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Research Article

IMPACT OF AZOLLA (*AZOLLA PINNATA*) SUPPLEMENTATION ON MILK PRODUCTION AND ECONOMIC EFFICIENCY IN JERSEY×SAHIWAL CROSSBRED COWS

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ABSTRACT

Four field studies were conducted during the 2018-2021 by establishing Azolla production units at farmer's field in Sri Ganganagar district of Rajasthan. At village level, each year's 50 crossbred lactating cows (Total 200) with same age (second to third lactation of 4 to 5 years old) at mid period of lactation were selected. The selected cows were divided in two groups as Control (C) group (n=25 Cows) and Treatment (T) group (n=25 cows) in all four trials. The control group was fed a standard diet consisting of maize green fodder, wheat straw and cottonseed cake, in accordance with ICAR feeding guidelines. The treatment group received the same basal diet, supplemented with 1.5 kg of fresh green Azolla (*Azolla pinnata*) daily. Cows were milked manually using the hand milking technique. Milk samples were collected every fortnight over a 90 day period for analysis. In Trials 1 (2018), 2 (2019) and 4 (2021), the average daily milk yield was significantly higher ($P<0.05$) in the treatment group compared to the control group across all fortnights, indicating consistent improvement in lactation performance with Azolla supplementation. Milk fat percentage remained consistent across both groups throughout the study period. Additionally, all four trials demonstrated a higher net profit and a superior Benefit: Cost (B:C) ratio in the treatment group, highlighting the economic advantage of incorporating Azolla into the diet.

Keywords: Azolla, Crossbred, Economics, Fat, Milk yield

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Azolla is an aquatic fern used for feeding of livestock. Lumpkin and Plucknet (1982) reported among the various species of Azolla, six are particularly well-known for their agricultural relevance: *Azolla pinnata*, *Azolla microphylla*, *Azolla filiculoides*, *Azolla caroliniana*, *Azolla mexicana* and *Azolla nilotica*. Azolla is very rich in protein, carotenoids, bio-polymers, and probiotics, vitamin, growth promoter intermediaries, minerals etc. Sanginga and Van Hove (1989) reported about its amino acid composition. Azolla has been recognized as a valuable protein -rich feed resource, containing approximately 21.6% protein along with all essential amino acids (Mandal *et al.*, 2012). It is also a good source of minerals, with calcium and phosphorus levels ranging between 0.4-1.0% and 0.5-0.9%, respectively (Subudhi and Singh, 1978). Numerous studies have highlighted the beneficial effects of Azolla supplementation in both livestock and poultry nutrition (Parthasarathy *et al.*, 2003; Chatterjee *et al.*, 2012; Kumar *et al.*, 2016). It can be used as a non-conventional feed source for livestock feeding mainly during scarcity of green fodder. Azolla is called 'Green gold' due to its chemical composition. Azolla provided better environment for digestibility resulted in betterabsorption of nutrients Gupta *et al.* (2019). Chatterjee *et al.* (2012) found and reported that feeding of azolla resulted in 11% increase in milk yield in crossbred cattle. Kumar (2020) found that Azolla fed dairy cows showed a significant ($P<0.005$) increase upto 10.43% in milk production. However, such studies are lacking in arid zone of Rajasthan. Therefore, the objective of this study was to assess the impact of dietary supplementation with *Azolla pinnata* on milk production and economic returns in Jersey × Sahiwal crossbred cows.

MATERIALS AND METHODS

The present investigation was designed and conductedin field conditions in Shree Ganganagar district, Rajasthan. The Azolla production units were established in villages. Samples of Azolla from established unit at farmer's field were collected for chemical analysis and according to AOAC (2005) the percentage of Dry Matter, Crude protein (CP) and Ether Extract (EE), Organic matter total ash content in Azolla were analyzed as part of the nutritional evaluation. The data were collected from 2018 to 2021 named as Trial 1 to trial 4. The trial procedure adopted was same for all experimental years. Each year, 50 crossbred lactating cows with same age with 2 to 3 lactation of 4 to 5 years old at mid-lactation stage were selected. The animals were divided in two groups as Control (C) group (n=25 Cows) and Treatment (T) group

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(n=25 cows). Animals in the control group were provided a diet consisting of maize green fodder, wheat straw and cottonseed cake, formulated according to ICAR (2013) feeding standards. The treatment group received the same basal diet, with the addition of 1.5 kg of fresh green *A. pinnata* daily. All cows were milked manually using the hand-milking technique. Milk samples were collected and recorded at fortnight interval for 90 days. The milk quantity was measured by weighing balance. The fat percentage was determined using the Gerber method, as outlined in IS 1224-1 (1977). The economic analysis was conducted using the methodology of cost of the inputs and sell of the produce at present prices of the market throughout the duration of the study. The data were analyzed using Analysis of Variance (ANOVA) as described by Snedecor and Cochran (1989) by using repeated measures ANOVA procedure.

