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Postpartum feeding intervention through herbal feed supplement (*Asparagus racemosus*) during winter and its effect on productivity of crossbred cows

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ABSTRACT

This study was undertaken to determine effect of daily minimum temperature conditions and postpartum *Asparagus racemosus* root powder supplementation on milk production and reproduction on freshly winter calved crossbred (Karan Fries) cows. Winter calved cows (10) with similar parity, milk production ability and body weight were subjected to experiment as ARRP (*Asparagus racemosus* root powder supplement @200mg/kg live body weight) and control group (n=5). Consuming similar amount of dry matter, postpartum *Asparagus racemosus* supplementation increased daily milk yield significantly at different daily minimum temperature during winter. With this dose level, effect of *Asparagus racemosus* root powder on reproduction and milk composition (fat, SNF and total solids) was not found significant. The milk yield of winter calved cows supplemented with AR was less affected to daily minimum temperature than the control un-supplemented cow (r^2 _ 0.38 vs. 0.54). *Asparagus racemosus* root powder supplement has beneficial effect on udder health of supplemented cows. Postpartum supplementation of *Asparagus racemosus* root powder reduced per litre cost of milk production and increased net return/day/animal. Therefore, it can be concluded that supplementation of *Asparagus racemosus* root powder postpartum is economically viable and beneficial to improve milk production in winter calved crossbred cows however, its potential used to ameliorate the temporary cold heat stress seems to be further studied.

Key words: Milk yield, Reproduction, *Shatavari*, Winter

Extremes in climate alter the energy transfer between animal body and its environment and can affect deleteriously (Gwazdauskas 1985, Bulbul and Ataman 2009). India a country of diversified climate and dairy animals are faced 4 types of environment round the years (Khan 2008). Moderate winter in the December and March is favourable; however, severe winter in January and February causes cold stress. That needs extra heat energy to maintain homeostasis of body core temperature. The extra heat energy requirements during winter to maintain thermal balance may hamper the production and reproduction (Mann *et al.* 2005) of lactating animal. Furthermore, early postpartum period is a very stressful condition, marked as low dry matter intake, higher nutrients demand, increase oxidative stress and depress immune system. Depressed feed intake and immune system and low level of antioxidant status cause more susceptibility to metabolic and infectious disease in lactating animals (Lloyd 1983, Nagahata *et al.* 1992, Fairfield *et al.* 2007, Sharma *et al.* 2011). These conditions worsen in winter calving cows. Indian dairy farming is traditional dairy farming, therefore, generating a new wisdom through indigenous natural resources has special significance. *Asparagus racemosus* (AR) are trusted and is part of various medicinal preparations used to cure various types of diseases validated as potential antioxidant and anti-stress (Velavan and Begum 2007, Velavan *et al.* 2007), immunomodulator, appetizer (Vijaya and Vasudevan 1994, Goel and Sairam 2002, Bhatnagar and Sisodia 2005), hepato-protector (Muruganandan *et al.* 2000, Pandey and Sahay 2001) and promotes adoptability against adverse condition (Bhattacharya *et al. 2002,* Muruganandan *et al.* 2002*,* Azmathulal *et al.* 2006). *Asparagus racemosus* was also reported as galactopoietic and aphrodisiac herb in dairy animal (Kumar *et al.* 2010 and 2011). Considering needs, safety and its beneficial effect, root of *Asparagus racemosus* was explored to improve the milk production and reproduction in winter calved crossbred cows.

