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Research Article

Effect of rumen protected fat (rumen bypass fat) on milk yield, composition, and organoleptic traits of Achai Jersey cross cows at livestock research and development station, Surezai, Peshawar, Khyber Pakhtunkhwa, Pakistan

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Abstract

The present study was conducted to find out the beneficial effects of rumen bypass fat on milk fat content, average daily milk production, and organoleptic qualities of milk of Achai Jersey Cross (AJC) cows in med-lactation at the Livestock Research and Development Station (LR & DS) Surezai Peshawar. A total of 16 animals were selected in the mid-lactation period and were divided into four experimental groups, i.e., A, B, C, and D, each group having four animals. Group A served as the control (0 g of bypass fat), while groups B, C, and D received 100 g, 200 g, and 300 g of bypass fat, respectively. The total duration of the research trail was 105 days (3.5 months), during which milk fat content, daily average milk production, and organoleptic qualities were analyzed. Results indicated a significant increase in daily milk production in group D (4.228 liters), followed by group C (3.748 liters) and group B (3.763 liters) as compared to control group A (2.913 liters). The highest percent increase in average daily milk production was recorded in group D (22.317%), followed by group C (12.092%), and group B (5.634%), as compared to control group A (-14.174%), where a reduction in daily milk production was recorded. Supplementation of high levels of bypass fat at 300g/day per animal resulted in a significant increase in milk fat content in group D (5.07%), followed by C (4.40%) and B (4.12%) as compared to control group A (3.72%). The highest percent increase in milk fat was indicated in groups D (35.35%), C (18.12%) and B (12.99%) as compared to control group A (2.72%), respectively. The organoleptic qualities of all of the tested parameters were equally accepted among all of the members of the panel. It was concluded that supplementation of bypass fat at 300g/day per animal has a significant effect on milk fat content, average daily milk production, and different organoleptic properties of milk in the studied cross-bred animals.

Keywords: Achai Jersey Cross; Bypass fat; Khyber Pakhtunkhwa; Mid-lactation; Milk fat

Introduction

In Pakistan, the constraints in raising livestock production are the non-availability of cash crops and a shortage in quality and quantity of animal feed throughout the year. Livestock play a key role in the agricultural economy and play a multifaceted role in providing livelihood support to the rural population. The shortage of feed resources coupled with their poor nutritive value lowers the productivity of dairy animals. Demand for energy is very high during the early stages of lactation, but supply does not commensurate with demand, thus affecting the production potential of an animal [1]. Large animals depend on body reserves to fulfil energy needs, which leads to significant loss in body weight and milk production.

Rumen-protected fat plays an important role as an energy source in dairy animals [2-5]. As unprotected fat is limited to 3% of dry matter (DM) intake in ruminants which decreases dry matter and fiber digestibility, makes it necessary to use protected fat in the animal's diet [6]. Furthermore, unprotected fat has a depressing effect on rumen cellulolytic microbial activity [7]. Supplementing ration with bypass fat enhances energy intake in early lactation, which lowers the risk of energy balance in lactation in dairy animals [8].

Bypass fat plays an important role in nourishing high producing crossbred cows, thereby increasing the energy level. Dietary fat, which resists lipolysis and bio hydrogenation in the rumen by rumen micro-organisms but gets digested in the lower digestive track is known as "bypass fat". Bypass fat protects the nutrient from degradation and bio hydrogenation in the rumen with an increase in the energy density of the diet, enabling the animals to meet their energy and essential fatty acid requirements, expressing their milk production potential to the fullest extent [9].

It doesn't interfere with rumen fermentation but supplies more energy to the animal for more milk synthesis after being digested in the abomasum. This helps in increasing unsaturated fatty acids in milk, which can produce softer butter and safer milk for human consumption, especially for heart patients [10, 11]. On the other hand, [12] stated that supplementation of bypass fat has no effect on the body weight gain and body condition score of supplemented animals. The current study was designed to find out the effects of different levels of rumen bypass fat on milk fat content, average daily milk production, and organoleptic traits of milk from AJC cows at LR and DS, Surezai Peshawar.

Materials and Methods

The present research trial was conducted to find out the effect of rumen bypass fat on milk yield, milk fat content, and organoleptic traits of AJC Cross Cows.

Study location

The study was conducted for a period of three and a half months (105 days) at the LR & DS Surezai, Peshawar. AJC cows were selected for the research trial to determine the effects of different levels of rumen bypass fats on milk production, milk composition, and organoleptic traits.

