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Effect of high plane of nutrition with herbal feed additive on intake, nutrient utilization and haemato-biochemical changes in post-partum Tharparker cows

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ABSTRACT

The study appraised the influence of higher plane of nutrition with herbal feed additive on feed intake, nutrient utilization, body condition score and blood-biochemical parameters in post-partum Tharparkar cows. Eighteen Tharparkar cows, ranging from second to fifth parity, with an average body weight of 340.3±5.5 kg and an average milk yield of 6.38±0.32 kg/d, were randomly divided into three groups. The control group (CON) was fed a basal diet consisting of concentrate mixture, fresh maize fodder and wheat straw, whereas, cows in Treatment-1 (T-1) received the same basal diet with 10% higher concentrate mixture and Treatment-2 (T-2), received basal diet with 10 % higher concentrate mixture along with a herbal feed additive @150mgkg-1 BW. The feeding trial lasted for 90 days. The DM and OM intake (kgd^{-1}) were comparable amongst the treatment groups whereas OM intake as %BW was significantly higher ($P<0.05$) in T-1 and T-2 groups than CON. The relative digestibility of various nutrients except EE was significantly ($P<0.05$) greater in T-2 group. The intakes of DCP, DOM, TDN and ME were significantly improved ($P<0.01$) in T-1 and T-2 groups than CON. Similarly, density of nutrients (DCP and TDN; %) of the composite diets were significantly ($P<0.001$) higher in T-2 followed by T-1 and CON groups, respectively. The body weight and body condition score (BCS) were similar among the groups. The cows of T-2 group exhibited significantly ($P<0.01$) higher haemoglobin and haematocrit values than CON and T-1 groups. Although, blood glucose, total protein and its fractions, A:G ratio, urea, AST and ALT were not affected. Thus, Tharparkar cows kept on higher plane of nutrition supplemented with herbal feed additive had significantly improved intake, nutrient utilization and haemotological parameters without affecting BCS and body weights.

Key words: Digestibility, Haemato-biochemical profile, Herbs, Intake, Post-partum, Tharparkar

India currently faces deficit in animal feed with 35.6% green fodder, 10.95% dry crop residues and 44.0% concentrate mixture as ingredients. By 2050, the requirement for fresh green and dry fodder is estimated to reach 1012 and 631 million tonnes, respectively. At the current growth rate of forage resources, this will result in 18.4 and 13.2% shortfall in green and dry fodders in the year 2050, correspondingly (IGFRI, 2024). Consequently, animals may be fed low-quality forages, leading to inadequate nutrient availability. Indigenous cattle are known for their resilience to poor-quality forages, disease resistance and heat tolerance, but often face crisis for lower milk production and shorter lactation periods (Yadav *et al.* 2020). Addressing these issues requires targeted nutritional support during peri-parturient and early post-partum periods. The early lactation phase is marked by hormonal changes, stress, reduced dry matter and energy intake, resulting in body fat mobilization and elevated plasma NEFA. Increasing calorific value of diet can improve voluntary intake, energy consumption, body weight gain, reduce fat mobilization and lower plasma NEFA levels (Vandchaar *et al*. 1999). There is growing worldwide interest in using herbs to enhance nutrient availability for livestock. Herbs and herbal extracts improve utilization of nutrients, influence rumen fermentation, and stimulate endocrine system and intermediate nutrient metabolism (Wanapat *et al.* 2008; Wenk, 2003). Moreover, they are safe, cost-effective and locally available. In this context, the present research aimed to assess the influence of higher plane of nutrition with herbal feed additive supplemention on nutrient intake and utilization, body condition score and blood-biochemical parameters in post-partum Tharparkar cows.

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MATERIALS AND METHODS

Preparation of herbal feed additive: Fresh stems of giloy (*Tinospora cordifolia*), roots of ashwagandha (*Withania somnifera*) and shatavari (*Asparagus racemosus*) were obtained from ICAR-IVRI Campus, Izatnagar and local market, dried under shade, ground into powder and stored in airtight plastic bags at ambient temperature for use.