MATERIALS AND METHODS

Location of study

The study was conducted in the experimental cattle shed of National Dairy Research Institute, Karnal, India located at 29°423 202 N and 76°583 52.52 E at an altitude of 834 ft

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Table 1. The fortnightly average minimum, maximum and daily temperature (°C) and THI during experiment

Fortnight	Minimum temp. (°C)	SEM	Maximum temp. (°C)	SEM	Daily temp. (°C)	SEM	THI	SEM
1	8.71	0.54	21.43	0.58	15.07	1.24	67.20	0.37
2	4.90	0.61	20.13	0.29	12.54	1.45	63.47	0.40
3	6.53	1.05	19.25	0.66	12.89	1.33	59.80	0.59
4	3.69	0.89	16.89	0.52	10.15	1.35	56.20	0.73
5	4.52	0.64	17.41	0.59	10.96	1.27	57.95	1.04
6	8.13	0.73	23.59	0.37	16.03	1.46	53.37	1.09
7	12.93	0.56	28.54	0.39	20.73	1.49	54.45	0.50
8	13.97	0.34	31.79	0.30	22.89	1.67	61.88	0.72
9	16.79	0.57	31.45	1.29	24.23	1.51	68.08	0.43
10	18.45	0.48	38.44	0.66	28.37	1.91	70.50	0.34

amsl. The experiment was conducted in December to April with minimum and maximum temperature variation from –0.2°C and 26.4°C.

Experimental animals

Considering the importance of prepartum management and its effect on milk production, pregnant Karan Fries crossbred cows (10) were selected after drying off around 60 days prepartum and after parturition divided randomly in 2 groups according to the most probable production ability (MPPA), parity and body weight at the initiation of lactation. The groups of animals were, viz. C- control (MPPA 3841.0±83.83, parity 2.6±1.12 and initial body weight 388.40±26.05 kg) and ARRP – *Asparagus racemosus* root powder supplement group (MPPA 3891.0±126.59, parity 2.4±0.9, initial body weight 394.40±18.90 kg). All animals were kept under similar management condition and fed as per NRC (1989).

Treatment and dose of herbal feed supplement

Herbal feed supplement, *Asparagus racemosus* root powder, was procured commercially. The specific dose of AR root powder during the postpartum period was derived based on an earlier report (Berhane 2000). The root powder of *AR* was supplemented after milking with small quantity of concentrate once at morning in a day. Depending upon the requirement of cows during the lactation period all animals were fed with berseem (*Trifolium alexandrinum*) and wheat straw (1–2 cm particle size) as a roughage and concentrate % based mix ration. During lactation period % ratio of concentrate and roughage in the offered mixed ration was 55:45. The physical composition (%) of the concentrate mixture was: maize grain 33, groundnut cake 21, mustard cake 12, wheat bran 20, deoiled rice bran 11, mineral mixture 2 and common salt 1. To estimate the total dry matter intake difference between offered and left over dry matter, if any, was measured next morning. Fresh and clean water was provided free of choice to each cow. The cows of ARRS group were supplemented *AR* root powder for 90 days, and its residual effects were recorded up to next 60 days of lactation under controlled feeding conditions.

Analytical techniques

The offered feed samples were analyzed for proximate principles and fibre fractionations as neutral detergent fibre (NDF) and acid detergent fibre (ADF) as per AOAC (1995) and Van Soest *et al.* (1991), respectively. The *AR* samples were also analyzed for total phenolic and tannin (Makkar 2003). The cows were milked three times in a day (4:30, 12:30 and 19:30h) and milk yield was recorded individually at each milking. A fortnightly composite sample from the 3 milking was analyzed for fat, SNF and total solids by automatic milk analyzer. The total solid values of milk sample were estimated by addition of SNF and fat value. Milk yield and milk fat percentage was used to calculate 4% fat-corrected milk (FCM). The values of milk fat *(ghee)* total cholesterol from composite sample of the 3 milking were estimated monthly (Reddy 2007). Weekly MCMT score and fortnightly milk SCC were calculated as per Sastry (1978) and International Dairy Federation (1984) respectively. Incidences of mastitis and sub-clinical mastitis were also monitored regularly at the institute's veterinary hospital. Fortnightly feed efficiency (yield of kg FCM per kg DMI) was calculated by total DMI of individual cow divided by their respective milk yield. Daily THI values were determined for the experimental period using the equation, THI = 0.72 (C_{db} + C_{wb}) + 40.6 as described by U.S. Weather Bureau where C_{db} and C_{wb} are the dry bulb temperature and wet bulb temperature (°C), respectively. After parturition, onset of estrus was observed during morning, noon and evening and signs of estrus were scored as per Van Eerdenburg *et al.* (1996). Service period (days), and number of services per conception recorded. Blood samples were collected during postpartum period from the jugular vein of all experimental animals into heparinized (20 IU heparin/ ml blood) tubes at monthly interval. Glucose in blood plasma (O-Toluidine method), plasma protein (using kit, Erba Mannnheim GmbH), urea and total immunoglobulin (McEwan and Fisher 1970)

