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Dietary Supplementation of Shatavari *(Asparagus Racemosus)* During Transition Period Influences Blood Metabolites, Milk Production and its Quality in Cattle

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ABSTRACT

Shatavari (*Asparagus racemosus*) has anti-oxidative, immunomodulatory and lactogenic functions. Effect of supplementing shatavari (*Asparagus racemosus*) root powder in the ration of peri-parturient Hardhenu cattle was evaluated. Based on most probable milk producing ability, parity and body weight, sixteen advance pregnant Hardhenu cows were divided into non-supplemental control group (CON; n=8) and supplemental group (SRP; n=8) which was fed shatavari root powder (SRP) @ 100mg/kg body from 60 days pre-partum until parturition and 200mg/kg body weight from parturition to 90 days post-partum. Milk yield, milk fat and protein percentage was significantly (P<0.05) higher in SRP group compared to CON. Milk somatic cell count (x10^5 cells/ml) and mean CMT score was significantly (P<*0.05*) lower in SRP group than CON. Percentage of teats infected with moderate (++) and serious (+++) sub-clinical mastitis (SCM) was comparatively less in SRP group than CON group (20.4 and 0.0% *vs*. 39.7 and 14.3%). Incidence of SCM during supplemental period was significantly (P<*0.05*) lower in SRP group while it was comparable (P>*0.05*) to CON group during residual period. Blood glucose, total cholesterol, HDL-cholesterol and total protein was significantly (P<0.05) higher while BUN was lower (P<*0.05*) in SRP group as compared to CON group. Milk yield was increased by 8.79% in SRP and the cost benefit ratio of supplementing shatavari was 1:2.59. It was concluded that shatavari supplementation in the diet of peri-parturient cows augments milk production, improves qualitative attributes of milk and reduces incidence of sub-clinical mastitis.

KEYWORDS: Production, Shatavari, Somatic Cell Count, Sub-clinical mastitis, Transition cows

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INTRODUCTION

Peri-parturient nutritional status of the dairy animals is the single most important factor that governs the productivity and health of the animal post-partum. During the transition phase, the pregnant animals are under severe stress due to hormonal, metabolic and other physiological challenges. Additionally, the feed intake is restricted due to presence of gravid uterus. This nutritional avoidance reduce the immunity and renders the animals vulnerable to various diseases. Different class of antibiotics and hormones have been used in past to decrease the incidence of peri-parturient disorders but, their application has become limited owing to their potent residual effects in milk. Therefore, certain indigenous plants have been explored and traditionally used to improve animal immunity and productivity. Mastitis, mostly reported in sub-clinical mastitis form (Hashemi et al.,2011) is the most economically important infection leading to extreme production losses, untimely culling of cows with higher genetic potential, drug and veterinary cost. Further, animal productivity in terms of growth and milk yield can be improved by using different herbs as a component of animal feed. There are several herbs, which have been described to improve the general wellbeing, milk production and reproduction of both humans and animals. Among them, Shatavari (*Asparagus racemosus*) needs a special mention. It is an important herbal plant of tropical and subtropical regions of India and contains steroidal saponins, sapogenins and phytochemicals (Karmakar et al. 2012) of medicinal importance.

Shatavari (*Asparagus racemosus*) has galactogogue and lactogenic function through enhancing blood protein and cellular division in mammary gland to augment lactation (Pandey et al., 2005). According to Bakshi and Wadhwa (2000), shatavari feeding either influences the feeding pattern, influences the growth of favourable microorganisms in the rumen, or stimulate the secretion of various digestive enzymes. All this in turn may improve the efficiency of utilization of nutrients or stimulate the milk secreting tissue in the mammary glands, resulting in improved productive and reproductive performance of dairy animals. Shatavari as a medicinal herb has properties to improve digestibility, antibacterial, immune-stimulation, coccidiostatic anthelmintic, antiviral or anti-oxidative (Uegaki et al., 2001). Kumar et al. (2014) reported that feeding of shatavari root powder significantly improved postpartum animal productivity by enhancing milk production and total milk immunoglobulins. It also reduces the service period and number of services per conception in a cost effective manner. These herbs were being used in pre-vedic time because they were safe to use, cheaper, easily available and has no side effect or residual effect on milk (Krishna et al., 2005).Mahantra et al., (2003) reported an increase of 25.10% in milk production when dairy animals were fed a herbal formulation containing 25% Shatavari.Somkuwar et al. (2005) and Tanwar et al. (2008) also confirmed similar findings in buffaloes and crossbred cows. Keeping in view the role of shatavari in lactogenic process, the current study was planned to investigate the effects of supplementingshatavariroot powder in the ration of peri-parturient Hardhenu cattle on blood metabolites, milk production and its quality.