Experimental animals and procedure: Eighteen early

Table 1. Ingredients of concentrate feed

Ingredients	Amount (kg/100kg)
Maize	35.0
Wheat bran	43.0
De-oiled soybean meal	7.0
Mustard cake	14.0
Common salt	1.0

* Mineral mixture was provided separately @ 50g per cow.

post-partum Tharparkar cows (30-60 d), averaging 340.28 kg BW and 6.38 kg milk yield, were divided into three equal groups: Control (CON), Treatment-1 (T-1) and Treatment-2 (T-2) and subjected to a 90 days feeding trial at Cattle and Buffalo farm, LPM section, ICAR-IVRI, Izatnagar. The cows in CON (control) group received green maize fodder, wheat straw and concentrate mixture as basal diet, while, the cows of T-1 group were provided basal diet with 10% higher concentrate mixture wherein the cows of T-2 group were offered basal diet with 10 % higher concentre mixture and herbal feed additive (T. cordifolia, W. somnifera and A. racemosus in the ratio 2:1:1) at 150 mg.kg-1BW. The basal diet fed to post-partum Tharparkar cows contained nutrients to fulfil the requirements as per the approved recommendations (ICAR, 2013). Approval of Institutional Animal Ethics Committee and Committee for the Purpose of Control and Supervision of Experiments on Animals in India was obtained for animal handling and experimental procedures.

Feeding management and measurement of digestibility: The predetermined amount of concentrate mixture was offered to all the cows in two equal meals at 6.00 AM and 4.00 PM, while T-2 group received the herbal feed additive along with concentrate mixture at 4.00 PM daily. Fresh maize fodder and wheat straw were offered ad libitum at 9.00 AM after intake of concentrate mixture. Residual feed was recorded daily to determine daily dry mater intake of individual cow in different groups. Towards the end of feeding trial, apparent digestibility was assessed using acid-insoluble ash (AIA) indicator method. Illustrative samples of feed, refusals and faecal samples were analyzed for AIA. Faecal samples were collected for 5 days at 8.0 AM, 12.0 PM and 4.0 PM, weighed and grounded. 20% fresh faeces were used for estimation of DM, whereas, 2.0% of fresh faecal samples were taken for crude protein analysis.

Body weight changes and BCS: Body weight and BCS of cows were recorded every fortnight. The weights of cows were recorded in early morning before feeding and watering. The BCS of experimental cows was assessed by simple visual method. A scale of 1 (emaciated condition) to 5 (obese condition) point with 0.25-unit increments was used for assessment.

Collection of blood samples and serum separation: Ten mL of blood samples were collected via jugular venepuncture from each experimental animal on 0, 45 and 90th day of feeding trial before feeding and watering. Two mL of samples were placed in EDTA vacutainers for hemoglobin (Hb) and haematocrit estimation, while the remaining 8.0 mL were placed in serum vacutainers, allowed to stand for some time and centrifuged at 2,000 x g for the duration of 10 minutes to collect and the serum which was transferred to Eppendorf tubes then stored at -20°C for bio-chemical analysis.

Analytical procedures: The offered feeds, herbal feed additive, leftover residues and faeces were analyzed for dry matter (DM), organic matter (OM), total ash (TA), ether extract (EE) and crude protein (CP) following AOAC (2012) methods. The fiber fractions i.e. NDF and ADF were measured following Van Soest *et al.* (1991). Haematocrit and Hb were measured by cyanomethaemoglobin technique (Dacie and Lewis, 1969) and Wintrobe's tube, respectively. Blood glucose, total protein and its fractions, urea, AST and ALT were analyzed using diagnostic kits (Coral Clinical Systems, Goa, India)

Statistical analysis: The data obtained from the experimental animals were statistically analyzed with SPSS Statistics (version 26.0) (Snedecor and Cochran, 2004). Duncan's Multiple Range Test categorized the means and periodic collection parameters were evaluated using repeated measures protocol within the General Linear Model (GLM). Statistical significance was ascertained at $P<0.05$.

RESULTS AND DISCUSSION

Nutritional composition of feeds and herbs provided to the experimental cows are shown in table 2. DM, OM, CP, EE, TA, NDF and ADF of wheat straw and fresh maize fodder were in line with earlier report (Chaudhary *et al.*, 2021). The EE of concentrate was consistent with results of Thanh and Suksombat (2015). The composition of T. cordifolia was in conformity with previous reports (Verma *et al.*, 2024). Likewise, the proximate composition of W. somnifera was in accordance with the findings of Verma and Mishra, (2021) and Kumari and Gupta, (2016). Moreover, composition of A. racemosus was in compliance with the report of Chavan *et al*. (2021).

