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Effect of *Asparagus racemosus* root powder supplementation during pre to postpartum period on milk yield and its composition in murrah buffaloes

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Abstract

Fifteen (n=15) dry and pregnant Murrah buffaloes were selected based on similar body weight, parity and milk yield and divided into three groups Control (Non-Supplement) and treatment (Supplement) T_1 & T_2 with five in each group. To investigate the effect of pre to postpartum supplementation of *Asparagus racemosus* root powder (ARRP) on milk production, its composition and economics, the T_1 groups of buffaloes were fed with *ARRP* @ 100 mg/kgBW during the prepartum to postpartum period @ 200 mg/kgBW. T_2 groups of buffaloes were fed with *ARRP* @ 150 mg/kgBW prepartum to postpartum period @ 300 mg/kgBW. The supplementation period was 60 days prepartum to continuing 90 days postpartum. All the buffaloes were also observed for up to 60 days after the withdrawal of supplementation as a post-supplementation period. The present study reported that pre to postpartum supplementation of herbal feed supplement ARRP did not affect the prepartum DMI, however, it increased the intake of dry matter during the postpartum period significantly ($p<0.05$) by increasing the digestibility of feed nutrients ($p<0.05$). ARRP supplementation has a significant ($p\leq0.05$) effect on buffalo daily milk yield. The ARRP dose also has a significant ($p\leq0.05$) effect on daily milk yield. Buffaloes (T_2) supplemented ARRP @ 150 mg/kg BW prepartum to 300mg/kg BW postpartum produced higher milk than the 100 mg/kg BW prepartum to 200mg/kg BW postpartum supplemented group (T_1). Daily milk yield during post supplementation period was also reported to be higher ($p\leq0.05$) than non-supplemented buffaloes (Control). The increase in daily milk was reported higher by 15.47 & 13.04% and 22.27 & 14.36% in T_1 & T_2 respectively during supplementation and post-supplementation periods than in the control group. Supplementation of ARRP @ 150 mg/kg BW prepartum to 300mg/kg BW postpartum had a significant effect on fat yield, % protein, protein yield, % SNF, SNF yield, % TS and TS yield. However, supplementation of 100 mg/kg BW prepartum to 200mg/kg BW postpartum improved the quality of milk in terms of fat yield, protein yield, SNF yield and TS yield over the Control group. As expected, the feed cost per kg milk production was not increased ($p>0.05$) but, pre to postpartum supplementation improved the margin money up to Rs. 2.52 over Rs 1.0 investment on feed cost. Therefore, pre to postpartum supplementation of ARRP had a beneficial effect on buffaloes in terms of milk production, composition and economic returns.

Keywords: *Asparagus racemosus*, herbal feed supplement, murrah buffalo, milk yield, composition, digestibility, dry matter intake, economics

Introduction

India is topmost position among the milk-producing nations in the world with total milk production of 221.1 million tonnes during 2021-22, largely contributed by buffaloes (43.4%) (Livestock Census, 2019) [1]. Buffaloes, described as the 'Black Gold' are the favourite multipurpose animals of farmers belonging to downtrodden, landless, small and marginal groups who possess poor expenditure ability, therefore, followed course roughage dry straw rich in lignin and poor in protein-based ration cause poor milk yield, reproduction and economic return. The productivity of buffalo in India is 5.96 kg (Livestock Census, 2019) [1] which is far below the actual potential due to several reasons among them feeding of imbalance ration is one (Kumar *et al*. 2019) [15]. In this age of higher population growth and demand for milk & milk products, it is a necessity to increase milk and food production. However, farmers are facing multiple socioeconomic and environmental challenges, such as pressure to decrease greenhouse gas production as well as a decrease in the use of human health concerns synthetic chemicals-based feed additives i.e., antibiotics and growth promoters in dairy animals & other livestock. In this regard, several reviews have highlighted the potential of feed enzymes and plant extracts to improve nutrient utilization in ruminants as alternatives to ionophore antibiotics (Jeong *et al*. 2010, Meale *et al*. 2014, McGrath *et al*.