were estimated to investigate the effect of *Asparagus racemosus* supplementation on blood metabolites. Although supplementation of AR is an extra investment, therefore, economics of milk production and cost save per day reduction in service period were also calculated over standard days of service period (93 days).

The least square's technique was applied to estimate the mean daily milk yield, and all values are expressed as mean±SEM (standard error of the mean). The significance of treatment differences was examined by Duncan's multiple range test (Harvey 1975). Student's t-test was employed to estimate the effect of treatment on reproductive performances, blood parameter and parameters related to economics of milk production (Snedecor and Cochran 1989).

RESULTS AND DISCUSSION

Feed intake: Postpartum AR root powder supplementation did not affect the dry matter intake. AR improved digestibility of nutrient (Dangi 2011) resulting in significant improvement in total DMI per animal per day (Berhane and Singh 2002, Gupta *et al.* 2004). However, in the present study result could not reach up to the level of significance. Although, increasing trends were observed in the supplemented ARRP group (Fig.1). ARRP supplementation improved digestion and assimilation of nutrients in dairy animals (Gupta *et al.* 2004, Dangi 2011), it might be responsible for significant (P<0.05) improvement in feed conversion efficiency in ARRP group than the control group.

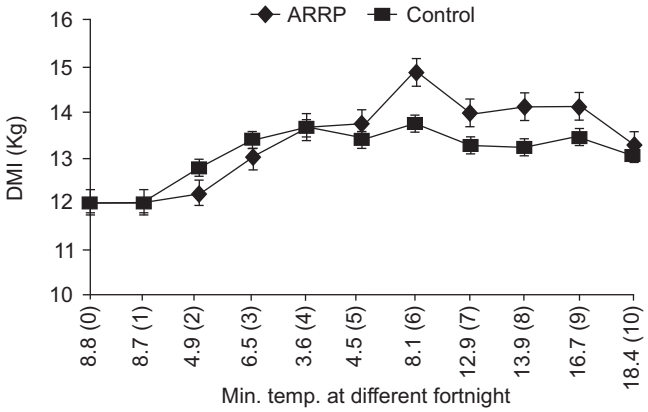

Fig. 1. Effect of ARRP herbal feed supplement on DMI (kg/day)

Milk production

Postpartum supplementation of ARRP increased average daily milk yield significantly (P<0.01) in the supplemented group than the control group. Up to 4 fortnights after withdrawal of supplementation, the residual effect of ARRP were also observed and found significantly (P<0.01) higher daily milk yield (Table 4). Reduction in daily milk yield (FCM) from the supplementation period to residual period in the control group was more evident. The reduction in milk yield was 3.51 kg against 2.18 kg in the supplemented ARRP group. On an average per day reduction in per day milk yield during residual period from 90 days to 150 days of lactation was 0.036 kg and 0.058 kg in the ARRP and control group, respectively. All cows attain her peak milk yield within 60 days of lactation and then maintain production and after 90 days that decline gradually. Based on declining rate in milk yield of the ARRP and control group it can be furnished that AR supplementation are helpful to maintain the persistency of milk production.

The effect of AR supplementation on milk yield at different environmental temperatures is given in Figs 2 and 3.