Body weight changes and BCS: The body weight changes and BCS did not differ significantly among the groups. The observed similar body weight changes were due to adult Tharparkar cows of about 5-6 years age used in our study. In line with our findings, Adjorlolo *et al.* (2019) observed analogous BW and BCS in cows fed 2.5 $kg.d^{-1}$ of concentrate mixture. Similarly, Vaswani *et al.* (2022) and Jain *et al.* (2011) documented no impact on BW in heifers of Sahiwal and crossbred cows by supplementing T. cordifolia (0.5 and 1% of DMI) and phytoadditive containing A. racemosus (1000 ppm.kg-1DMI), respectively.

Nutrient intake and relative digestibility: The intake of DM and OM ($kg.d^{-1}$) was comparable amongst the treatment groups whereas OM intake as % BW was significantly ($P<0.01$) greater in T-1 and T-2 groups than CON (Table 4). Likewise, intake of DM (% BW) also showed increasing trend ($P<0.06$) in T-1 and T-2 groups relative to CON.

Table 2. Nutritional composition of feeds and herbs (% DM)

Nutrients*	Concentrate mixture	Wheat straw	Green maize fodder	T.cordifolia	W.somnifera	A.racemosus
DM	88.02	92.14	23.00	94.35	91.38	86.70
OM	92.53	91.29	86.87	91.67	92.18	95.31
CP	18.23	3.28	8.02	7.47	5.39	5.07
EE	3.59	1.07	1.27	1.53	2.55	0.82
TA	7.47	8.71	13.13	8.33	7.82	4.69
NDF	41.95	83.30	66.51	38.83	39.86	22.55
ADF	13.31	53.60	37.73	23.14	26.54	13.1

*DM; dry matter, OM; organic matter, CP; crude protein, EE; ether extract, TA; total ash, NDF; neutral detergent fibre, ADF; acid detergent fibre

The fortnightly mean DM intake was significantly higher (P≤0.001) in both T-1 and T-2 groups (Table 3). The results of our study are compatible with the previous reports of Patton *et al.* (2006) and Rabelo *et al.* (2003) in dairy cows and Tufarelli *et al.* (2011) and Hailu *et al.* (2011) in sheep who reported increased DMI with higher levels of dietary energy and concentrate mixture, respectively. Further, Broderick (2003) reported that increasing dietary protein content improved DMI in dairy cattle. Similarly, Kumavat *et al.* (2017), Jamara *et al.* (2014), Berhane and Singh (2002) and Mahantra (2003) in large ruminants observed increased DMI following A. racemosus supplementation at 125 to 150 mg.kg^{-1} BW. Moreover, Mir *et al.* (2015) also reported a significant improvement in DMI of lactating Murrah buffaloes supplemented with T. cordifolia @120 g.d^{-1}. In our study, the improvement in DMI observed with higher plane of nutrition and herbal feed additive combination might be attributed to enhanced nutrient digestibility, leading to reduced feed retention time in the rumen.

Digestibility of nutrients except EE was significantly (P<0.05) higher in T-2 group (Table 4). The enhanced digestibility of various nutrients in group T-2 was probably attributed to the presence of bioactive compounds in herbal feed additive that can enhance saliva production, support beneficial bacteria and protozoa, improve overall digestive system performance, ultimately benefiting nutrient metabolism and nutrient utilization. Our findings were supported by earlier reports (Dhuria *et al.* 2013; Meel *et al.* 2015), who reported significant increase in terms of DM, OM and CP digestibility in rams by *A. racemosus* supplementation (4% of DM) and higher digestibility coefficients of DM and OM in vitro in rumen liquor of calves supplemented with W. somnifera (3% of DM). The bioactive components present in herbs can modulate rumen fermentation, influence digestion and increase the retention of amino acids and energy without reducing feed intake, thereby enhance ruminant productivity (Wanapat *et al.* 2008; Kuralkar and Kuralkar, 2021).