2018, Silva *et al*. 2018, AlSuwaiegh *et al*. 2022) [13, 24, 12, 25, 3]. Herbs and plant secondary compounds that have antimicrobial and therapeutic potentials generally recognized as safe have been reported to improve animal performance at par with synthetic additives (Tassoul and Shaver, 2009, Silva *et al*. 2018, Andreazzi *et al*. 2018) [17, 25, 2]. *Asparagus racemosus* traditionally known as *Shatavari* is an important medicinal plant of tropical and subtropical India. It has therapeutic importance to manage the complications during pregnancy and the postpartum period in women and animals. *Asparagus racemosus* root powder (ARRP) has been reported as one of the important galactopoietic and therapeutic herbs beneficial for the dairy sector. However, a systematic study on *Asparagus racemosus* root powder supplementation (prepartum to postpartum) and its effect on milk production, composition and economics is lacking in Murrah buffaloes. To fill up the gaps in knowledge in buffaloes the study was conducted to study the effect of *Asparagus racemosus* root powder supplementation on milk yield, composition and its economics in Murrah buffaloes.

Materials and Methods

The present study was conducted on Murrah buffaloes reared at ICAR National Dairy Research Institute (NDRI) Karnal situated at an altitude of 250 meters above the mean sea level in Indo-Gangetic alluvial plains on 29°42'N latitude and 72°02'E longitude. The climate of the farm is subtropical. All groups of animals were reared under similar climatic conditions. Fifteen (n=15) dry and pregnant (60 days before the expected date of calving-prepartum) buffaloes were selected and grouped based on their milk yield, parity and body weight. Selected buffaloes were divided into three experimental groups C-Control, T_1 and T_2 with 5 animals in each group. All groups were kept as prepartum to continue postpartum. All buffaloes were free from physiological, anatomical and infectious diseases and all the buffaloes were fed as per the NRC (1982) [20]. *Asparagus racemosus* root powder (ARRP) was supplemented along with the concentrate to buffaloes of treatment groups (T_1 & T_2) as mentioned below from 60 days Prepartum to 90 days postpartum.

Treatment groups (T_1 & T_2) as mentioned below from 60 days Prepartum to 90 days postpartum

Treatment	Prepartum period	Postpartum period
Control	Roughage and concentrate as per NRC (1982) [20]	Roughage and concentrate as per NRC (1982) [20]
T_1	Control diet + ARRP @100 mg/kg /day	Control diet + ARRP @ 200 mg/kg /day
T_2	Control diet + ARRP @ 150 mg/kg /day	Control diet + ARRP @ 300 mg/kg /day

During the prepartum and postpartum period, buffaloes were fed a total mixed ration made with green maize, jowar (sorghum) & dry wheat straw and concentrate. The concentrate was prepared by Maize (33%), Groundnut Cake (21%), Mustard Cake (12%), Wheat Bran (20%), De-oiled rice Bran (11%), Mineral Mixture (2%) and common Salt (1%). The feeding schedule (particularly concentrates) of individual animals was revised at fortnightly intervals and was reformulated based on the body weight of the animal and the milk yield on the last day of the previous fortnight. The quantity of feeds, fodder and concentrate offered and residue left by the individual animals were recorded on a fortnightly basis on two consecutive days. Suitable modifications in the feeding plan were also made depending up on the availability of green fodder. During the feeding trial, the quantity of feeds, fodder and concentrate offered and residue left by the individual animals were recorded on a fortnightly basis.

The experimental shelter was an individual tying system with head-to-head arrangements of experimental animals. The Body weight of the experimental animals was recorded initially at 2 months before calving and then at 15-day intervals, at calving and subsequently at 15-day intervals till the end of the experimental period. The body weight of each animal was measured early in the morning between 7.30 A.M. to 8.30 a.m. before providing any feed or water to the animals, using an electronic weighing scale with a precision of 200 g. The absolute rate of body weight change was estimated by using the following formula given by Broody (1945) [8].

Analytical Techniques: To analyse the composition of colostrum, about 100 ml of well-mixed colostrum sample of morning milking were collected daily for up to five days of colostrum period from each animal in a milk sample bottle and stored at -20° $_C$ till further analysis. Colostrum fat, protein and total immunoglobulin as per Garber's method, Kjeldahl procedure (AOAC, 2000) [4] and Pfeiffer *et al.*, (1977) [22].