MATERIAL AND METHODS

Feeding trial

Feeding experiment on Hardhenu cattle was carried out at the cattle farm of the Department of Animal Genetics and Breeding while the laboratory work was performed in the Department of Animal Nutrition, LUVAS, Hisar. This investigation on the animals was undertaken after due approval from the 22^{nd} meeting of Institutional Animal Ethics Committee, LUVAS, held on 25.01.2022. Sixteen Hardhenu cattle during their advanced pregnancy (60 days pre-partum) were selected and divided into two groups i.e., non-supplemental control group (CON; n=8) and shatavari (*Asparagus racemosus*) root powder supplemented group (SRP; n=8) according to most probable milk producing ability (3580±35 lt/ lactation), parity (2 & 3^{rd}) and body weight (464.8±10.7kg). Dried shatavari roots were procured from local market and pulverised to pass through 1mm screen. CON group was fed total mixed ration comprising wheat straw, green fodder (*Sorghum bicolor* and *Trifolium alexandrinum*) and concentrate supplements (Table 1) to meet the nutrient requirement as per ICAR (2013) feeding standards. Many studies have been conducted on the feeding of graded levels of shatavari in dairy animals during post-partum period with varied results (Chavan et al., 2023,Somkuwar et al.,2005 and Tanwar et al.,2008)). In this study, SRP group was fed shatavari root powder @ 100 mg/kg live body weight once in a day during 60 days pre-partum until parturition and 200 mg/kg live body weight once in a day from parturition to 90 days post-partum in addition to the ration fed to CON. A premix consisting of a small portion of concentrate mixture and shatavari root powder was prepared and fed to the animals once in a day.

Table 1. Ingredients and nutritional value of rations fed during pre and post-partum period

Ingredients as fed (kg/head/day)	Pre-partum diet	Post-partum diet
Wheat straw	3.00	4.00
Green fodder	20.0	25.0
Maize	0.90	2.20
Wheat	1.95	1.60
Barley	1.13	1.50
Groundnut cake	0.60	1.50
Mustard cake	0.68	1.50
Soybean meal	0.23	0.70
Mineral mix*	0.11	0.19
Common salt	0.06	0.09
Total as fed (kg/head/d)	28.65	38.28
Total as DM (kg/head/d)	10.95	15.88
Nutrient (% of DM)		
Crude protein	11.4	16.7
Fat	2.40	3.04
NDF	38.5	30.8
ADF	27.5	22.0
Ca	0.52	0.86
P	0.37	0.45

*Composition of Mineral mix (g/100g): Di-calcium phosphate: 53.25; Calcium carbonate: 18.5; Magnesium carbonate: 17.5; Sodium sulphate: 8.0; Zinc sulphate, monohydrate: 2.2; Copper sulphate, anhydrous: 0.25; Manganese dioxide: 0.20; Cobalt chloride, monohydrate: 0.05; Potassium iodate: 0.05

Recording of observations and sample analysis

The feed intake was recorded at fortnightly intervals on two consecutive days, the average of two days intake was used for daily dry matter intake. A digestion trial of five days was conducted by manual quantitative collection of total faeces from individual animal offered weighed quantity of test diet and recording its refusal. The samples of feed offered, refusals and faeces were analysed for proximate principles (AOAC, 2005). FCR and economics of feeding SRP in lactating cattle was assessed at the completion of feeding trial. Daily milk yield of morning (5.00 AM) and evening (5.00 PM) of individual animal was recorded using digital balance. Milk samples of morning and evening were collected from individual animal and pooled at each fortnight for estimation of major constituents of milk. Protein, Fat, SNF and lactose percentage was estimated using pre-calibrated Milk Analyser machine (MRC Lab Milk Analyser, India Model: MIA-S-30, S/N: 9166) for two days and average of two days was recorded. The milk samples were also taken for assessing the somatic cell count (SCC) as an indicator of mastitis with the method described by Schalm et al. (1971). Fat corrected milk was calculated by the formula suggested by Gaines, (1928): 4% FCM (kg) = (0.4 × total milk yield in kg) + (15 × total fat yield in kg).