The intake of DCP, DOM, TDN (g.kg^{-1}W0.75) and ME (Mcal.d^{-1}) was significantly (P<0.01) greater in T-1 and T-2 groups than CON. Similarly, density of nutrients (DCP and TDN; %) of the composite diets was significantly (P<0.001) higher in T-2 followed by T-1 and CON groups. The

Table 3. Body weight changes, body condition score and fortnightly dry matter intake kgd^{-1} in post-partum Tharparkar cows

Attributes	Treatment			SEM	P-value
	CON	T-1	T-2		
Body weight, kg					
Initial	339.17	342.50	339.17	5.51	0.965
Final	355.83	364.17	363.33	5.81	0.830
BW changes, gd^{-1}	185.22	240.78	268.56	23.78	0.295
Body condition score (BCS)					
Initial	3.21	3.21	3.25	0.04	0.898
Final	3.58	3.60	3.53	0.02	0.505
Mean	3.42	3.41	3.43	0.02	0.822
Fortnight dry mater intake, kgd^{-1}					
Initial	9.67	10.39	10.07	0.31	0.420
Final	8.68^{a}	10.29^{b}	10.40^{b}	0.27	0.006
Mean	9.35^{a}	10.64^{b}	10.70^{b}	0.10	≤0.001

^{ab}Means bearing different superscript in a row differ significantly.

Table 4. Nutrient intake and utilization in post-partum Tharparkar cows

Attributes	Treatment			SEM	P-value
	CON	T-1	T-2		
			Intake, kgd^{-1}		
DM	87.73	9.08	9.09	0.12	0.394
OM	7.91	8.43	8.44	0.12	0.11
			Intake, % BW		
DM	2.54	2.62	2.61	0.01	0.061
OM	2.30[a]	2.43[b]	2.42[b]	0.02	0.001
			Digestibility, %		
DM	56.94[a]	58.10[a]	61.29[b]	0.72	0.007
OM	60.80[a]	61.98[a]	64.40[b]	0.62	0.018
CP	64.40[a]	65.37[a]	69.22[b]	0.79	0.003
EE	73.41	74.56	75.70	0.44	0.077
NDF	46.66[a]	47.65[a]	54.83[b]	2.23	0.012
ADF	38.81[a]	39.47[a]	44.20[b]	0.88	≤0.001
			Nutrient intake, $gkg^{-1}W^{0.75}$		
DCP	8.17[a]	8.82[b]	9.25[c]	0.11	≤0.001
DOM	60.26[a]	64.96[b]	67.39[c]	0.76	≤0.001
TDN	63.28[a]	68.88[b]	70.76[b]	4.76	0.008
ME, $Mcald^{-1}$	18.18[a]	19.72[b]	20.54[b]	0.34	0.006
			Nutrient density, %		
TDN	57.85[a]	60.33[b]	62.76[c]	2.06	≤0.001
DCP	7.47[a]	7.80[b]	8.21[c]	0.31	≤0.001

[abc]Means bearing different superscript in a row differ significantly. DM, dry matter, OM, organic matter; CP, crude protein; DCP, digestible crude protein; DOM, digestible organic matter ; TDN, total digestible nutrients; ME, Metabolizable energy; EE, ether extract; NDF, neutral detergent fibre; ADF, acid detergent fibre SEM, standard error of the mean.

observed increase in nutrient intake is likely to be due to increased concentrate intake and the bioactive components in herbs that enhanced the availability of fermentable carbohydrates and proteins, promoting a favourable rumen environment for microbial growth, fermentation and enhanced nutrient utilization. Consistent with our findings, earlier studies have also observed improved intake of TDN in crossbred heifers and beef cattle when higher levels of concentrate were included in their diets (Pereira *et al.* 2007; Souza Duarte *et al.* 2011). Similarly, Sultana *et al.* (2012)