To determine the proximate composition of the feed sample, Dry matter (DM), Crude protein (CP), ether extract (EE), crude fibre (CF), nitrogen-free extract (NFE), total ash (TA) and nitrogen-free extract (NFE) were estimated by the methods of AOAC (2000) [4], Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were estimated by the method of Goering and Van Soest (1970) [9].

Total tannin and saponin content in the ARRP sample was estimated as per Makkar, (2003) [18] and Hiai *et al*. (1976) [11].

Table 1: Proximate analysis of the feeds used during the experiment

Nutrients %	Wheat Straw	Green Jowar	Green maize	Concentrate mixture	Green maize	Concentrate mixture
	During Intake trial				During Digestion trial	
DM	91.83	27.93	23.5	90.51	27.41	90.51
OM	87.69	88.18	88.77	94.56	90.24	94.56
CP	3.30	6.44	9.23	20.53	9.45	20.53
CF	29.74	27.46	26.98	10.28	26.98	10.28
EE	0.32	1.25	1.26	4.41	1.34	4.41
NFE	54.87	52.58	52.41	69.62	52.47	69.62
NDF	66.49	75.11	62.71	38.72	62.58	38.72
ADF	38.21	49.15	39.08	16.68	37.64	16.68
Ash	12.31	11.82	11.23	5.44	9.76	5.44

Table 2: Secondary plant metabolites and proximate composition of ARRP

Particulars	% Content (On DM basis)
Total Phenolics	4.58
Total Tannin	3.71
Saponins	4.3
OM	88.3
DM	90.87
CP	6.1
CF	18.26
EE	1.87
Total Ash	11.7
Acid sol. Ash	0.46
NDF	31.19
Insoluble Ash in NDF	1.90
ADF	23.23
Cell contents	68.82

Milking of buffaloes was done under Flat Barn Milking Parlour system operated at around 50 pulsations per minute and the vacuum was adjusted at 400mm/hg. Milk yield was recorded daily and FCM was calculated as per Tyrell and Reid (1965) [29]. About 100 ml of milk samples from individual animal of each milking was collected in a properly cleaned milk sample bottle and pre-warmed at 39-40 °C before analysis to analyse the milk composition i.e., fat, protein, lactose and SNF fortnightly by using Lacto Star-automatic milk analyzer (Funke Gerber, Model No. 3510-055007).

Statistical analysis

The least squares technique was applied to estimate the mean daily milk yield and the significance of treatment differences was examined by Duncan's multiple range test (Harvey 1975) [10]. Student's t-test was employed to estimate the effect of treatment on dry matter intake, digestibility, daily milk yield, composition and cost of milk production (Snedecor and Cochran 1989) [27].

Results & Discussions

Dry matter intake (DMI)

Supplementation of ARRP did not affect the prepartum DMI, however, it helps to increase the intake of dry matter during the postpartum period significantly ($p<0.05$) by increasing the digestibility of nutrients (Table 4) as reported in the present study. The overall average values of DMI (kg/day) during prepartum period (60 days) to postpartum (90 days) were 13.11±0.14, 13.66±0.14 and 13.79±0.14 in control, T_1 and T_2, respectively (Table 3). Dry matter intake (DMI) is directly related to available digestible nutrients and microbial yield. Increased DMI leads to the supply of more energy and nutrients to the animals. The results of the present investigation on DMI were similar to Mishra *et al.* (2008) [19] who reported that postpartum supplementation of root powder of *Asparagus racemosus* in dairy cows & buffaloes. DMI decreased drastically toward the calving time. This may be due to the increase in the size of the fetus occupies most of the space in the abdominal cavity, causing pressure on the rumen and thereby the DM intake of the animal was reduced from interval to interval. Tyagi, (2007) [30] also found that the DM intake was higher at -60 days of parturition and as the pregnancy advanced the DM intake decreased and was lowest on the day of parturition. The result of the present study revealed that ARRP supplementation helps to regain the DMI postpartum as evidenced by the DMI of the first fortnight after calving (Table 3).

