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Research Article

Impact of challenge feeding on milk composition and peak milk yield of Sahiwal cattle in the arid region of Rajasthan

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Abstract

The present research was carried out with the objectives of investigating the effect of challenge feeding on milk composition and peak milk yield of Sahiwal cattle. The study was organized on eighteen healthy, advance pregnant Sahiwal cattle from 60 days prepartum to 120 days postpartum. The animals in the control group were given a standard ration, while in the challenge-fed group, the animals were given a supplementary amount of concentrate mixture. There was no significant effect of challenge feeding on the major milk constituents. The weekly milk fat percentage averaged 4.10±0.10 and 3.94±0.10 in the control and treatment groups, respectively. The lactose (4.44±0.05 and 4.32±0.05), protein (3.51±0.07 and 3.67±0.06) and SNF (8.87±0.04 and 8.95±0.05) percentages also showed non-significant difference among the two treatment groups. The mean number of days required to attain peak yield in cows of the control and treatment group were 44.44±0.99 and 49.56±1.14 days, respectively. The cows of the control group attained peak yields significantly (P<0.05) earlier than the cows of the treatment group.

Keywords: Challenge feeding, Milk composition, Peak milk yield, Sahiwal

Highlights

- In milch cattle during dry and postpartum periods, challenge feeding provides increased nourishment.
- There was no significant effect of challenge feeding on the major milk constituents.
- Fat and lactose levels were marginally higher in the milk of the control group of cows.
- Peak yields of the cows of the treatment groups were found to be statistically non-significant.
- The cows of the control group attained peak yields significantly earlier than the treatment group.

INTRODUCTION

Livestock plays a pivotal role in the Indian economy. About 70% of India's population is dependent on agriculture and livestock-associated activities. Animal husbandry is arguably the most significant combined activity that gives farmers access to quick money, and as such, it is essential to the socioeconomic well-being of livestock farmers in India. The total milk production of India stands at 230.58 million tonnes in 2022-23 (BAHS, 2023). Cows provide 51.31% of milk production in India with a production of 119.69 million tonnes in 2022-23. The population of milch non-descript/indigenous animals stands at 37.16 million in 2019, and the milk production from these non-descript/indigenous cows is 46.67 million tonnes (BAHS, 2023).

Although India has a great population of indigenous cows but, the performance of these animals is very poor. The lactation yield of our indigenous cattle is very low. In rural areas, indigenous animals are often fed with low quality feeds and agricultural byproducts which have low nutritive value. In our country, there is an acute shortage of green and leguminous fodder as most of the land area is utilized for food grains production, and the milch animals are deprived of good quality fodders. In addition to this, in India, concentrate feeding to animals is neglected during dry period as well as in milking stage due to poor economic condition of livestock farmers, so these dairy animals are deprived of essential nutrients.

The period from two months pre-calving to three months post-calving calving, which includes the transition period, is the most stressful period in the annual cycle of dairy cows. It is physiologically and nutritionally a very stressful period, particularly as feed intake is reduced while the demand for support of foetal growth and initiation of milk synthesis are increased. Suboptimal transition from dry season to lactation decreases peak milk supply and persistency and consequently total milk production, diminishes

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reproductive performance and can potentially eliminate the whole profit potential for a particular cow in that lactation (Drackley, 1999). Suboptimal transition from dry period to lactation can decrease total milk production, reproductive performance and the profit potential of dairy animals. Therefore, in order to maximize their production capacity and minimize health issues, milch cows must be wisely and sufficiently fed at this time (Bhat *et al*., 2000). This will increase the dairy producers' income level. Hence, the present study attempts to observe the effect of challenge feeding on the major milk constituents, peak yield and days required to attain peak yield of Sahiwal cattle.

MATERIALS AND METHODS

The current study was carried out from 1 October 2018 to 30 June 2019 at the Livestock Research Station, Kodamdesar, RAJUVAS, Bikaner, Rajasthan.

Test animal

Eighteen (18) pregnant Sahiwal cattle were selected 2 months prior to calving according to data obtained from breeding records of animals. These pregnant animals were allocated in two groups (each group with 9 animals) depending on parity, body weight and milk yield of previous lactations to preserve homogeneity among experimental animals.