Table 2. Plant secondary metabolites and nutritional properties of *AR* and feeds offered

Particulars/ constituents (%DM basis)	OM	CP	EE	Total ash	NDF	ADF	Total phenolics	Total Tannin
AR (root)	90.7	6.47	0.35	2.5	38.14	13.4	4.57	3.68
Concentrate	91.33	20.46	4.23	8.67	43.49	13.5	-	-
Berseem	89.93	17.83	3.34	10.07	31.29	26.52	-	-
Wheat Straw	91.16	3.13	0.96	8.84	68.82	54.16	-	-

Table 3. DMI (kg/d) and Feed efficiency in Karan Fries cows

Parameters	Control	ARRP
DM intake (kg/day) during Supplementation period	13.00±0.26	13.10±0.24
DM intake (kg/day) during residual period	13.25±0.37	13.89±0.21
DM intake per 100 kg body weight during supplementation period	3.34±0.07	3.25±0.06
DM intake per 100 kg body weight During residual period	3.25±0.08	3.32±0.06
Feed conversion efficiency (kg DMI/ kg FCM) during supplementation period	0.74a±0.03	0.64b±0.01
Feed conversion efficiency (kg DMI/ kg FCM) during residual period	0.75±0.04	0.65±0.02

Means with different superscripts a, b in a row differ significantly (P<0.05)

Table 4. Milk yield and body weight change in winter calving Karan Fries cows

Parameters	Control	ARRP
Milk yield (kg/day) during supplementation period	19.53^{a}±0.22	22.16^{b}±0.22
Milk yield (kg/day) during residual period	16.22^{a}±0.19	18.67^{b}±0.19
4% fat corrected milk yield (kg/day) during Supplementation period	20.07^{a}±0.22	22.22^{b}±0.22
4% fat corrected milk yield (kg/day) during residual period	16.56^{a}±0.19	20.04^{b}±0.19
Body weight change from day zero to end of supplementation (kg)	–3.80	27.80
Body weight change from day end of supplementation to end of residual period (kg)	8.10	- 2.10
Fortnightly body weight change during supplementation period (kg)	-0.63^{A}±2.34	4.63^{B}±0.90
Fortnightly body weight change during residual period (kg)	2.03±2.09	–0.53±2.22

Means with different superscripts a, b in a row differ significantly (P<0.01);means with different superscripts A, B in a row differ significantly (P<0.05).

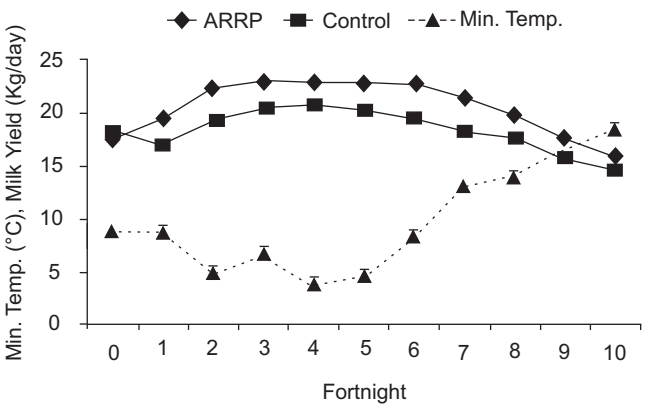

Fig. 2. Lactation curves of control and AR supplemented cows at different temperature (°C).

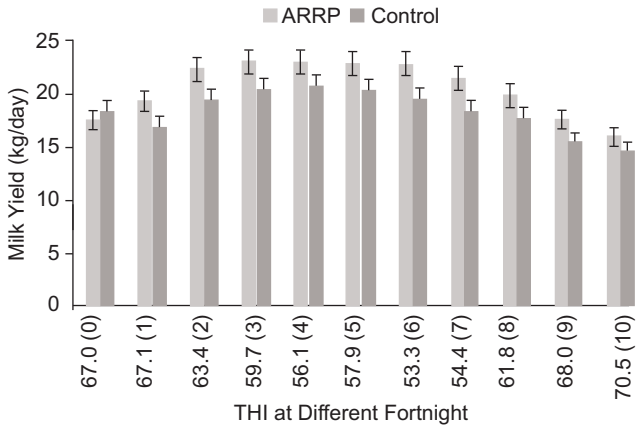

Fig. 3. Milk yield at different THI.

