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Effect of Plane of Nutrition on Nutrient Utilization in Pre-partum Murrah Buffaloes and Birth Weight of Their Calves

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ABSTRACT

The present study was conducted to ascertain the effect of feeding a higher level of metabolizable energy and metabolizable protein on feed intake, nutrient utilization, and optimizing their calves' birth weight. Eighteen pregnant Murrah buffaloes in the last trimester of pregnancy were distributed into three groups (n=6) based on average body weight (629.69±15.05 kg) and lactation number (3.27±0.05). The feeding trial was conducted 90 days before prepartum. Group T_1 (Control) was fed as per ICAR (2013) recommendation, whereas animals in group T_2 (HME) were offered 30% higher energy and group T_3 (HMP) were offered 40 % higher protein than ICAR (2013) recommendation. Concentrate mixture and green fodder were offered to an individual animal as per experimental protocol. Dry matter intake (DMI) was similar among the groups. Average daily body weight gain was higher ($P<0.05$) in HMP, followed by HME and control group. It was observed that apparent digestibility coefficients (%) of dry matter, organic matter, ether extract, neutral detergent fibre and acid detergent fibre were higher ($P<0.05$) in groups HMP and HME as compared to control, the differences between HMP and HME were non-significant. Birth weight of calves was higher ($P<0.01$) in HMP than HME groups as compared to control, however, the best response was observed in group HMP. It was concluded that the higher levels of protein in the diet of pregnant Murrah buffaloes during last trimester can produce increased calf birth weight compared to high levels of energy.

Key Words: High energy, High protein, Murrah buffalo, Digestibility, Birth weight of calf

INTRODUCTION

The buffaloes is considered as the main dairy animals in India, contributing 51% to the country's total milk production (BAHFS, 2015). In the world, India is the leader in buffalo population with 108.7 million buffalo heads, which is 56.75 per cent of the world's buffalo population (20th livestock census, 2019). Diversity of the buffaloes in India is represented by 19 registered and well-defined breeds along with non-descript populations. Murrah is the prominent buffalo breed in the country, followed by Surti, Mehesana and Jafarabadi. (Vohra *et. al.,* 2016).

Maternal nutritional status is one of the extrinsic factors programming nutrient partitioning and ultimately growth, development, and function of the major fetal organ systems (Wallace *et al.,* 1999; Godfrey and Barker, 2000). Generally, puberty in Murrah buffalo heifers is attained at the age of 34 months. This delay in puberty is due to mainly two reasons; first reason underfeeding during the growing period with a lower average daily gain. Secondly, it is also due to lower birth weight. The growth of calves depends on birth weight. Therefore, birth weight is a major factor in reducing time taken to attain puberty and the age of first calving. If the mother is severely underfed during the last three months of pregnancy, it might affect the young, causing death *in utero* or reducing viability at birth (Mc Donald, 2002). Therefore, proper nutrition is required during this phase. It was hypothesized that feeding of higher energy and protein than that recommended by ICAR (2013) during advanced pregnancy might be beneficial. The specific objective of the study was to monitor the effects of feeding 40% higher levels of dietary protein and 30% higher levels of dietary energy than the recommendation of ICAR (2013) during the last trimester of pregnancy on nutrient utilization in dame and the birth weight of the calves.

MATERIALS AND METHODS

Eighteen Murrah buffaloes in last trimester of pregnancy were distributed into three groups (n=6) based on average body weight (629.69±15.05 kg) and

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lactation number (3.27±0.05). These animals were divided into three groups (six animals in each group) based on the body weight and lactation number as T_1 (Control), T_2 (HME) and T_3 (HMP). Physical compositions of different concentrate mixtures are presented in Table 1. The animals in control group were fed as per ICAR (2013) feeding standards. Buffaloes in HME group were fed 30% more energy while protein and other nutrients were fed as per ICAR (2013) feeding standards. Animals in HMP group were fed 40% more protein while energy and other nutrients were fed as per ICAR (2013) feeding standards. All three groups were fed mineral mixture and common salt at 60 g/day and 30g/day, respectively. All animals were fed their respective concentrate mixture, green fodder and wheat straw in the form of total mixed ration (TMR) Before

