthakhoun *et al.* 2011). In several ways, swamp buffaloes outperform cattle, including nitrogen (N) recycling and fibre digestion, as well as ruminal ammonia nitrogen (NH<sub>3</sub>-N) levels in connection to effective fermentation (Wanapat *et al.* 1994, Chanthakhoun *et al.* 2012, Wanapat *et al.* 2016). In several

experimental conditions, the buffaloes have shown higher ruminal ammonia and VFA concentration than cattle (Iqbal *et al.* 2018 and Devendra 2002). Higher concentrations of bacteria were detected in the rumen of the buffaloes than cattle on various feeding system (Pant and Roy 1970, Singh *et al.* 2013 and Iqbal *et al.* 2018). They also observed higher proteolytic and cellulolytic bacteria population in the rumen of buffalo fed wheat straw and concentrate based diet compared to cattle. In the presence of similar sources of energy, the rumen micro-organisms of the buffalo can withstand higher concentrations of urea nitrogen than zebu cattle. According to Ranjhan and Pathak (1979), buffalo digest 2 to 5% more nutrient than cattle. With this background, the present study was carried out to determine effect of cereal straw based total mixed ration (TMR) in cattle and buffalo on voluntary feed and nutrient intake, body weight, rumen fermentation profile and nutrient digestibility.

### MATERIALS AND METHODS

*Ethical statement:* The protocol of experiment was sanctioned by Institutional Animal Ethical Committee (IAEC) of the College of Veterinary Science and Animal Husbandry, Anand Agricultural University (AAU), Anand vide sanction no. 335/ANRS/2021. Animals were cared and managed as per protocol and directives of IAEC.

*Animal grouping and total ration preparation:* Two

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group of seven cattle ( $T_1$ ) and seven buffalo ( $T_2$ ) were formed based on body weight ( $395.04 \pm 44.18$  and  $401.43 \pm 13.26$  kg) at Animal Nutrition Research Station and Reproductive Biology Research Unit, College of Veterinary Science and Animal Husbandry, AAU, Anand for 75 days of the comparative study. They were dewormed and vaccinated before starting the experiment. They were housed in well ventilated concrete floored sheds having individual feeding and watering facilities. All animals were fed total mixed ration (TMR) having 30:70 concentrate (C) to roughage (R) ratio to meet their nutrients needs (ICAR 2013). TMR was prepared using wheat straw, maize, soybean meal, deoiled rice bran, molasses and mineral mixture 70, 5, 7, 7, 10, and 1 (kg/100 kg), respectively. TMR was supplemented with vitamin A, D<sub>3</sub> and E @ 24000 IU, 7200 IU and 120 mg/100 kg, respectively.

**Animal feeding:** Animals were fed two times daily at 9:00 and 16:00 h. Clean and wholesome water was provided *ad lib.* to all animals. They were let loose for exercise for two hours in the morning and one hour in the afternoon under controlled conditions. The daily feed intake was calculated considering left over on next morning. The experimental animals were weighed fortnightly for two consecutive days in the morning (8.00 AM) before feeding and watering using electronic weighing balance.

**Digestibility of nutrients:** Digestion trial of seven days after adaption of 21 days was conducted on all 14 experimental animals. Quantitative record of feed consumed, refusal and faeces voided by each cattle and buffalo was maintained during the entire trial period. Representative samples of feeds offered, residue leftover and faeces voided during the digestion trial were analyzed for proximate and fibre fractions as per AOAC (1995) and Van Soest *et al.* (1991), respectively.

**Rumen fermentation:** Rumen liquor (150 ml) was collected from each experimental animal at 0, 3 and 6 h post feeding through a stomach tube applying negative pressure created with suction pump (Lane *et al.* 1968). The rumen liquor was immediately brought to the laboratory and strained through four layered muslin cloth under continuous CO<sub>2</sub> infusion and was referred as Strained Rumen Liquor (SRL). The pH was determined immediately after collection using portable digital pH meter. The samples of SRL were analysed for ammonia-N (Pearson and Smith 1943) and total-N by Kjeldahl's method. Soluble-N in supernatant of SRL after centrifuging was estimated by Kjeldahl's method and non-protein nitrogen was estimated by Trichloro-acetic acid precipitation of SRL in supernatant by Kjeldahl's method. The concentration of total VFA was determined by the steam distillation method (Barnett and Reid 1957), using Markham micro-distillation apparatus.

**Statistical analyses:** The experimental design used was completely randomized design. The mean of value was presented with standard error. The experimental data were subjected to one-way analysis of variance (ANOVA) as per the methods of Snedecor and Cochran (1994). The difference between treatment means were considered

significant at less than 5% level.