The experimental animals were separated from the main herd 7-10 days before the start of the experiment to acclimatize them to the new environment.

Experimental treatments

Selected animals were distributed into two different groups, namely treatment and control. The prepartum and postpartum feeding schedules for both groups are given in Table 1 and Table 2, respectively.

Parameters recorded

The experimental data for different parameters under the present study were:

Milk composition: Fortnightly samples of individual animals were collected during 2 times of milking (morning and evening) in a cleaned plastic bottle. The milk samples collected during 2 times were stored in a refrigerator. Milk samples of the individual animals were collected in clean plastic bottles and were analyzed for fat, protein, lactose and solid-not-fat using an automatic milk analyzer (Milkoscan Mars- Milk @ Laboratory Products- Gerber Instruments).

Peak yield and days taken to achieve peak yield: The peak yield and days taken to achieve peak yield were calculated from the milk yield of the experimental animals.

Statistical analysis

Data were statistically analyzed as per Snedecor and Cochran (1994) for two groups by using statistical 't' test. Data were expressed as Mean ± S.E. For calculation of Mean and S.E., descriptive statistics was used. Comparable means differed significantly if $P<0.05$, i.e. at a 5% level of significance.

RESULTS

Milk composition

Milk fat percentage: The fortnightly mean of milk fat percentage of the cows of control and treatment group are presented in Table 3. The overall mean milk fat percentage of the first eight fortnights of lactation was 4.10±0.10 and 3.94±0.10 for the control and treatment groups, respectively. Milk fat percentage was higher

Table 1. Prepartum feeding schedule

Days prepartum	Control group	Treatment group (challenge feeding)
60 days to 22 days	Forage - ad lib., Concentrate - 2 kg/day	Forage - ad lib., Concentrate - 3.5 kg/day
21 days to 0 day	Forage - ad lib., Concentrate - 3.5 kg/day	Forage - ad lib., Concentrate - 3.5 kg + 250 gm/day till it reaches 1% body weight

Table 2. Postpartum feeding schedule

Days postpartum	Control group	Treatment group (challenge feeding)
1st two weeks	Forage - ad lib., Concentrate for maintenance - 2 kg/day, Concentrate for Production-1kg/ 3 kg of milk	Forage - ad lib., Concentrate for maintenance - 2 kg/day, Concentrate for production – 1 kg/3 kg of milk + 500 gm concentrate/ day till free choice level
2nd week onwards to 16th week	Forage - ad lib., Concentrate for maintenance- 2 kg/day, Concentrate for production - 1 kg/3 kg of milk	Forage - ad lib., Concentrate – Free choice

during the initial period of lactation but declined after the animals reached their peak potential. The inclination in milk fat percentage before and after peak milk yield is achieved indicates negative correlation between milk yield and milk fat percentage. The milk fat percentage of challenge-fed group of cows did not differ significantly from the control group of cows.

Table 3. Mean ± S.E. of fortnightly averages of fat % of the milk of the animals of the control and treatment group

Fortnight after calving	Control group	Treatment group
1st	4.37±0.27	4.36±0.26
2nd	4.10±0.31	3.97±0.33
3rd	4.03±0.24	3.82±0.26
4th	3.84±0.33	3.63±0.29
5th	3.98±0.30	3.52±0.31
6th	4.06±0.29	4.02±0.28
7th	4.13±0.29	3.98±0.26
8th	4.26±0.26	4.26±0.23
Overall	**4.10±0.10**	**3.94 ± 0.10**

Milk lactose percentage: The fortnightly mean of milk lactose percentage of the cows of the control and treatment group is presented in Table 4. The overall mean of milk lactose percentage for first eight fortnights of lactation were 4.44±0.05 and 4.32±0.05 for control and treatment group of cows, respectively. The differences between mean lactose content of the control and treatment group were not significant.