Table 1. Chemical composition of fodder and feed ingredients

Nutrients	Maize grain	Soybean meal	Maize fodder	Sorghum fodder	Berseem fodder	Wheat straw	Control	HME	HMP
Dry matter	90.12± 0.31	90.32± 0.62	21.50± 0.43	22.45± 0.36	17.45± 0.49	90.89± 0.87	89.37± 0.24	90.22± 0.32	90.79± 0.48
on % DM basis									
Organic matter	94.80± 0.47	94.60± 0.65	90.53± 0.52	90.29± 0.45	90.53± 0.13	89.97± 0.62	92.30± 0.45	92.84± 0.48	92.96± 0.32
Crude protein	9.80± 0.31	45.50± 0.23	10.13± 0.34	9.55± 0.25	18.50± 0.25	4.15± 0.26	19.50± 0.36	20.50± 0.36	27.30± 0.41
Ether extract	4.11± 0.13	1.70± 0.15	2.16± 0.16	2.04± 0.95	2.10± 0.17	1.05± 0.27	3.20± 0.18	3.40± 0.29	3.30± 0.26
NDF	22.05± 0.45	18.01± 0.36	62.70± 0.39	63.10± 0.56	48.10± 0.44	77.70± 0.38	21.20± 0.93	20.80± 0.54	20.70± 0.24
Ash	5.20± 0.32	5.40± 0.17	9.47± 0.48	9.71± 0.35	9.47± 0.39	10.03± 0.37	-	-	-
ME (MJ/kg)	-	-	8.24± 0.77	-	-	6.90± 0.17	6.30± 0.25	8.25± 0.26	5.90± 0.48
MP (g/kg)	-	-	6.45± 0.27	-	-	0	16.5± 0.74	17.5± 0.78	23.80± 0.79
Cell wall constituent analyses of fodder and feed ingredients (% DM basis)									
NDICP	1.97± 0.56	9.2± 0.42	3.02± 0.24	3.39± 0.16	6.39± 0.45	2.08± 0.77			
ADICP	0.5± 0.39	0.9± 0.24	1.78± 0.39	2.19± 0.67	3.29± 0.28	1.03± 0.37			
ME(MJ/kg)	12.61± 0.37	14.72± 0.28	8.24± 0.77	7.87± 0.56	8.83± 0.23	6.90± 0.17			
MP(g/kg)	6.24± 0.77	27.75± 0.47	6.45± 0.27	5.50± 0.37	11.02± 0.29	0 -			
TDN (%)	78.45± 0.36	79.29± 0.25	59.95± 0.46	52.42± 0.67	55.54± 0.58	41.53± 0.33			

NDF, neutral detergent fibre; ADF, acid detergent fibre; ME, metabolizable energy; MP, metabolizable protein; NDICP, neutral detergent insoluble crude protein; ADICP, acid detergent insoluble crude protein; HME, 30% higher ME than ICAR (2013); HMP, 40% higher protein than ICAR (2013) the start of the experimental feeding, animals were dewormed for control of both internal and external parasites. Fortnightly body weight was taken during experimental duration of 90 days.

A metabolic trial was conducted around 30 days prior to parturition to determine the nutrient digestibility. Representative samples of feed offered, faeces voided, and urine excreted were collected and brought to the laboratory for suitable aliquoting (Schneider and Flatt, 1975) of biological samples. The feed, left over residues, and faecal samples were analyzed for their proximate composition (AOAC, 2005) and cell wall constituents (Van Soest *et al.,* 1991). Neutral detergent insoluble CP (NDICP), acid detergent insoluble CP (ADICP), total digestible nutrients (TDN), metabolizable energy (ME) and metabolizable protein (MP) were calculated according to NRC (2001).

Blood samples were collected from the jugular vein using a heparinized vacutainer in the morning before offering food. Plasma was obtained by centrifuging at 3000×g for 10 min and frozen at -20ºC for later analysis of blood parameters. IgG was quantified by coomercial kit (Bioassay Laboratory technique ELISA kit) following manufacturer's instruction.

Data on various parameters (body weight, DMI) were analyzed by one way ANOVA method of Snedecor and Cochran (2004) using the Statistical Analysis System (2000). Data are presented as mean ± SE. Differences with probabilities ($P<0.05$; $P<0.01$) were considered significant.