## RESULTS AND DISCUSSION

**Nutrient intake and body weight changes:** The chemical composition of TMR is given in Table 1. The nutrients

Table 1. Chemical composition of total mixed ration (TMR) (% on dry matter basis)

Parameter	TMR
Crude protein	7.55
Ether extract	1.85
Crude fibre	33.03
Nitrogen-free extract	44.04
Total ash	13.53
Organic matter	86.47
Neutral detergent fibre	58.84
Acid detergent fibre	38.72

of TMR were sufficient to meet crude protein and total digestible nutrients requirement of animals as revealed by positive weight changes in both groups (Table 2). The daily intake of dry matter and nutrients like crude protein (CP), digestible crude protein (DCP) and total digestible nutrient (TDN) were non-significant between the group and was numerically higher in buffalo as compared to cattle. The same on percent and metabolic body weight basis was significantly ( $P < 0.05$ ) higher in buffalo compared to cattle. The body weight gain of crossbred cattle ( $T_1$ ) was significantly higher than buffalo ( $T_2$ ) indicating better utilization and conversion of nutrients. Even though, regulation of DMI is considered as a complex mechanism, influenced by stimulatory and inhibitory signals based on

Table 2. Body weight and nutrient intake of cattle and buffaloes fed TMR

Attribute	$T_1$ (Cattle)	$T_2$ (Buffalo)
<b>Body weight (kg)</b>		
Initial	$395.04 \pm 44.18$	$401.43 \pm 13.26$
Final	$419.43 \pm 1.74$	$416.29 \pm 2.31$
Change	$24.39 \pm 6.42$	$14.86 \pm 3.71$
<b>Daily intake</b>		
DM (kg)	$8.21 \pm 0.10$	$8.74 \pm 0.08$
CP (g)	$575.23 \pm 7.32$	$611.99 \pm 5.43$
DCP (g)	$306.77 \pm 3.90$	$331.57 \pm 2.94$
TDN (kg)	$4.25 \pm 0.05$	$4.59 \pm 0.04$
DM (kg/100 kg BW)	$1.98^b \pm 0.02$	$2.12^a \pm 0.02$
CP (g/100 kg)	$139.33^b \pm 1.38$	$148.85^a \pm 1.48$
DCP (g/100 kg BW)	$74.30^b \pm 0.73$	$80.64^a \pm 0.80$
TDN (kg/100 kg BW)	$1.03^b \pm 0.01$	$1.11^a \pm 0.01$
DM (g/kg $W^{0.75}$ )	$89.25^b \pm 0.93$	$95.70^a \pm 0.89$
CP (g/kg $W^{0.75}$ )	$6.24^b \pm 0.06$	$6.69^a \pm 0.06$
DCP (g/kg $W^{0.75}$ )	$3.33^b \pm 0.04$	$3.62^a \pm 0.03$
TDN (g/kg $W^{0.75}$ )	$46.21^b \pm 0.48$	$50.25^a \pm 0.47$

TMR, total mixed ration; DM, dry matter; CP, crude protein; DCP, digestible crude protein; TDN, total digestible nutrient. Means with different superscripts (a,b) in a row differ significantly ( $P < 0.05$ ).

energy requirement, sensory effect of feed, habitual factors, ruminal distension, rumen osmolarity, fuel sensing by tissue intake and concentrate to roughage ratio (Cantalapiedra-Hijar *et al.* 2009, NRC 2021).

Similarly, Sinha *et al.* (2016) reported non-significant differences in daily intake of dry matter, gross, digestible and metabolizable energy between group of cattle and buffalo fed three total mixed diet having 60:20:20, 40:30:30 and 20:40:40 ratio of concentrate: wheat straw: green maize, respectively whereas ME and NE intake on metabolic body weight basis was significantly higher in buffalo group than cattle. A non-significant difference in daily intake dry matter (Garg *et al.* 2014), dry matter, organic matter, crude protein and NDF (Maeda *et al.* 2012), total dry matter and crude protein intake (Lapitan *et al.* 2004) also reported between group of cattle and buffalo fed supplemented balanced ration diet with 40% concentrate + 60% roughage, and diet consisted of 50% corn silage, 30% wet brewer's spent grains and 20% concentrate mixture, respectively.

Contrary to the present findings, Singh *et al.* (2018) observed significantly higher daily intake of dry matter, neutral detergent fibre (NDF), acid detergent fibre (ADF) and ether extract in buffalo compared to cattle fed total mixed rations.