Table 4. Mean ± S.E. of fortnightly average of lactose % of the milk of the animals of control and treatment group

Fortnight after calving	Control group	Treatment group
1st	4.31±0.14	4.44±0.12
2nd	4.50±0.10	4.33±0.15
3rd	4.50±0.12	4.21±0.20
4th	4.69±0.16	4.28±0.09
5th	4.58±0.21	4.34±0.12
6th	4.45±0.12	4.37±0.12
7th	4.36±0.09	4.37±0.14
8th	4.10±0.10	4.24±0.13
Overall	**4.44±0.05**	**4.32±0.05**

Milk protein percentage: The fortnightly mean of milk protein percentage of the cows of the control and treatment group is given in Table 5. The overall mean milk protein percentage was higher in the treatment group (3.67±0.06) as compared to the control group (3.51±0.07). The differences between the mean protein contents of the control and treatment groups were not significant. The slightly higher protein content in milk may be attributed to an extra feeding of protein-rich concentrate to animals of the challenge-fed group.

Table 5. Mean ± S.E. of fortnightly average of protein % of the milk of the animals of control and treatment group

Fortnight after calving	Control group	Treatment group
1st	3.59±0.18	3.64±0.20
2nd	3.61±0.20	3.57±0.20
3rd	3.56±0.21	3.64±0.20
4th	3.48±0.19	3.66±0.19
5th	3.48±0.19	3.73±0.17
6th	3.50±0.19	3.73±0.17
7th	3.43±0.20	3.66±0.18
8th	3.47±0.19	3.72±0.18
Overall	**3.51±0.07**	**3.67±0.06**

Solid not fat (SNF) percentage: The fortnightly means of milk SNF percentage of the cows of the control and treatment groups are presented in Table 6. The overall mean milk SNF percentage was slightly higher for the treatment group (8.95±0.05) as compared to the control group (8.87±0.04). The milk SNF percentage of cows in the control and treatment groups did not differ significantly.

Table 6. Mean ± S.E. of fortnightly averages of SNF % of the milk of the animals of the control and treatment group

Fortnight after calving	Control group	Treatment group
1st	8.83±0.12	8.89±0.14
2nd	8.89±0.14	9.00±0.14
3rd	8.94±0.16	9.00±0.17
4th	9.00±0.14	9.22±0.09
5th	8.89±0.14	8.89±0.16
6th	8.83±0.12	8.89±0.14
7th	8.72±0.09	8.94±0.16
8th	8.83±0.12	8.78±0.12
Overall	**8.87±0.04**	**8.95±0.05**

Peak milk yield

The data on mean peak milk yields of animals of the control and treatment groups is presented in Table 7. In the study of data, it was revealed that mean peak yield of the cows of the treatment group (14.07±1.16 kg) was higher than the control group (10.57±1.17 kg). However, the difference in peak yield of the cows of the treatment group was found to be statistically non-significant. The highest peak yields of the individual animals in the control and treatment

Table 7. Mean ± S.E. of peak milk yield (kg) achieved by animals of control and treatment group

Control group		Treatment group	
Cow no.	**Peak yield**	**Cow no.**	**Peak yield**
311	8.1	314	16.9
297	14.8	123	17
73	16	267	14.7
277	13.4	05	16.8
205	8.5	160	15.9
223	10.8	252	13.9
166	6.3	276	9.1
88	10.5	06	14.9
07	6.7	207	7.4
Mean	**10.57±1.17**	**Mean**	**14.07±1.16**

groups were 16 kg and 17 kg, and the lowest peak yields were 6.3 kg and 7.4 kg, respectively. The higher plane of prepartum and postpartum nutrition may have provided propulsion to the animals of the treatment group towards higher peak yield.

Days taken to achieve peak milk yield

The data on number of days required after calving to achieve peak milk yield by animals of the control and treatment group is presented in Table 8. The mean number of days required to attain peak milk yield in

Table 8. Mean ± S.E. of number of days required after calving to achieve peak milk yield by the animals of control and treatment group

Control group		Treatment group	
Cow no.	**No. of days after calving**	**Cow no.**	**No. of days after calving**
311	43	314	53
297	46	123	54
73	51	267	49
277	46	05	52
205	43	160	51
223	44	252	48
166	41	276	45
88	44	06	50
07	42	207	44
Mean	**44.44^{a}±0.99**	**Mean**	**49.56^{b}±1.14**

*Means bearing different superscripts differ significantly (P<0.05)

cows of the control and treatment group were 44.44±0.99 and 49.56±1.14 days, respectively.