From calving until 90 days post-partum, cows were screened at fortnightly intervals for assessing the status of sub-clinical mastitis (SCM) with Modified California Mastitis Test (MCMT) using CMT kit (DeLaval Private Limited) as per the method of Sastry (1978). 2.0 ml milk from individual quarter of every animal was stripped in CMT paddle in each cup and then 3.0 ml of reagent was poured in each cup and stirred anti clockwise. Inferences were drawn based on ‘No gel-formation as negative; Traces of gel formation as very mild infection (+); Slight gel formation as moderate infection (++), and; Very thick gel formation as serious infection with sub-clinical mastitis (+++).CMT score was calculated as “Number of teats infected with mild, moderate, or seriousSCM divided by total number of teat infected”.Based on readings of MCMT, whether positive or negative, incidence of sub clinical mastitis (SCM) was calculated in CON control and SRP group during supplementation period (90 days post-partum) and until 60 days after stopping SRP supplementation as residual period. Incidence of SCM was calculated as”Number of teats positive for SCM divided by total number of teats functional during the period”.

At the end of experiment, blood samples were collected by jugular veni-puncture for assessing the blood metabolites using Ebra EM-200 biochemistry analyzer (Sr. No. B110318, Ebra Mannheim, Transasia Bio-medicals ltd). Reproductive parameters *viz.* period from calving to first estrus, service period and number of inseminations per conception were recorded. Cost benefit ratio was calculated based on total cost of shatavari (*A. racemosus*) fed pre and post-partum period and income from extra milk produced in SRP group.

The milk samples from individual quarter of each animal were used for MCMT test while for SCC and milk composition, sample from all the four quarters of an animal were pooled. Thus, a total number of 384 milk samples for MCMT test (192 samples each from CON and SRP group) and 192 samples for SCC (96 samples each from CON and SRP group) were analysed.

Statistical analysis

To compare the means of different observations of CON and SRP group for statistical evidence, analysis of the data was carried out by independent sample t-test with SPSS statistical software (20). In all the observations, the P-value of < 0.05 was set as the level of significance.

RESULTS AND DISCUSSION

The ingredient and chemical composition of the experimental total mixed ration fed during pre-partum and post-partum period are listed in Table 1. Rations offered to both the groups was kept iso-nitrogenous and iso-caloric during pre- as well as post-partum period.Feed intake (FI), nutritive value of rations, nutrient intake and nutrient digestibility (Table 2) was not affected ($P<0.05$) due toSRP supplementation, indicating that dietary supplementation of shatavari had no adverse effects on voluntary feed intake and nutrient utilization.

Table 2. Feed intake (kg), Nutritive value, Nutrient intake and their digestibility under different dietary treatments

Attributes		CON	SRP	SEM	P value
Feed intake (FI, kg)					
Fortnights	1	13.5±0.82	12.3±1.02	0.65	0.350
	2	13.4±0.89	12.5±1.04	0.67	0.525
	3	13.1±1.01	12.8±0.82	0.63	0.799
	4	13.2±0.81	12.5±0.85	0.57	0.573
	5	12.9±0.81	12.7±0.73	0.52	0.898
	6	13.2±0.93	13.2±0.73	0.57	0.997
Overall FI, kg		13.2±0.83	12.7±0.81	0.56	0.639
Nutritive value					
CP% TMR		14.2±0.08	14.2±0.13	0.07	0.854
DCP% TMR		8.16±0.20	8.31±0.35	0.19	0.730
TDN% TMR		54.6±0.93	55.4±0.89	0.63	0.526
Nutrient's intake					
DMI, kg		14.3±0.10	14.5±0.15	0.09	0.409
DCPI, kg		1.17±0.03	1.20±0.04	0.02	0.562
DEEI, kg		0.80±0.01	0.88±0.02	0.01	0.953
DCFI, kg		1.51±0.04	1.51±0.07	0.04	0.891
TDNI, kg		7.84±0.13	8.05±0.12	0.09	0.290
% Nutrient Digestibility					
DM		56.7±1.28	57.9±1.12	0.83	0.492
OM		56.3±1.30	57.7±1.08	0.84	0.399
EE		70.2±1.45	69.8±1.45	0.99	0.843
CF		50.4±1.14	50.1±1.62	0.96	0.888
NFE		51.5±1.36	53.0±1.20	0.90	0.424
NDF		47. ±1.27	47.6±0.98	0.78	0.864
ADF		42.1±1.64	42.4±1.63	1.12	0.914