**Nutrient digestibility:** Digestibility coefficients of DM, OM, CP, EE, CF, NFE, NDF, ADF, cellulose and hemicellulose did not differ significantly among the groups. However, buffalo digested higher CF (5.04%), NDF (2.22%), and ADF (2.17%) as compared to cattle (Table 3). A slower digesta passage from the reticulo-rumen (Pradhan *et al.* 1991), more active cellulases from *Fibrobacter succinogenes* and *Ruminococcus flavefaciens* (Kudo *et al.* 1991) resulted in faster digestion of crop residues incubated in the reticulo-rumen (Wanapat 1989) which may be the

Table 3. Nutrient digestibility (%) of cattle and buffaloes fed TMR

Attribute	T <sub>1</sub> (Cattle)	T <sub>2</sub> (Buffalo)	% change over cattle
DM	51.98±0.51	52.15±1.48	+0.33
OM	58.63±0.59	57.49±1.44	-1.94
CP	53.33±1.78	54.18±2.05	+1.59
EE	70.27±0.41	71.29±1.92	+1.45
CF	53.73±2.27	56.44±1.46	+5.04
NFE	61.31±0.97	60.86±1.36	-0.17
NDF	49.08±1.04	50.17±1.69	+2.22
ADF	47.82±1.20	48.86±1.39	+2.17

TMR, total mixed ration; DM, dry matter; OM, organic matter; CP, crude protein; EE, ether extract; CF, crude fibre; NFE, nitrogen free extract; NDF, neutral detergent fibre; ADF, acid detergent fibre.

reason that buffaloes have higher digestibility than their cattle counterparts. Paul and Lal (2010) reported that cattle and buffaloes when fed on roughage-based diet, dry matter (DM) and crude fiber (CF) digestibility were 4.5% and 4.6% higher in buffaloes, respectively.

Singh *et al.* (2018) also observed non-significant digestibility of dry matter, organic matter, hemicellulose and crude protein between group of cattle and buffalo fed total mixed rations. A non-significant difference in digestibility of DM, OM, EE, non-fibrous carbohydrate-NFC, NDF, ADF, and TDN was reported by Lapitan *et al.* (2004) and Maeda *et al.* (2012) between cattle and buffaloes fed diet having 40% concentrate + 60% roughage and corn silage + wet brewer's spent grains + concentrate mixture, respectively.

A better digestive ability of DM, OM, CP, NDF, ADF, cellulose and hemicelluloses was observed in buffaloes

Table 4. Rumen fermentation profile of cattle and buffaloes fed TMR

Attribute	Treatment	0 h	3 h	6 h	Mean
pH	Cattle (T <sub>1</sub> )	7.07	6.84	7.09	7.00±0.08
	Buffalo (T <sub>2</sub> )	7.07	6.93	7.05	7.01±0.04
TVFA (mM/dl)	Cattle (T <sub>1</sub> )	11.13 <sup>z</sup>	13.35 <sup>x</sup>	12.28 <sup>y</sup>	12.25 <sup>b</sup> ±0.91
	Buffalo (T <sub>2</sub> )	12.00 <sup>z</sup>	15.88 <sup>x</sup>	14.70 <sup>y</sup>	14.19 <sup>a</sup> ±1.58
TN (mg/dl)	Cattle (T <sub>1</sub> )	89.25 <sup>y</sup>	95.55 <sup>x</sup>	86.80 <sup>y</sup>	90.53 <sup>b</sup> ±2.57
	Buffalo (T <sub>2</sub> )	97.65 <sup>y</sup>	112.35 <sup>x</sup>	95.20 <sup>y</sup>	101.73 <sup>a</sup> ±6.00
NH <sub>3</sub> -N (mg/dl)	Cattle (T <sub>1</sub> )	10.85 <sup>y</sup>	14.18 <sup>x</sup>	11.38 <sup>y</sup>	12.13±1.36
	Buffalo (T <sub>2</sub> )	12.08 <sup>y</sup>	15.75 <sup>x</sup>	10.15 <sup>z</sup>	12.65±1.50
NPN (mg/dl)	Cattle (T <sub>1</sub> )	26.95 <sup>y</sup>	31.15 <sup>x</sup>	26.60 <sup>y</sup>	28.23±1.71
	Buffalo (T <sub>2</sub> )	30.80 <sup>y</sup>	35.00 <sup>x</sup>	24.15 <sup>z</sup>	29.98±1.71
SN (mg/dl)	Cattle (T <sub>1</sub> )	35.00 <sup>y</sup>	47.60 <sup>x</sup>	35.00 <sup>y</sup>	39.20±5.14
	Buffalo (T <sub>2</sub> )	36.75 <sup>y</sup>	50.05 <sup>x</sup>	34.30 <sup>y</sup>	40.36±5.43
TCA precipitable N (mg/dl)	Cattle (T <sub>1</sub> )	54.25	47.95	51.80	51.33 <sup>b</sup> ±2.57
	Buffalo (T <sub>2</sub> )	60.90	62.30	60.90	61.36 <sup>a</sup> ±0.57