RESULTS AND DISCUSSION

Composition of *Azolla pinnata*

The proximate composition of *A. pinnata* (on a dry matter basis) was found to be as follows: dry matter (DM) 9.01±0.05%, organic matter (OM) 79.24±0.26%, crude protein (CP) 23.13±0.087%, ether extract (EE) 3.89±0.22% and total ash (TA) 19.61±0.15%. The chemical composition of *Azolla pinnata* was found to be broadly consistent with previous studies reported by Verma *et al.* (2021), Ali and Leeson (1995) & Tamang and Samanta (1993).

Table 1. Fortnightly Milk Yield (kg/day) of Crossbred Cattle in different group (n=25)

	Trail 1 (2018)		Trail 2 (2019)		Trail 3 (2020)		Trail 4 (2021)	
Fortnights	C	T	C	T	C	T	C	T
1.	5.37^{a}±0.04	5.76^{b}±0.05	6.22^{a}±0.07	6.50^{b}±0.07	6.39±0.06	6.54±0.08	6.19^{a}±0.10	6.70^{b}±0.04
2.	5.38^{a}±0.03	5.83^{b}±0.05	6.34^{a}±0.04	6.66^{b}±0.18	6.45±0.06	6.65±0.07	6.26^{a}±0.11	6.76^{b}±0.04
3.	5.47^{a}±0.03	5.91^{b}±0.05	6.20^{a}±0.09	6.54^{b}±0.07	6.48±0.07	6.60±0.08	6.28^{a}±0.11	6.69^{b}±0.06
4.	5.50^{a}±0.04	5.94^{b}±0.05	6.34^{a}±0.33	6.60^{b}±0.06	6.41^{a}±0.09	6.65^{b}±0.07	6.21^{a}±0.12	6.74^{b}±0.05
5.	5.42^{a}±0.04	5.87^{b}±0.05	6.15^{a}±0.09	6.62^{b}±0.05	6.39±0.08	6.61±0.08	6.20^{a}±0.11	6.71^{b}±0.06
6.	5.26^{a}±0.12	5.83^{b}±0.05	6.19^{a}±0.10	6.55^{b}±0.07	6.42±0.07	6.59±0.08	6.09^{a}±0.12	6.69^{b}±0.06
Overall Mean	5.40^{a}±0.03	5.85^{b}±0.02	6.24^{a}±0.03	6.57^{b}±0.02	6.42^{a}±0.01	6.60^{b}±0.01	6.20^{a}±0.02	6.71^{b}±0.01

*Values with different superscripts in a row differ significantly at ($P<0.05$).
Standard diet without supplementation (C) or supplemented with Azolla (T)

Table 2. Economics of Azolla supplementation in Crossbred Cattle in different group

Economic Indicators	Trail 1 (2018)		Trail 2 (2019)		Trail 3 (2020)		Trail 4 (2021)	
	C	T	C	T	C	T	C	T
Gross Return From Milk (Rs.)	216.00	234.40	249.60	263.20	256.80	264.40	248.40	268.80
Net Profit (Rs.)	153.40	178.80	177.29	202.16	182.44	203.25	174.04	207.65
Cost of Inputs (Rs.)	62.6	55.6	72.30	61.03	74.36	61.15	74.36	61.15
Benefit:Cost (B:C) Ratio	3.45	4.21	3.45	4.31	3.45	4.32	3.34	4.39

*Standard diet without supplementation (C) or supplemented with Azolla (T)