Table 5. Blood biochemical profile in post-partum Tharparkar cows

Parameters	Treatments			SEM	P- value		
	CON	T-1	T-2		T	P	T*P
Hb, gdL^{-1}	11.39[a]	11.53[a]	12.34[b]	0.10	≤0.001	0.002	0.011
Haemotocrit, %	33.51[a]	33.92[a]	36.30[b]	0.29	≤0.001	0.002	0.011
Glucose, $mgdL^{-1}$	60.39	60.21	60.55	0.59	0.98	0.55	0.10
Total protein, gdL^{-1}	7.35	7.30	7.35	0.03	0.75	0.92	0.95
Albumin, gdL^{-1}	3.30	3.32	3.46	0.03	0.10	0.42	0.72
Globulin, gdL^{-1}	4.06	3.98	3.89	0.04	0.33	0.51	0.86
A:G ratio	0.82	0.84	0.90	0.02	0.16	0.41	0.74
Urea, $mgdL^{-1}$	29.11	29.45	29.20	035	0.92	0.24	0.87
AST, UL^{-1}	84.11	83.62	82.98	0.33	0.40	0.93	0.30
ALT, UL^{-1}	27.65	28.10	28.58	0.39	0.62	0.07	0.95

[ab] and [xy]Means bearing different superscript in a row and column differ significantly. A:G, albumin:globulin; AST, aspartate transaminase; ALT, alanine transaminase; T, treatment; P, period.

and Mahfuz *et al.* (2018) reported increased CP intake with higher levels of concentrate mixtures in lactating goats. Bhinda *et al.* (2022) found increased DCP and TDN intake in crossbred heifers fed with A. racemosus @ 150 and 200 mg.kg^{-1}BW. Berhane and Singh (2002) also reported higher DCP and TDN intake in crossbred cows with polyherbal supplementation containing A. racemosus. The higher intake of concentrate in T-1 as well as T-2 groups led to higher nutrients intake due to associative effects. However, highest nutrient density of composite diet in group T-2 may be contributed to higher concentration of nutrients and enhanced nutrients digestibility.

Haematological parameters: The mean values of Hb and haematocrit were significantly (P≤0.001) higher in T-2 group (Table 5). A significant period effect was observed (P< 0.01) and the values increased from day 45 of feeding trial. The increased levels of Hb and haematocrit in T-2 group may be attributed to iron content (0.28 %) in T. cordifolia (Mutalik and Mutalik, 2011), folic acid in A. racemosus (Kulkarni and Verma, 1993) and the antioxidant property of *W. somnifera* that reduces premature RBC removal (Afonso *et al.* 2023). Similar to our findings, Raj (2018) observed increased Hb and haematocrit in crossbred calves supplemented with *T. cordifolia* at 4% of DMI for 90 days.

Blood biochemical parameters: No significant effect of high plane of nutrition and herbal feed additive was observed on serum glucose, total protein and its fractions, A: G ratio, AST and ALT among the groups (Table 5). Similarly, Lohakare *et al.* (2006) in calves and Sharma *et al.* (2018) in cows observed no significant effect on serum total protein and its constituents on feeding varying dietary protein levels and *T. cordifolia* @150g.d^{-1}, respectively. Likewise, Verma *et al.* (2024) in buffalo calves reported no effect on serum glucose, total protein, globulin and ALT levels following *W. somnifera* supplementation @ 25g.d^{-1}. The serum urea concentration was also similar amongst the groups and remained within the normal physiological range of cattle (Kaneko *et al.* 2008). Likewise, Sharma *et al.* (2018) and Benchaar *et al.* (2008) reported no significant variation in serum urea of crossbred cows supplemented with T. cordifolia and A. racemosus. Furthermore, feeding higher dietary crude protein has been associated with elevated blood urea concentrations, indicating a positive correlation (Larsen *et al.* 2014; Islam *et al.* 2019). Thus, feeding higher nutritional plane with herbal feed additive did not alter the homeostatic mechanisms in postpartum Tharparkar cows.

The present findings concluded that feeding of post-partum Tharparkar cows with higher plane of nutrition (10% higher concentrate mixture) along with herbal feed additive (*T. cordifolia*, *W. somnifera* and *A. racemosus* 2:1:1; @150 mg.kg-1BW) improved the intake, nutrient digestibility, plane of nutrition, Hb and haematocrit without any adverse effect on the body weight and body condition score. Therefore, herbal feed additives hold great prospects with higher concentrate mixture feeding in improving the nutrient intake and subsequent utilization in ruminants.

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