TMR, total mixed ration; TVFA, total volatile fatty acids; TN, total nitrogen; NH<sub>3</sub>-N, ammonia nitrogen; NPN, non-protein nitrogen; SN, soluble nitrogen; TCA precipitable N, trichloroacetic acid precipitable nitrogen. Means within a row and species with different superscripts (x,y,z) differ significantly (P<0.05). Means within a column and parameters with different superscripts (a,b) differ significantly (P<0.05).

than cattle (Agarwal *et al.* 2009, Chanthakhoun *et al.* 2012, Singh *et al.* 2018) on feeding total mixed rations, and poor-quality roughage. Greater digestibility of fibre fraction in buffaloes than in cattle may be attributed to more cellulolytic bacterial population and greater fibrolytic activity of adherent microbes in the buffaloes than cattle (Singh *et al.* 2013). The variation in digestibility of nutrients may be attributed to breed variation within the species of cattle and buffaloes.

**Rumen fermentation:** Rumen fermentation parameters are given in Table 4. Mean strained rumen liquor (SRL) pH, ammonia nitrogen (NH<sub>3</sub>-N), non-protein nitrogen (NPN) and soluble nitrogen (SN) of cattle and buffalo groups differed non-significantly ( $P>0.05$ ). It indicates stable rumen fermentation and no adverse effect due to feeding of total mixed rations in both the species. Significant ( $P<0.05$ ) higher value of total volatile fatty acids (TVFA), total nitrogen (TN), trichloro acetic acid precipitable nitrogen (TCAP-N) was noted in buffaloes compared to cattle. The higher concentration of TVFA and nitrogen fractions might have stabilized the rumen pH of buffaloes. The periodical study revealed that rumen pH lowers at 3 h after feeding and again elevated at 6 h post feeding with statistically non-significant periodical difference. The concentration of TVFA and all nitrogen fractions except TCAP-N was found significantly ( $P<0.05$ ) elevated at 3 h and normalized at 6 h post-feeding to pre-feeding level, except NPN which was significantly ( $P<0.05$ ) lower than before feeding. The concentration of TCAP-N in SRL showed only numerical difference at different post feeding period in cattle and buffaloes.

Similarly, non-significant difference in rumen pH (6.5 vs. 6.4) and ammonia (28.9 vs. 31.6 mg/dl) between dairy cattle (*Bos taurus*) and buffalo (*Bubalus bubalis*), and significantly higher TVFA (151.8 vs. 88.7 mM) concentration in buffaloes than cattle was reported by Chiariotti *et al.* (2020) due to significantly higher number of protozoal counts in buffaloes and only existence of *Epidinium* genera (*E. cuadatum* and *E. ecuadatom*) and *D. crystagali* in buffalo rumen. Chanthakhoun and Wanapat (2012) observed significantly higher ( $P<0.01$ ) concentration of TVFA and butyrate in buffalo compared to cattle. It may be due to higher cellulolytic bacterial population and fibrolytic activity of microbes (Singh *et al.* 2013). Franzolin *et al.* (2010) also observed no difference ( $P>0.05$ ) in ruminal pH between buffaloes and cattle. Malik *et al.* (2021) observed non-significant difference in NH<sub>3</sub>-N concentration between cattle and buffaloes.

In contrast, Sousa *et al.* (2000) showed higher ( $P<0.01$ ) ruminal pH in buffaloes (pH=6.78) compared to cattle (pH=6.58) fed diets containing different proportions of neutral detergent fibre. Zanetti *et al.* (1995) found higher ruminal ammonia nitrogen (17.18 mg/dl) in buffaloes compared to the cattle (11.93 mg/dl) at 2 h post feeding on diet composed of coast cross hay, ground corn and cottonseed meal. Devendra (2002) reported higher ruminal NH<sub>3</sub>-N in swamp buffaloes than cattle. Iqbal *et al.* (2018)

also reported non-significant higher concentrations of total VFA, acetate and propionate in buffalo than those in Jersey cows. The higher NH<sub>3</sub>-N concentration in rumen liquor of buffaloes owing to higher proteolytic activity than cattle, was proposed (Paliwal and Sagar 1990) and confirmed (Bhatia *et al.* 1992).

It may be concluded that under similar feed and managemental conditions, intake of dry matter and nutrients per unit of body weight was lower, with non-significant difference in nutrients digestibility and inferior nitrogen fermentation as observed in cattle than buffaloes. The body weight gain of the cattle was higher than buffaloes, indicating better nutrients utilization.

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