Experimental design

Sixteen Achai Jersey cross cows of the nearly same lactation period were selected for the study. All of the relevant information for these cows was obtained from the stock register of the Farm Management Section. Each experimental animal was treated with ecto and endo-parasites before conducting the experimental trial. Experimental animals were divided randomly into four groups, i.e., A, B, C, and D, with four animals in each group. Animals in control group A were fed with a basal diet (green fodder, wheat straw, and concentrate ration) only. Animals in groups B, C, and D were fed with a basal diet supplemented with rumen-protected fat containing long-chain saturated fatty acids at rates of 100, 200, and 300g/day/lactating animal, respectively

(Table 1). Fresh drinking water was available to experimental animals throughout the day. The duration of the experimental trial was 105 days. A 15-day adaptation period was given to the experimental animals. Bypass fat was thoroughly mixed in the concentrate mixture before being offered to experimental animals.

Animals were hand milked twice daily (05:00 am & 03:00 pm) and the milk yields were recorded. Milk samples (20 ml) from individual animals were thoroughly mixed and shifted to the laboratory in clean and sterile Borosil glass bottles. As per Lee *et a.* [13], the chemical composition of milk samples was analyzed through Lactoscan (Milk Analyzer). Organoleptic traits, including smell, taste, and color, were evaluated by 10 members comprised of officers and officials of Livestock Research & Development Station Surezai through a nine (09) point hedonic scale. An evaluation proforma in this respect has been prepared by the concerned panelist.

Table 1. Quantity of Rumen bypass fat offered to each experimental animal group is given in the table

Group	Bypass Fat (g/day)	No. of Animals
A	00	04
B	100	04
C	200	04
D	300	04

Statistical analysis

For statistical analysis, SPSS 21.0 for Windows (SPSS Inc., Chicago, IL) was used. The data was analyzed through one-way Analysis of Variance (ANOVA). A Complete Randomized Design (CRD) model was used for analysis of treatments. The statistical model included the effects of supplementation of different levels of bypass fat on milk production, fat content, and SNF content. Data was expressed as a mean with standard deviation, and the difference was tested through Tukey's test. When $P \leq 0.05$ differences were considered as significant.

Results

The present research trial was conducted to find out the effects of bypass supplementation on milk quality and quantity in AJC cows at LR & DS Surezai. During the research trial, data was collected for daily milk production, milk fat, solid not-fat (SNF), and organoleptic quality of milk from AJC cows. The detailed results are discussed as under.

Effects of supplementation of bypass fat on milk production

The daily milk production of experimental animals was analyzed on a daily basis two times a day (average daily milk) for 105 days (three and a half months). The detailed results of the supplementation of different levels of bypass fat on average daily milk production and percent milk increase are given in (Table 2).

Table 2. Effect of supplementation of different levels of bypass fat on milk production

Group	Initial Milk (Liter)	Final Milk (Liter)	Increase Milk %
A	3.394±0.02	2.913±0.07^{c}	-14.176±2.08^{d}
B	3.562±0.14	3.763±0.14^{b}	5.634±0.74^{c}
C	3.344±0.08	3.748±0.06^{b}	12.092±1.34^{b}
D	3.456±0.04	4.228±0.05^{a}	22.317±0.75^{a}

Means under different superscripts are significantly different ($P \leq 0.05$)
Where=0g bypass fat, B=100g, C=200g, D=300g

The results indicated a significant (P< 0.05) increase in daily milk production in group D (4.228 liters), followed by group C (3.748 liters) and group B (3.763 liters) as compared to control group A (2.913 liters). However, a very slight change was observed in the groups B and C animals in their final milk production as compared to the group D animals, which showed a significant (P< 0.05) increase in daily milk yield as compared to the control group.

Effects of supplementation of bypass fat on milk fat content

The milk fat content of experimental animals was analyzed every alternate day for 105 days (three and a half months). The detailed results of the supplementation of different levels of bypass fat on milk fat content are given in (Table 3). The present findings showed that supplementation of bypass fat also significantly (P≤0.05) increased the percent fat content of the milk in groups D, C, and B from 2.72% to 12.99, 18.12, and 35.35%, respectively. The highest percent fat content was recorded in group D, which was supplemented with 300g of bypass fat, followed by groups C, B, and control A, supplemented with 200g, 100g, and 0g of bypass fat, respectively.