The fortnightly average of daily milk yield in Dec, January and February in the control group was lower than the supplemented ARRP group. The correlation between fortnightly minimum daily temperature and daily milk yield during supplementation period in the control group was –0.70 which was less evident in the supplemented ARRP group, i.e. –0.48. The degree of correlation in different groups clearly indicates that milk yield of *Asparagus racemosus* supplemented cows were less affected with cold thus, it helps to sustain the milk productivity during low temperature. The correlation value between milk yield and temperature for all fortnights in the Control and ARRP groups were –0.79 and –0.90 respectively. Similarly, regression values were also lesser in the supplemented ARRP group than the Control group (Table 5).

The effect of *Asparagus racemosus* on milk constituents such as fat, SNF and total solids was not significant. Fat, SNF and total solids in the control were 4.19±0.18; 4.06±0.28; 8.68±0.02 and ARRP groups during supplementation period were 8.71±0.14, and 12.87±0.24 and 12.61±0.34% respectively.

Due to hypothermic condition in winter, a cow needs extra energy to maintain their body core temperature. Furthermore, early lactation requires higher energy to sustain the milk production. Exceeding demand of energy than the consumption causes loss of body weight at early lactation. Loss of body weight during the first 2 fortnight of early lactation was more pronounced in the control cow, although, subsequently, it was reduced and an average reduction in body weight was –0.63 kg/fortnight. Losses of body weight in the AR supplemented cows recovered from the end of first fortnight and showed a positive change in body weight from the second fortnight continuously (Fig. 4). The AR supplemented group producing higher milk and gain in body

Table 5. Environmental temperature and its association with milk yield

Parameters	Control	ARRP
Correlation between milk yield and minimum daily temperature during supplementation period (°C)	–0.74	–0.62
r^2 value between milk yield and minimum daily temperature during supplementation period (°C)	0.54	0.38
Correlation between milk yield and THI during supplementation period	–0.73	–0.79
r^2 value between milk yield and THI during supplementation period	0.54	0.63

weight averagely 4.63 kg/fortnight. The difference in change in body weight between both groups was significant (P<0.05). To our best knowledge, literature on AR supplementation and its effect on milk production and body weight change during winter is not available, therefore, results could not be compared. However, similar results were also reported in supplementation of silymarin a hepatoprotective phytochemical derived from herbal plant milk thistle. AR has also hepatoprotective properties and supplementation of silymarin, a natural hepatoprotector agent that reduce postpartum losses of condition in treated cows (Tedesco *et al.* 2004), that might be associated to severe hepatic lipidosis (Gerloff *et al.* 1986). After withdrawal of supplementation, the trends could not be sustained and rate of gain in body weight declined in the AR supplemented group than the control group (Fig. 4). During the residual period, the control group producing lower milk and gaining higher body weight than the supplemented group with lower DM intake. At the same time, both DM intake and milk yield in the supplemented group were slightly higher suggesting the importance of the AR supplementation in feed nutrients assimilation and its use efficiency (Table 4). Anabolic property of AR might be responsible for the better body weight gain in the supplemented cows as reported in mice (Sharma *et al.* 1986) and in growing heifer (Gupta *et al.* 2004).

Similarly, supplementation of AR root powder with varying dose levels in postpartum crossbred cow improved

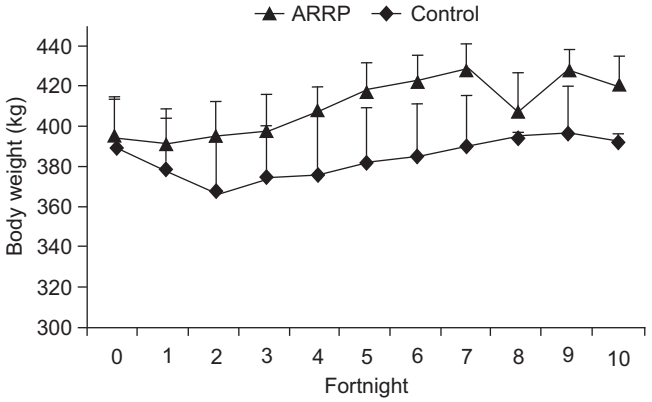

Fig. 4. Body weight change at different fortnight in winter calving KF cow.