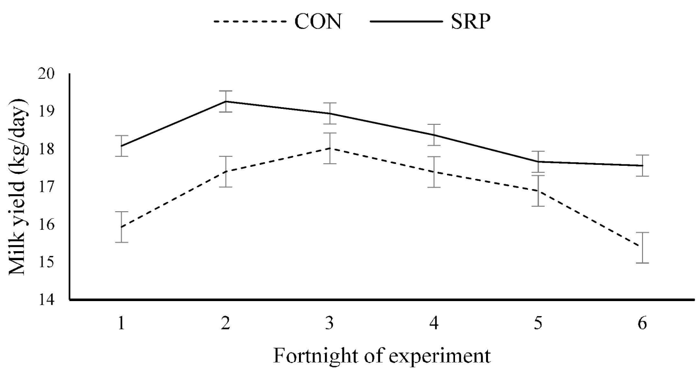

Fig 1. Milk Production at different fortnights of lactation in CON and SRP group

CON: non-supplemental control group; SRP: Shatavari root powder supplemented group

Milk production (kg/day) was significantly (P<*0.05*) higher in SRP group compared to CON group at all the six fortnights of the experiment (Fig. 1). Overall milk production and reproduction performance data of the animals are shown in Table 4. An increase of 1.48 kg milk per day (8.79%) was reported in SRP group. FCM yield was also significantly (P<0.05) higher in SRP group (19.1±1.01 kg/day) than CON group (15.0±0.64 kg/day). FCR of animals fed shatavari was better (*p<0.05*) than animals not fed shatavari (0.68±0.03 *vs* 0.91±0.05 kg DMI/kg FCM). Animals under SRP group attained peak milk yield earlier (*p<0.05*) as compared to CON (32.8±2.36 *vs* 42.1±5.24 days). However, no difference (P>*0.05*) in the peak milk yield of both the groups was observed. These findings are in agreement with the results reported by Jingar et al. (2018) and Soni et al. (2016) who reported that shatavari is effective in enhancing and economizing milk production in dairy animals. This might possibly be due to galactogogue and mammogenic action of shatavari, which increase prolactin level as reported earlier by Kumar et al. (2008).

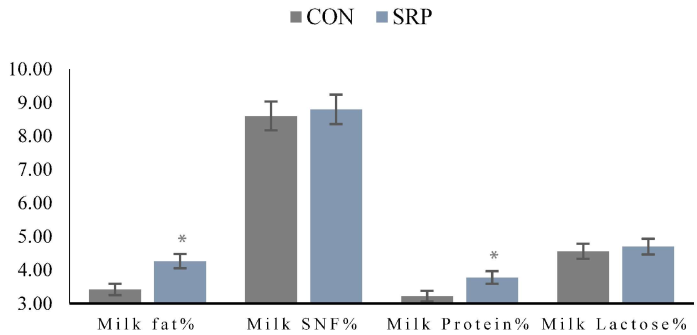

Fig: 2. Compositional characteristics of milk in CON and SRP group cows

CON: non-supplemental control group; SRP: Shatavari root powder supplemented group

Significantly lower (P<*0.05*) milk fat percentage and milk protein percentage was reported in CON group in comparison to SRP (3.42±0.15 *vs* 4.27±0.10 and; 3.22±0.06 *vs* 3.78±0.07, respectively) while milk SNF (8.60±0.12 *vs* 8.80±0.10) and lactose (4.56±0.06 *vs* 4.70±0.06) percentage remain unaffected due to shatavari supplementation (Fig. 2). The increased milk fat and protein content in the SRP supplemented group might be due to the healthier udder tissue indicated by reduced SCM.