The cows of the control group attained peak milk yields significantly (P<0.05) earlier than the cows of the treatment group.

DISCUSSION

The current study focused on eighteen healthy, advanced pregnant Sahiwal cattle from 60 days prepartum to 120 days postpartum. The number of days required after calving to achieve peak milk yield in the treatment group is higher than that of the control group because milk yield of the treatment group was higher and took more days to reach its peak. The animals in the challenge-fed group received an additional quantity of concentrate combo, whilst the animals in the control group received the usual ration.

The overall mean milk fat percentage was found to be 4.10±0.10 and 3.94±0.10 for the control and treatment groups, respectively. The present findings are endorsed by those reported by Das *et al*. (2007), Kamboj *et al*. (2016), Netsanet *et al*. (2016), Naik *et al*. (2017) and Raval *et al*. (2019). On the other hand, Singh *et al*. (2003) and Roche *et al*. (2013) found that animals maintained on greater feeding levels had more milk fat content than animals kept on lower feeding levels.

The overall means of milk lactose percentage were found to be 4.44±0.05 and 4.32±0.05 for the control and treatment groups of cows, respectively. These findings regarding lactose percentage of milk are in acquiescence with Das *et al*. (2007), Kamboj *et al*. (2016), Netsanet *et al*. (2016) and Raval *et al*. (2019), who found no significant effect of elevated feeding regimen on lactose percentage of milk but dissimilar to present findings reported by Prasad (1994) and Roche *et al*. (2013).

The overall mean milk protein percentage was higher in the treatment group (3.67±0.06) as compared to the control group (3.51±0.07). The present findings are related to those of Khan *et al*. (2002), Singh *et al*. (2003), Das *et al*. (2007), Kamboj *et al*. (2016), Netsanet *et al*. (2016) and Raval *et al*. (2019). On the other hand, Spiekers *et al*. (1991 and Prima *et al*. (2018) reported significant (P<0.05) increased milk protein content in a nutritionally elevated group of cows. The overall mean milk SNF percentage was slightly higher for the treatment group (8.95±0.05) as compared to the control group (8.87±0.04). The present findings are in accordance with the observations of Roche *et al*. (2013), Kamboj *et al*. (2016), Netsanet *et al*. (2016) and Raval *et al*. (2019). On the other hand, Das *et al*. (2007) observed that SNF content was slightly higher for a control group of animals than for a steaming-up group of animals supplemented with an additional concentrate mixture during the prepartum period.

The highest peak yields of the individual animals in the control and treatment groups were found to be 16 kg and 17 kg, and the lowest peak yields were 6.3 kg and 7.4 kg, respectively. These findings are in compliance with the findings of earlier researchers (Das *et al*., 2007; Kamboj *et al*., 2016; Raval *et al*., 2019), who also found that higher feeding regimens have no significant effect on the peak milk yield of animals. However, contradictory results were reported by Johnson

(1979) and Singh *et al*. (2003), who reported significant (P<0.05) higher peak yield in animals fed at higher levels than those fed at lower levels. The mean number of days required to attain peak milk yield in cows of the control and treatment groups were found to be 44.44±0.99 and 49.56±1.14 days, respectively. The present findings are in conformity with the observations of Kamboj *et al*. (2016) and Raval *et al*. (2019), who reported that animals of the control group achieved peak milk yield significantly (P<0.05) earlier than the treatment group of animals fed on a higher level of concentrate prepartum (26 days vs 35 days). On the other hand, Bhat *et al*. (2000) and Das *et al*. (2007) reported that extra feeding prior to and during lactation has no significant effect on days taken to achieve peak milk yield.

In conclusion, there was no significant effect of challenge feeding on the major milk constituents and peak yield. The cows of the control group attained peak yields significantly (P<0.05) earlier than the cows of the treatment group.

Conflict of interest: Authors have no conflict of interest in this study.

Author's contributions: VS: Presented research work from PhD degree programme; AKJ: Interpretation of the data; SCG: Major advisor, guided the 1st author for the above degree programme; PC: Helped in tabulation of data and interpretation of the data. All the data has been collected and analyzed by the first author for his PhD research.

Data availability statement: All data generated or analyzed during this study are included in this article. The corresponding author is willing to provide the raw data upon reasonable request.

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