milk yield significantly (Mishra *et al.* 2008, Tanwar *et al.* 2008). Similar results were also reported in buffalo with supplementation of AR root powder @ 25 g/day/animal (Somkuwar *et al.* 2005). AR improves milk production either by improving feed intake and its digestibility (Berhane and Singh 2002, Gupta *et al.* 2004, Dangi 2011) or strengthening the endocrine system which could lead to higher prolactin secretion that helps in division of mammary gland alveolar (Singh 2010). Modulation of adoptability power against an adverse conditions might also be a possibility to improve the milk yield during winter (Bhattacharya *et al.* 2002, Muruganandan *et al.* 2002, Azmathulal *et al.* 2006).

Reproductive performance

Extreme environment either hot or cold affects the normal reproductive physiology of dairy animal ameliorating these effects and reducing the service period is a matter of concern for dairy farmers. Reproductive performance in terms of estrus behaviour score, first postpartum estrus, service period and services per conception in the present study were statistically similar in the both ARRP and control group. However, reproductive performance improved numerically but not up to the level of significance, might be due to small number of experimental animals. Supplemented cow came early in heat postpartum and conceived early with the lesser number of service required for conception. Reduction in the postpartum estrus and service period were 16.59 days and 21.4 days, respectively in ARRP supplemented group. Similarly, service per conception was also improved by 28.57% in comparison to control group. Early initiation of estrus in the supplemented cows might be estrogenic properties of AR as reported in mice (Pandey *et al.* 2005). Early commencement of cyclicity and conception in cows was also associated to their immunity level during early lactation. The AR supplemented cows were conceived earlier and have significantly (P<0.05) better immunity level (Table 6). Mallick and Prakash (2011) also reported that supplementation of *Guduchi* an immunomodulator herb improved immunity level in crossbred cow and is therefore, the key to early cyclicity commencement in the supplemented cows. Study on the effect of AR supplementation on reproductive performance of dairy animal is limited. Beneficial effect of AR supplementation on postpartum heat and service period and conception rate was also reported by Berhane (2000) but no any scientific evidences explained improvement in reproductive performance in crossbred cow. Other route through which AR can improve the reproductive performance is energy balance. During winter maintaining productivity and body core temperature causes the decrease in body weight. Decrease in body weight articulates negative energy balance, and it has been associated with delay onset of cyclicity (Mann *et al.* 2005). In the present study, body weight gain was observed negative in the control group, and positively higher in the supplemented ARRP group that clearly expresses a sign of positive energy balance

Table 6. Reproductive performance in winter calving Karan Fries cows

Group	First estrus behaviour score	First postpartum estrus (days)	Service period (days)	Services per conception
Control	178±13.6	55.59±6.83	151.01±0.97	2.80±0.57
ARRP	203±14.3	49.00±6.83	129.60±0.97	2.00±0.57

consequently better reproductive performance (Folman *et al.* 1973, Villa-Godoy *et al.* 1988, Spicer *et al.* 1990, Sklan *et al.* 1991, Spicer *et al.* 1993). The blood metabolites especially plasma glucose and urea concentration are also associated with conception in cow. Butler (1998) reported that plasma urea level was inversely related to uterine pH. Increased plasma urea concentrations may interfere with the normal inductive actions of progesterone in the micro-environment of the uterus and thereby causing sub optimal conditions for the support of embryo development. As blood glucose is the main source of energy for ovarian function (Rabiee *et al.* 1997), and influences bovine thecal cell steroidogenesis *in vitro* (Stewart *et al.* 1995), which may play a major role in achievement of postpartum follicles development and ovulation. However, further studies are needed to confirm the role of AR in reproductive performance of cows.