RESULTS AND DISCUSSION

The detailed chemical composition of feed ingredients is presented in Table 1. Dry matter Intake (DMI) and digestibility coefficients of dry matter (DM), organic matter (OM0, crude protein (CP), ether extract (EE), neutral detergent fibre (NDF) and acid detergent fibre (ADF) are presented in table 2. The DMI in HME and HMP was higher ($P<0.05$) than in the control. Since the gestation period advances, dry matter requirement also increases. From the third fortnight onwards, the dry matter intake increased in all three groups, and it

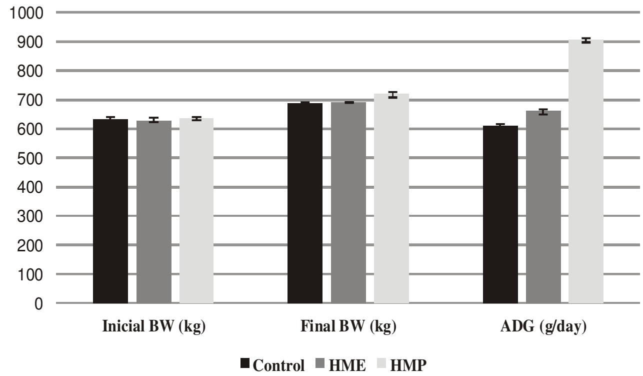

Fig. 1. Bodyweight and body weight gain in various groups

gradually decreased before 10-15 days of parturition. Jabbar, (2004) found that DMI increased on both higher energy and higher protein levels of the feed than the control group in lactating Nili-Ravi buffaloes. The increasing dietary energy density improved DM intake (Vazquez-Anon *et al.,* 1997). Based on the above reviews, it was inferred that the higher energy and higher protein levels in the feed increases the DMI. In contrast, another report indicated that there was no effect of varying energy and protein levels on DM intake (Broderick, 2003).

Apparent digestibility of CP, NDF and ADF were higher ($P<0.05$) in HMP followed by HME as compared to control. Similarly, El-Ashry *et al.* (2003) reported that the buffaloes fed with the diet containing higher energy level recorded highest digestibility of DM, CP, CF and EE. Similarly, in the present study, the digestibility of nutrients in the HME group was found to be significantly higher than control. It is known that apparent digestibility of CP increased with increased dietary level of protein (Das and Singh, 1999; Lohakare *et al.* 2006; Singh *et al.,* 2009). Nevertheless, Malik *et al.* (1998) reported that the digestibility of CP was not affected by the levels of feed intake. Data pertaining to nitrogen balance are presented in table 2. N excretion in faeces and N excretion in urine was affected by different levels of ME and MP in the diet. The nitrogen retention was found higher ($P<0.05$) in group HMP followed by HME and control. Increased nitrogen intake at constant dietary energy level did not increase nitrogen digestibility but increased nitrogen retention

Table 2. Intake and digestibility of nutrient, and nitrogen balance

Particulars	Control	HME	HMP
Body weight (kg)	653.50±9.10	648.34±3.60	657.29±8.30
DMI (kg/d)	17.39^{a}±0.70	17.54^{ab}±0.90	17.74^{b}±0.40
DMI (% BW)	2.68±0.36	2.72±0.25	2.69±0.92
CPI (g/d)	1766.12±38.15	1727.29±36.89	2480.13±31.23
CPI (g/100kg BW)	2.70±0.40	2.67±0.60	3.78±0.70
TDN intake (kg/d)	8.05±1.34	10.98±0.24	7.96±1.75
MPI(g/100kg BW)	143.23±4.80	144.22±4.73	197.19±9.38
MEI(MJ/100kg BW)	18.44±0.12	25.54±0.44	18.68±0.35
Digestibility (%) of nutrients			
Dry matter	62.36^{a}±0.6	65.25^{b}±0.7	65.73^{b}±0.8
Organic matter	67.59^{a}±0.2	71.22^{b}±0.4	72.33^{b}±0.8
Ether extract	67.28^{a}±0.7	72.67^{b}±0.4	71.05^{b}±0.5
Crude protein	61.27^{a}±0.8	63.17^{b}±0.5	69.84^{c}±0.2
Neutral detergent fibre	52.58^{a}±1.1	50.67^{ab}±0.1	55.81^{b}±0.4
Acid detergent fibre	31.71^{a}±0.8	32.61^{ab}±0.4	35.19^{b}±0.3
Nitrogen balance			
Total N intake (g/d)	292.9^{a}±5.90	297.4^{a}±6.70	314.5^{b}±7.70
N excreted in faeces (g/d)	129.17±11.95	133.89±9.45	141.18±8.75
N excreted in urine (g/d)	139.02±6.74	132.99±4.57	134.26±15.89
Total N excreted (g /d)	268.19±7.73	266.88±5.07	275.44±11.39
Total N retention (g/d)	24.71^{a}±2.39	30.52^{b}±2.18	39.06^{c}±3.85