Table 3: Mean (±SE) of Dry Matter Intake in different treatment groups

Fortnights	Dry Matter Intake (Kg/buffalo/day)		
	Control	T_1	T_2
Prepartum period			
- 4	12.97±0.24	13.25±0.24	13.42±0.24
- 3	13.56±0.31	13.99±0.31	14.42±0.31
- 2	13.46±0.47	13.73±0.47	13.84±0.47
- 1	13.11±0.37	13.78±0.37	14.10±0.37
At Calving	11.35±0.32	11.14±0.32	10.95±0.32
Postpartum period			
1	13.40^{a}±0.18	14.23^{b}±0.18	14.06^{b}±0.18
2	14.23^{a}±0.24	15.03^{b}±0.24	14.83^{ab}±0.24
3	13.65^{a}±0.20	14.51^{b}±0.20	14.78^{b}±0.20
4	12.94^{a}±0.29	13.91^{b}±0.29	14.31^{b}±0.29
5	12.75±^{a}0.19	13.41^{b}±0.19	13.56^{b}±0.19
6	12.76^{a}±0.13	13.25^{b}±0.13	13.38^{b}±0.13
Mean±SE	13.11^{a}±0.14	13.66^{b}±0.14	13.79^{b}±0.14

Means bearing different superscripts within a row differ significantly ($p\leq0.05$)

Digestibility of nutrients

The ARRP supplementation has a significant ($p\leq0.05$) effect on % DMD. However, it was dose-dependent. The differences between the Control and T_1 groups were not reported as significant ($p>0.05$). Similar results were observed for the crude fibre digestibility coefficient of the diets was significantly ($p\leq0.05$) higher in T_1 and T_2 than control but it was non-significantly different among T_1 and T_2 groups. The crude protein digestibility coefficient of the diets was significantly ($p\leq0.05$) higher in both the T_1 and T_2 groups than Control, but it was non-significantly different among the T_1 and T_2 groups. Numerically higher digestibility ($p>0.05$) of EE, ADF, NDF and NFE were also observed. The findings were at par with Mishra (2008) [19] and Bhinda *et al.* (2022) [6].

Table 4: Mean (±SE) of % digestibility of nutrients in different treatment groups

Nutrients	% Digestibility of nutrients		
	Control	T_1	T_2
DM	62.78^{a}±1.34	66.84^{a}±1.34	67.76^{b}±1.34
OM	64.93±1.36	68.79±1.36	69.44±1.36
CP	62.14^{a}±2.11	69.66^{b}±2.11	74.43^{b}±2.11
CF	49.02^{a}±1.50	57.66^{b}±1.50	61.57^{b}±1.50
EE	77.56±2.57	80.08±2.57	79.49±2.57
ADF	42.90±2.87	46.74±2.87	48.85±2.87
NDF	53.55±2.17	59.86±2.17	59.57±2.17
NFE	71.78±1.69	73.43±1.69	72.09±1.69

Means bearing different superscripts within a row differ significantly ($p\leq0.05$)

Table 5: Voluntary intake of different nutrients in lactating buffaloes under different groups