Udder health

During the supplementation period, average of somatic cell counts in the ARRP group was significantly (P<0.05) lower than that of control group. The respective value during the residual period were also lower but not up to the level of significant (P>0.05). The incidence of sub-clinical mastitis (MCMT) per teat in the supplemented ARRP group were also significantly (P<0.05) lower than that of non-supplement control group. Supplementation of AR lowered the values of SCC and MCMT score, but it could not lower significantly quarter wise percent prevalence of sub-clinical mastitis. Incidences of clinical mastitis in the supplemented group were not reported. However, 2 out of 5 cows suffered from mastitis during the supplementation period. In the present study plasma total immunoglobulin was reported

Table 7. Effect of *A. racemosus* supplementation on Plasma glucose, total protein, urea and immunoglobulin concentration during supplementation period

Group	Plasma glucose (mmol/dL)	Plasma total protein (g/dL)	Plasma urea (mg/dL)	Plasma immunoglobulin concentration (mg/ml)
Control	3.73^{a}±0.08	5.24^{a}±0.18	45.14^{a}±1.22	23.31^{a}±2.09
ARRP	4.12^{b}±0.06	5.64^{a}±0.19	41.19^{b}±1.75	26.57^{b}±1.71

Means with different superscripts a, b in a column differ significantly (P<0.05).

significantly higher, which indicated the better immunity level in the supplemented ARRP group (Table 7). Research conducted on rats/mice/ showed that AR had anti-inflammatory, immunomodulator and immunopotentiator properties that enhance the phagocytosis and bactericidal capacity of neutrophils and macrophages (Mandal *et al.* 1998, Gautam *et al.* 2004, Gautam *et al.* 2009, Rekhate *et al.* 2010) might be resulted as the lower SCC and lower incidence of mastitis. However, further study is required to confirm their role in dairy animal.

AR supplementation and its associative economics: Alleviated reproductive performance and diseases incidence has direct economic implications in terms of losses due to reduced production on one hand and additional cost on management on the other (Mulligan *et al.* 2006). Therefore, reducing the service period and diseases incidence means increasing lifetime production and profitability in dairy farm (Agarwal *et al.* 2005). The AR supplementation reduced service period by 21.41 days over the control group (Table 6). Estimated cost saved over per day reduction in the service

Table 8. Effect of herbal feed supplement on prevalence of sub-clinical mastitis and milk somatic cell counts

Parameters	Control	ARRP
Milk SCC during supplementation period ($\times 10^5$ cells/ml)	1.55^{a}±0.19	1.03^{b}±0.10
Milk SCC during post supplementation residual period ($\times 10^5$ cells/ml)	1.22^{a}±0.18	1.04^{a}±0.12
Weekly MCMT score during supplementation period (per teat)	0.70^{A}±0.06	0.47^{B}±0.05
Weekly MCMT score during residual period (per teat)	0.79±0.09	0.68± 0.07

Means with different superscripts a, b in a row differ significantly (P<0.05)**;** means with different superscripts A, B in a row differ significantly (P<0.01).

Table 9. ARRP herbal feed supplement and associative economics

Parameters	Control	ARRP
Extra cost on per day extended service period (₹)	20.63^{a}±1.01	9.25^{b}±0.45
Cost of milk production per litre including cost incurred on prolong service period (₹)	8.46^{a}±0.32	7.06^{b}±0.15
Net return per day per animal during supplementation (₹)	135.8^{a}±9.78	161.08^{b}±7.26
Net return per day per animal during Post supplementation (₹)	94.17^{a}±8.75	129.68^{b}±9.38

Means with different superscripts a, b in a row differ significantly (P<0.05).

period in the supplemented group was ₹10.38 over the control group. The increase milk yields/day and reduced extra cost of treatment and maintenance on extended length of the service period resulted reduced cost of milk production per litre significantly (P<0.05) by 16.54%. Based on prevailing price of milk, supplementation of AR increased profitability by 10.99% (₹ 25.27)/day/cow over the control group (Table 8).

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