DMI, dry matter intake; CPI, crude protein intake; MPI, metabolizable protein intake; MEI, metabolizable energy intake; [a,b,c] Means bearing different superscripts in a row differ significantly (P<0.05); HME, 30% higher ME than ICAR (2013); HMP, 40% higher protein than ICAR (2013)

(Diaz *et al.,* 2001). Singh *et al.* (2009) reported that increased nitrogen retention with 20% higher protein in Bhadawari buffalo calves. Lohakare *et al.* (2006) reported decrease nitrogen retention in crossbred calves fed with a low protein diet. N balance was significantly (P<0.05) higher in HME group as compared to the control, which indicates the high energy increases the utilization of nutrients. Chaudhari *et al.* (2020) reported similar findings in lactating Murrah buffaloes.

The average body weight gain differed significantly (P<0.05) among the groups (Figure-1). Bodyweight increased significantly (P<0.05) in HMP group as compared to HME group and control. Lohakare *et al.* (2006) reported higher average daily gain in crossbred calves fed diet containing high metabolizable protein. The present study also coincides with the

Table 3. Average birth weight of calves and total immunoglobulin (mg/dl) level of calves and Murrah buffaloes

Particulars		Control	HME	HMP
Birth weight (kg)		31.26^{a}±0.30	33.18^{b}±0.37	36.28^{c}±0.40
Immunoglobulin (mg/dl)	Buffaloes	32.68^{a}±0.57	32.81^{a}±0.49	34.20^{b}±0.35
	Calves	31.70^{a}±0.31	32.56^{a}±0.42	35.76^{b}±0.51

[(a,b,c)] Means bearing different superscripts in a row differ significantly (P<0.01); HME, 30% higher ME than ICAR (2013); HMP, 40% higher protein than ICAR (2013) review that the increasing dietary energy density improved weight gain in lactating Holstein cows (Broderick, 2003). Malik *et al.* (1998) found a higher average daily gain (g/d) in crossbred heifers fed 20% and 40% higher CP. Other report also indicates that higher protein had a significant influence on body weight gain (g/d) than high energy since the protein is essential for muscle repair and growth (Sletmoen-Olsen *et al.,* 2000).

Data on the average birth weight of Murrah buffalo calves are presented in Table 3. The calf birth weights in HMP group was higher (P<0.01) than HME group and control. The calf birth weight in HMP group was about 14% higher than the control and 8.9% higher than that observed in the HME group.Improved birth weight was reported by Gunn *et al.* (2013) and Bolze *et al.* (1985) due to feeding of a high protein diet, and by Schoonmaker *et al.* (2003) and Radunz *et al.* (2010) due to feeding of high energy diet.

Total immunoglobulin level (Table 3) in buffaloes was significantly higher (P<0.01) in group HMP than HME and Control. In contrast of the present study, a negative correlation was found between serum IgG of pre-partum cows and colostral IgG by Toghyani *et al.* (2015). Present findings corroborated with the report that the maternal colostrum had a significant effect on the total immunoglobulin status of the calves because of the increased immunoglobulin concentration in the colostrum of cows fed with high protein diet (Francisco *et al.,* 1993; Toghyani *et al.,* 2015).

CONCLUSION

From the present study, it is evident that feeding of diets containing higher protein and energy during the last trimester of pregnancy resulted in higher birth weight of calves of Murrah buffaloes. But the protein seemed to be more important than energy during this period. Hence it can be concluded that the higher levels of protein in the diet can produce increased calf birth weight compared to high levels of energy.

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