Parameters	Treatments		
	Control	T_1	T2
DM intake (kg/day)	14.45±0.68	14.67±0.68	14.77±0.68
DM intake (kg/100kg B.W.)	2.37±0.15	2.40±0.15	2.63±0.15
Dig. DM intake (kg/day)	9.14±0.54	9.82±0.54	9.84±0.54
Dig. DM intake (g/kg $W^{0.75}$)	75.0±10.0	80.0±10.0	85.0±10.0
OM intake (kg/day)	13.26±0.63	13.46±0.63	13.56±0.63
Dig. OM intake (kg/day)	8.67±.50	9.27±.50	9.26±.50
Dig. OM intake (g/kg $W^{0.75}$)	71.0±5.0	75.5±5.0	80.0±5.0
CP intake (kg/day)	1.86±0.14	1.90±0.14	1.90±0.14
Dig. CP intake (kg/day)	1.17±0.14	1.33±0.14	1.40±0.14
Dig. CP intake (g/kg $W^{0.75}$)	9.5±1.0	10.9±1.0	12.0±1.0
CF intake (kg/day)	2.84±0.09	3.04±0.09	2.93±0.09
Dig. CF intake (kg/day)	1.45^a±0.09	1.78^b±0.09	1.79^b±0.09
Dig. CF intake (g/kg $W^{0.75}$)	11.8^a±1.0	14.49^b±1.0	15.56^b±1.0
E E intake (kg/day)	0.33±0.04	0.35±0.04	0.36±0.04
Dig. EE intake (kg/day)	0.26±0.04	0.29±0.04	0.29±0.04
Dig. EE intake (g/kg $W^{0.75}$)	2.07±0.3	2.32±0.3	2.47±0.3
NFE intake (kg/day)	8.75±0.42	8.66±0.42	8.87±0.42
Dig. NFE intake (kg/day)	6.32±0.31	6.37±0.31	6.29±0.31
Dig. NFE intake (g/kg $W^{0.75}$)	51.48±4.0	51.86±4.0	54.61±4.0
ADF intake (kg/day)	4.20±0.19	4.21±0.19	4.36±0.19
Dig. ADF intake (kg/day)	1.83±0.18	1.98±0.18	2.13±0.18
Dig. ADF intake (g/kg $W^{0.75}$)	14.89±2.0	16.23±2.0	18.41±2.0
NDF intake (kg/day)	7.66±0.35	7.80±0.35	7.74±0.35
Dig. NDF intake (kg/day)	4.20±0.27	4.68±0.27	4.70±0.27
Dig. NDF intake (g/kg $W^{0.75}$)	34.07±2.0	38.08±2.0	40.63±2.0
% TDN	65.47±1.69	68.90±1.69	67.98±1.69

Means bearing different superscripts within a row differ significantly ($p \leq 0.05$)

Milk Yield

Milk is one key component of dairy farming that affects the profitability of dairy farms. The results of the present study reveal that ARRP supplementation has a significant ($p \leq 0.05$) effect on buffalo daily milk yield. The increase in milk yield was dose-dependent. Buffaloes (T_2) supplemented ARRP @ 150 mg/kg BW prepartum to 300 mg/kg BW postpartum produced higher milk than the 100 mg/kg BW prepartum to 200 mg/kg BW postpartum supplemented group (T_1). Daily milk yield during post supplementation period was also reported to be higher ($p \leq 0.05$) than non-supplemented buffaloes (Control). The increase in daily milk yield was reported by 15.47 & 13.04% and 22.27 &14.36% higher in T_1 & T_2 respectively during supplementation and post-supplementation periods than in the control group. The milk yield of the T_2 group was higher by 5.89% over the T_1 group. It is evident from the results that ARRP supplementation not only improved milk production but also sustained it at higher levels for a longer period even though there was a linear consistent decline in milk yield during the supplementation period in both the treatment groups being the descending phase of lactation. The results were at par with Arora *et al.* (1983) [5] Ramesh *et al.* (2000) [23], Mishra *et al.* (2008) [19], Tanwar *et al*. (2008) [28] and Kumar *et al*. (2011) [16]. The improvement in milk production can be attributed to better DMI and digestibility of feed nutrients as reported in the present study (Table 4), udder health and hormonal changes towards galactopoiesis (Arora *et al.* 1983, Ramesh *et al.* 2000, Mishra *et al*. 2008, Tanwar *et al*. 2008, Kumar *et al*. 2011, Singh *et al*. 2012) [5, 23, 19, 28, 16, 26]. ARRP contains some active components, which stimulate the hypothalamus or pituitary gland, leading to the release of higher levels of prolactin hormone (Singh *et al*. 2012) [26] thereby increasing milk production. While estrogenic effect of ARRP on mammary glands stimulates alveolar secretary epithelial cell division and proliferation (Pandey *et al*., 2005) [21] which may help in the sustenance of increased milk production.