Table 3. Effect of supplementation of different levels of bypass fat on milk fat content

Group	Initial Fat %	Final Fat %	Increase Fat %
A	3.62±0.09	3.72^{c}±0.17	2.72^{d}±2.20
B	3.65±0.13	4.12^{b}±0.17	12.99^{c}±1.09
C	3.72±0.05	4.40^{b}±0.08	18.12^{b}±1.29
D	3.75±0.06	5.07^{a}±0.09	35.35^{a}±2.75

Means under different superscripts are significantly different (P≤0.05).
Where=0g bypass fat, B=100g, C=200g, D=300g

Effects of supplementation of bypass fat on milk SNF content

The milk composition of the experimental animals was analyzed every alternate day for 105 days (three and a half months). The detailed results of the supplementation of different levels of bypass fat on milk composition like SNF are given in (Table 4). The current findings indicate that supplementation of different levels of bypass fat does not significantly affect the SNF content of milk in experimental animals. As there is no significant change observed in initial and final SNF% in any of the treated groups as compared to the control group.

Table 4. Effect of supplementation of different levels of Bypass fat on SNF content.

Group	Initial SNF %	Final SNF %
A	8.415±0.006	8.415±0.005
B	8.416±0.006	8.418±0.005
C	8.413±0.006	8.417±0.049
D	8.417±0.006	8.420±0.005

Means under different superscripts are significantly different (P≤0.05).
Where A=0g bypass fat, B=100g, C=200g, D=300g

Effects of supplementation of bypass fat on organoleptic quality of milk

Recent findings indicated that the addition of bypass fat has a significant effect on the taste of milk, such that increasing the level of bypass fat results in a high score of milk taste, thereby increasing the acceptability of milk produced. The highest numerical score was indicated by groups D, and C, followed by B, and the lowest in control group A. Supplementation of bypass fat resulted in improved flavor such that the highest numerical score was indicated by group D, followed by groups C, and B, and the lowest in control group A. Results indicated that the texture of milk was not

significantly affected by the increasing level of bypass fat. Results indicated that supply of bypass fat resulted in decreased score values such that an increasing level of bypass fat results in the lowest score in group D, followed by C, B, and the highest in control group A (Table 5).

Table 5. Effect of supplementation of different levels of bypass fat on organoleptic quality of milk.

Group	Taste	Flavor	Texture	Color
A	6.60±0.52^{b}	6.90±0.74^{b}	7.50±0.53	7.50±0.53^{a}
B	7.10±0.57^{ab}	7.10±0.74^{ab}	7.60±0.52	7.30±0.48^{a}
C	7.50±0.53^{a}	7.60±0.70^{ab}	7.80±0.43	7.00±0.47^{ab}
D	7.70±0.48^{a}	7.80±0.79^{a}	8.00±0.47	6.70±0.48^{b}

Where A=0g bypass fat, B=100g, C=200g, D=300g. Means under different superscripts are significantly different (P≤0.05)

Discussion

Bypass fats play an important role in nourishing high-producing crossbred cows, thereby increasing their energy level. Dietary fat that resists lipolysis and bio hydrogenation in the rumen by rumen micro-organisms but gets digested in the lower digestive track is known as "bypass fat". This bypass fat is degraded by the small intestine lipases [14]. Bypass fat protects the nutrient from degradation and bio hydrogenation in the rumen with an increase in the energy density of the diet, enabling the animals to meet their energy and essential fatty acid requirements, expressing their milk production potential to the fullest extent [9]**.** The present results indicated that supplementation of bypass fat to dairy animals resulted in a significant (P≤0.05) increase in milk production in all of the tested animals. The present findings are also in line with those of [11, 15, 16], who reported similar significant improvement in milk yield in ruminants due to supplementation of bypass fat. Supplementation of different levels of bypass fat resulted in a gradual increase in milk production as compared to control group. Similar findings were reported by Hammon *et al.* [17], who stated that supplementation of rumen bypass fat in early lactation has a positive effect on milk yield through correcting negative energy balance and thus maintaining the production requirements of dairy animals. The most significantly high (P≤0.05) milk increase was recorded in group D (4.228L) supplemented with 300g of bypass fat, as compared to control group A (3.456L). Our results also got the support of Barley and Baghel [18], who reported increased milk production and high milk fat content in bypass supplemented groups. Supplementation of 100g (B) and 200g (C) bypass fat also resulted in a significant (P≤0.05) increase in milk production (3.763) and (3.748) respectively, as compared with control groups. The present day findings are in line with those of Gulati *et al.* [19], who also stated that bypass fat supplementation in dairy cows resulted in increased milk production along with increased fat and SNF content. No significant (P≥0.05) difference was recorded in the average daily milk production of groups B and C. It was clarified from the present findings that bypass supplementation resulted in a significant (P≤0.05) increase in percent milk production for all of the experimental animals. Results indicated that the highest percent milk increase was recorded in group D (22.317) as compared to control group A (-14.176). Similarly, the addition of bypass fat resulted in a significant increase in milk production in dairy animals [20]. The addition of 100g (5.634%) and 200g (12.092%) bypass fat also indicated a significant increase in the percent milk production of all of the tested animals. Results also indicated that average daily milk production and percent milk