Milk SCC (x10^5 cells/ml), status and incidence of SCM is presented in Table 3. Supplementation of shatavari significantly (P<*0.05*) reduced milk SCC (1.86±0.32 x10^5 cells/ml in SRP *vs* 4.25±0.66 x10^5 cells/ml in CON). Mean CMT score per teat was also lower (P<*0.05*) in SRP group than CON. In CON group, 45.83% of the functional teat were infected with mild (+) SCM followed by 39.7 and 14.3% that had moderate (++) and serious (+++) SCM infection, respectively. On the contrary, majority (79.58%) of the functional teats in SRP were infected with mild (+) SCM only, followed by moderate (++) SCM in 20.42%. No case of serious (+++) SCM was reported in SRP group. Mostly the hind-right quarter was observed infected with SCM in both the groups, which might because of the general habit of cows of resting on the right side. Percent incidence of SCM during the supplemental period was significantly (P<0.05) lower in SRP than CON (19.27±1.34 *vs* 35.42±2.36). However, incidence of SCM was at par (P>*0.05*) between the groups during residual period which indicates enhanced immunity in shatavari fed animals. Similar to the current finding, Sharma (2009) and Saini et al. (2018) also observed significant effect of feeding shatavari on milk quality and incidence of sub-clinical mastitis. Batavani et al. (2007) also reported that protein fraction and chemical composition of cow milk are linked to the sub-clinical mastitis.

Table 3. Milk SCC, status and incidence of SCM in CON and SRP group (Mean±SE)

Attributes	CON	SRP	SEM	*P* value
Fortnightly SCC (x10^5 cells/ml)				
1	3.95^b±0.66	1.95^a±0.33	0.44	0.017
2	4.40^b±0.72	1.71^a±0.35	0.52	0.005
3	4.15^b±0.65	1.88^a±0.44	0.48	0.012
4	4.48^b±0.67	1.71^a±0.27	0.49	0.002
5	4.15^b±0.71	2.05^a±0.37	0.47	0.021
6	4.35^b±0.66	1.89^a±0.29	0.47	0.004
Overall SCC	4.25^b±0.66	1.86^a±0.32	0.47	0.006
Status of SCM				
Mean CMT Score/teat	0.61^b±0.09	0.23^a±0.02	0.06	0.001
% + CMT Score	45.8±11.92	79.5±6.91	--	--
% ++ CMT Score	39.7±8.18	20.4±6.91	--	--
% +++ CMT Score	14.3±6.37	0.00±0.00	--	--
% Fore Left quarter infected	7.50±4.53	6.67±4.54	--	--
% Fore Right quarter infected	36.1±11.77	22.2±9.41	--	--
% Hind Left quarter infected	15.3±8.19	12.2±4.86	--	--
% Hind Right quarter infected	41.0±9.95	58.7±15.17	--	--
% Incidence of SCM				
Supplemental period	35.4^b±2.36	19.2^a±1.34	2.46	0.001
Residual period	32.8±2.29	29.6±1.95	1.51	0.317

*Mean values bearing different superscripts in a row differ significantly (P<0.05).
CON: non-supplemental control group; SRP: shatavari root powder supplemented group; SCC: somatic cell count; SCM: sub clinical mastitis; CMT: California mastitis test.

Table 4. Production and reproduction parameters of experimental animals (Mean±SE)

Attributes	CON	SRP	SEM	*P* value
Overall average milk yield, kg/day	16.8^a±0.91	18.3^b ±0.84	0.29	0.005
Increase in milk yield, kg/d (% increase)	--	1.48 (8.79)	--	--
FCM, kg/day	15.0^a±0.64	19.1^b ±1.01	0.37	0.010
FCR on FCM basis	0.91^b±0.05	0.68^a ± 0.03	0.04	0.003
Peak milk yield, kg	20.1±1.89	21.0 ±1.71	0.23	0.062
Days to peak milk yield	42.1^b±5.24	32.8^a ±2.36	2.05	0.020
Days taken to first estrous	39.8±1.96	37.1±1.35	1.20	0.276
No. of AI per conception	2.00±0.21	1.57±0.20	0.15	0.175
Service period, days	82.7±5.29	73.0±6.19	4.14	0.256

*Mean values bearing different superscripts in a row differ significantly (p<0.05).
CON: non-supplemental control group; SRP: Shatavari root powder supplemented group; FCM: Fat Corrected Milk Yield; FCR: Feed conversion ratio= kg DMI/ kg FCM yield; AI: Artificial insemination.