Table 3. Fortnightly Milk Fat (kg) of Crossbred Cattle in different group

	Trail 1 (2018)		Trail 2 (2019)		Trail 3 (2020)		Trail 4 (2021)	
Fortnights	C	T	C	T	C	T	C	T
1.	3.82±0.04	3.74±0.04	3.80±0.04	3.70±0.04	3.66±0.05	3.63±0.05	3.64±0.05	3.58±0.05
2.	3.80±0.04	3.76±0.04	3.74±0.04	3.72±0.05	3.66±0.05	3.65±0.05	3.65±0.05	3.60±0.05
3.	3.76±0.05	3.71±0.05	3.74±0.05	3.71±0.05	3.68±0.05	3.68±0.05	3.69±0.07	3.63±0.05
4.	3.74±0.05	3.69±0.05	3.72±0.05	3.69±0.05	3.70±0.06	3.66±0.06	3.66±0.06	3.60±0.06
5.	3.88±0.03	3.83±0.03	3.86±0.03	3.77±0.04	3.76±0.05	3.70±0.05	3.73±0.05	3.64±0.05
6.	3.87±0.03	3.82±0.03	3.86±0.03	3.78±0.04	3.78±0.03	3.70±0.05	3.76±0.04	3.65±0.05
Overall Mean	3.81±0.02	3.75±0.02	3.78±0.02	3.72±0.01	3.70±0.02	3.67±0.01	3.68b±0.01	3.61a±0.01

*Standard diet without supplementation (C) or supplemented with Azolla (T)

Fortnightly Daily Milk Production (kg/day) of Crossbred Cattle

The fortnightly daily milk productions (kg/day) of crossbred cattle were presented in table 1. In Trial 1 (2018), Trial 2 (2019) and Trial 4 (2021). Milk productions (kg/day) were considerably greater in Azolla supplemented cattle in each fortnight and overall performance in milk yield was also significantly better in treatment group. In Trial 3 (2020), milk Yield (kg/day) was significantly higher in 4th fortnight and overall performance in milk production was also significantly better in treatment group. The milk production increased due to higher protein and minerals content and better digestibility process. Comparable findings regarding the impact of fresh Azolla supplementation on milk yield were reported by Bhutia *et al.* (2020) where milk yield was reported increased to 6.5 lit to 7.8 liter/day/animal. Kumar *et al.* (2020) found that dairy animals supplemented with Azolla produce 0.5 to 0.9 liter increase in daily milk yield per animal. Kumar (2020) also found increase in milk yield increased after feeding of azollato dairy cows. The results of this study align with those of Nidhi *et al.* (2015), who observed a notable increase in milk production with Azolla supplementation.

Fortnightly Milk Fat (%) in Crossbred Cattle

The fortnightly milk fat (%) of crossbred cattle was presented in table 3. In Trial 1 (2018), Trial 2 (2019) and Trial 3 (220) Milk Fat was similar in all fortnights and overall performance in milk fat was also same between control and treatment groups. In Trial 4 (2021), overall performance in milk fat was significantly lower in treatment group it might be due to the higher milk yield as inverse relation for milk fat and milk yield and results of the present study were contradictory with Kumar (2020) and Kour *et al.* (2020) who found there was increase in milk fat (%) after feeding of azolla in dairy cows.

Economics of Azolla Supplementation

The economics of *Azolla* supplementation in Crossbred Cattle in different group were presented in table 2. In all trials Net Profit (Rs.) higher in treatment groups as compared to control group while Benefit: Cost Ratio were in trial 1- (3.45 vs 4.21), in trial 2-(3.45 vs 4.31), in trial 3-(3.45 vs 4.32) and in trial 4-(3.34 vs 4.39) in control and treatment groups, respectively. Pillai *et al.* (2005) reported that 20-25% saving in feed when fed with fresh Azollaby increased milk production in dairy cattle. Verma *et al.* (2021) also found that A modest investment of Rs. 1611/- in Azolla supplementation farmers capable to fetchan extra return of Rs. 6344/- per dairy cow. The Benefit: Cost ratio was determined to be 2.93:1. Kour *et al.* (2020) also found that the benefit cost ratio was observed to be higher in Azolla feeding 1.01 compared to control i.e. 0.73 in HF cows.

CONCLUSION

The current results demonstrate that supplementing with fresh green Azolla positively impacted milk yield and economic returns, without any negative effects on animal health. Azolla serves as an excellent protein source, supplying essential nutrients that support milk production. It can be an effective feed option for dairy cows in rural areas, especially during times of feed scarcity or limited concentrate availability.

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