production significantly decreased in control group A (3.394 to 2.913). The present day findings are supported by the early work of Sirohi *et al.* [1], who stated that supplementation of 300g of bypass fat per day/animal resulted in a significant increase in milk production by 15.6% in supplemented groups as compared to control. The current findings clarified that supplementation of bypass fat at different levels resulted in a significant increase both in average daily milk production and percent milk production in all experimental animals. Similarly, an increase in milk production from 5.5% to 24% was reported by [21-23] due to supplementation of bypass fat in dairy animals. Our findings are also in line with [24], who reported a significant increase in milk production in bypass fat supplemented groups. The present day findings indicate a significant increase in milk fat content in response to increasing levels of bypass fat. Our results also got the support of Barley and Baghel [18], who reported an increased milk fat content in bypass supplemented animals. A significantly higher fat content was recorded in group D (5.07%) supplemented with 300 grams of bypass fat as compared to other supplemented groups and control. Similar results were also reported by [1, 8]. Supplementation of 100g (4.12) and 200g (4.20) grams bypass fat also resulted in a significant increase in milk fat content as compared to the control group (3.72). Our findings are also supported by the early findings of Parnerkar *et al.* [21], who stated that supplementation of bypass fat significantly increased the milk fat content of the supplemented dairy animals. Supplementation of bypass fat resulted in a significant increase in milk fat and milk production [19].

It was clarified from the present findings that supplementation of bypass fat also significantly increased the percent fat content of the milk from 2.72% to 12.99, 18.12, and 35.35%, respectively. The highest percent fat content was recorded in group D supplemented with 300g of bypass fat, followed by groups C, B, and control A, supplemented with 200g, 100g, and 0g bypass fat, respectively. Our findings are also in support of the early work of [11, 25], who reported similar increases in milk fat content in response to supplementation of bypass fat to dairy animals. The overall results indicated that supplementation of increasing levels of bypass fat also results in a significant increase in milk fat content of the experimental animals. Our findings are also in agreement with [8, 16, 20] who recorded similar increase in the milk fat content due to supplementation of bypass fat to dairy animals. Our findings are also in line with Soni and Patel [24], who reported a significant increase in fat percentage in bypass fat supplemented groups.

The current findings indicate that the supplementation of different levels of bypass fat did not significantly affect the SNF content of milk in the experimental animals. These findings are supported by the early results of Naik *et al.* [16], who also reported no significant difference in the SNF content of experimental animals. Quite comparable effects were reported by [1, 8] during bypass fat supplementation to dairy animals. Our findings are also in agreement with those of Ahmed *et al.* [12], who reported no significant effects of supplementation of bypass fat on the performance of supplemented fed animals. The present findings indicate that the organoleptic attributes were equally acceptable among the panelists. The findings are supported by the results indicated by Arafat *et al.* [26], who also noticed that the quality of samples was acceptable among the members when evaluating the organoleptic quality of milk.

Conclusion and Recommendations

It is concluded from the present study findings that supplementation of bypass fat at 300g/day per animal has a significant effect on the milk fat content,

daily average milk production, and organoleptic qualities of milk from light-weight AJC cows. In light of our results, it is recommended that bypass fat at 300g/day per lactating animal may be supplemented to improve not only milk fat content but also milk quantity and organoleptic qualities of milk in light-weight dairy cows.

Authors' contributions

Conceived and designed the experiments: S Ullah, S Khan & K Kaleem, Performed the experiments: ZU Rehman, Z Ullah, R Iqbal, IU Khan & Z Ullah, Analyzed the data: S Khan, Contributed materials/ analysis/ tools: S Ullah, S Khan, K Kaleem, ZU Rehman, R Iqbal, IU Khan, I Ullah, Z Ullah, Z Ullah & HU Rahman, Wrote the paper: S Ullah, S Khan & HU Rahman.

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