Milk Composition

In the present study, it was reported that the effect of ARRP supplementation on the quality of buffalo's milk was dose-dependent. Supplementation of ARRP @ 150 mg/kg BW prepartum to 300 mg/kg BW postpartum had a significant effect on fat yield, % protein, protein yield, % SNF, SNF yield, % TS and TS yield. However, supplementation of 100 mg/kg BW prepartum to 200 mg/kg BW postpartum improved the quality of milk in terms of fat yield, protein yield, SNF yield and TS yield over the Control group. As the price of milk is generally based on fat percentage in India, therefore, buffalo milk with higher nutrient content may fetch more money. Thus, ARRP supplementation may help to increase the sale price of buffalo milk and income from buffalo farming. However, further study is needed to explore the possibility of producing quality milk production on a large sample size. Similar results were also reported in crossbred cows (Kumar *et al.* 2011, Khera *et al.* 2022) [16, 14]. Birhanu and Majumdar (2019) [7] reported ARRP supplementation has significant effects on buffalo milk protein (%), and fat (%) but not on total solids (%).

Economics of Milk Production

Economically, herbal feed supplement is considered costly, the present investigation proved that the supplementation of ARRP neither affect total feeding cost nor per kg cost of milk production. However, it improved the margin up to Rs. 2.52 over Rs 1.0 investment on feed cost. It can be inferred from these results that ARRP supplementation @ 100-150 mg/Kg BW at pre-partum and 200-300 mg/Kg BW at post-partum period is profitable because supplementation at both doses improved milk production and its quality.

Table 6: Effect of ARRP Supplementation on Milk Production, Composition and Economics of Milk Production

Particulars	Control	T_1	T_2
Average Daily Milk Yield (kg/ buffalo)			
During Supplementation	$8.53^{a}\pm0.22$	$9.85^{b}\pm0.22$	$10.43^{c}\pm0.22$
Post Supplementation	$7.59^{a}\pm0.67$	$8.58^{b}\pm0.67$	$8.68^{b}\pm0.67$
During Supplementation (4% FCM)	$13.329^{a}\pm0.39$	$15.882^{b}\pm0.39$	$17.354^{c}\pm0.39$
Post Supplementation (4% FCM)	12.44±0.71	13.45±0.71	14.43±0.71
Milk Composition and Nutrient Yields			
% Milk Fat	7.55±0.17	7.80±0.17	8.11±0.17
Milk Fat Yield (kg/buffalo/day)	$0.656^{a}\pm0.02$	$0.789^{b}\pm0.02$	$0.871^{c}\pm0.02$
% Milk Protein	$3.53^{a}\pm0.07$	$3.60^{a}\pm0.07$	$3.79^{b}\pm0.07$
Milk Protein Yield (kg/buffalo/day)	$0.31^{a}\pm0.01$	$0.36^{b}\pm0.01$	$0.41^{c}\pm0.01$
% Milk Lactose	5.31±0.09	5.44±0.09	5.54±0.09
Milk Lactose Yield (kg/buffalo/day)	$0.46^{a}\pm0.01$	$0.55^{b}\pm0.01$	$0.60^{c}\pm0.01$
% Milk SNF	$9.71^{a}\pm0.04$	$9.83^{a}\pm0.04$	$9.91^{b}\pm0.04$
Milk SNF Yield (kg/buffalo/day)	$0.85^{a}\pm0.02$	$0.99^{b}\pm0.02$	$1.06^{c}\pm0.02$
% Milk TS	$17.26^{a}\pm0.20$	$17.64^{a}\pm0.20$	$18.12^{b}\pm0.20$
Milk TS Yield (kg/buffalo/day)	$1.50^{a}\pm0.04$	$1.78^{b}\pm0.04$	$1.94^{c}\pm0.04$
Economics of Milk Production			
Average supplementation expenditure (Rs./ buffalo/day)	0	11.47	14.93
Total Feeding Cost/kg of Milk (Rs.)	9.37	9.41	9.55
Margin of receipt over control (Rs./ buffalo /day)	-	27.94	37.72

Conclusion
The present study concluded that pre to postpartum ARRP supplementation has a significant effect on buffalo milk production and its quality. It has the potential to increase the income over the investment. Thus, pre to postpartum supplementation of ARRP is economically viable and beneficial, and it could serve as a potential management tool to improve milk production, composition and net returns from buffalo husbandry.

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