Between the groups, no differences (P>0.05) were reported in the reproductive parameters like days taken by animals to 1st estrous, number of AI per conception and service period of the groups, although, these attributes improved numerically in SRP group (Table 4). On contrary to our findings, shatavari supplementation has been reported to reduce service period and number of services per conception (P<0.05) by Kumar et al. (2014). Similarly, Ranasinghe et al. (2021) reported that subclinical infection of udder around the breeding period was associated with 14% increase in artificial inseminations per conception.Blood glucose, serum total cholesterol, HDL-cholesterol and serum total protein were higher (*p<0.05*) in SRP group in comparison to CON group (Table 5). Serum triglycerides and LDL-cholesterol did no change but BUN decreased significantly (P*<0.05*) due to shatavari feeding. Earlier study by Kumar et al. (2014) indicated significant effect of shatavari on blood biochemical parameters of cows. Likewise, blood glucose, serum protein, total cholesterol and HDL-cholesterol increased (*p<0.05*) in shatavari fed cows in present study also.

Table 5. Blood biochemical parameters of experimental animals (Mean±SE)

Parameter	CON	SRP	SEM	P value
GLU mmol/L	3.60^{a}±0.14	4.27^{b}±0.04	0.11	0.001
BUN, mg/dl	42.5^{b}±2.43	36.2^{a}±1.08	1.51	0.034
Triglycerides, mg/dl	19.6±2.24	18.3±1.87	1.42	0.675
CHO, mg/dl	134.1^{a}±4.50	156.0^{b}±7.56	5.10	0.026
HDL, mg/dl	74.3^{a}±5.60	89.9^{b}±3.73	3.82	0.036
LDL, mg/dl	49.5±3.64	53.8±4.79	2.96	0.481
Total Protein, g/dl	4.31^{a}±0.16	5.25^{b}±0.16	0.16	0.001

*Mean values bearing different superscripts in a row differ significantly (P<0.05).
CON: non-supplemental control group; SRP: shatavari root powder supplemented group; GLU: blood glucose; BUN: blood urea nitrogen; CHO: total cholesterol; HDL: High-density lipoprotein; LDL: low-density lipoprotein

Economics of supplementing shatavari in transition cows is presented in Table 6. Cost of the feeding shatavari including pre- and post-partum period was Rs. 8298.00 per animal while the extra FCM yield was 4.09 kg per animal in SRP group. Instead of the extra investment on feeding shatavari, SRP group had a net return of Rs. 4585.50 per animal during the experimental period. Cost benefit ratio (B:C) of supplementing shatavari in the ration of peri-parturient cows was 1:2.59.

Table 6: Effect of *Shatavari* supplementation on economics of milk production in cows

	Economic evaluation	
A	Extra average FCM yield/day/animal, kg	4.09
B	Income from extra FCM produced per day, Rs. (A x 35)	143.15
C	Total extra FCM yield, kg (A x 90)	368.10
D	Income from total extra FCM, Rs. (C x 35)	12883.50
E	Average dose of shatavari, gm	73.76
F	Average cost of daily shatavari dose, Rs. (E x 0.750)	55.32
G	Total cost of feeding shatavari, Rs. (F x 150)	8298.00
H	Net return from extra milk produced, Rs. (D-G)	4585.50
I	Cost Benefit (B:C) Ratio* (B/F)	1:2.59

*B:C Ratio= income from extra FCM produced per day (Rs.)/ cost of daily SRP dose (Rs.)

CONCLUSION

Supplementation of shatavari (*Asparagus racemosus*) in the ration of peri-parturient Hardhenu cows @ 100mg/kg BW 60-days pre-partum and @ 200mg/kg BW 90-days postpartum increased the milk yield, improved blood biochemical parameters, milk composition and feed conversion ratio. It also reduced milk somatic cell count and incidence of sub-clinical mastitis. Thus, it may be concluded that shatavari improves the productivity and quality of milk in dairy cows.

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