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Productive Efficiency of Lactating Buffaloes Fed Bypass Fat under Field Conditions: Effect on Milk Yield, Milk Composition, Body Weight and Economics

Research Article

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ABSTRACT

An experiment was conducted in early lactating buffaloes for the period of 3 months in Jadakheria and Polisimal village of Limkheda Taluka in Dahod district of Gujarat to assess the effect of supplementation of bypass fat on milk production, composition, body weight change and economic efficiency. Forty buffaloes in their 2nd and 3rd lactation were equally divided in completely randomized design in two groups according to their milk production and body weight, control group 'CON' was fed with a basal diet without bypass fat and treatment group 'BYFAT' was supplemented with bypass fat (Ca salt of palm oil fatty acids) at 20 g/kg milk yield. Fortnightly body weight changes, feed intake, milk production and composition were recorded for individual animal. The result revealed that the average daily milk yield and 6% fat corrected milk (FCM) was significantly (P<0.01) increased in BYFAT group compared to CON. Milk fat percent and fat yield was increased (P<0.001) due to feeding of bypass fat than control diet. There was significant (P<0.001) decrease in body weight loss in BYFAT group compared to control. The receipt for sale of milk was significantly (P<0.001) improved in bypass fat supplemented buffaloes compared to control animals. Feeding of bypass fat significantly (P<0.01) improved net returns on sale of milk.

KEY WORDS by pass fat, energy balance, fat percent, milk production, revenue.

INTRODUCTION

Most of the animals in developing countries including India are fed on agriculture by-products and low quality crop residues, which have got inherent low nutritive value and digestibility. The shortage of feed resources coupled with their poor nutritive value is of major concern to low productivity of dairy animals. High producing buffaloes in early lactation do not consume sufficient dry matter to support maximal production of milk (Goff and Horst, 1997). Demand for energy is very high during early stage of lactation but supply is not commensurate with demand due physiological stage or limited intake may affects production potential of animal in the whole lactation length (Sirohi *et al.* 2010). Hence, during early lactation, dairy animals are often forced to draw on body reserves to satisfy energy requirements (negative energy balance); this leads to substantial loss in body weight which adversely affects production, resulting in lower yield (Kim *et al.* 1993).

Cereal grains and fats plays an important role as source of energy in the ration of high yielding dairy animals for optimum productivity but due to use of cereals for human consumption and monogastric animals the alternate source of energy in dairy ration is supplemental fat (Saijpaul *et al.* 2010). Inclusion of unprotected fat in dairy ration is limited to 3% of dry matter (DM) intake, beyond which digestibility of DM and fibre are reduced (NRC, 2001). It has also depressing effect on rumen cellulolytic microbial activity (Ranjan *et al.* 2010). However, by protecting the fats from ruminal degradation, it is possible to increase fat content of the ration up to 6-7% of the DM intake, so that the fats get digested and absorbed optimally in the lower tract for milk and fat production without affecting digestibility of DM and fibre. It is stated that supplementing ration of lactating animals with bypass fat enhances energy intake in early lactation which reduces deleterious effect of acute negative energy balance on lactation (Tyagi *et al.* 2010).

Supplementation of bypass fat not only increases energy intake but also increase unsaturated fatty acid content of buffalo milk and more economic returns to dairy farmers (Parnerkar *et al.* 2010). Diets containing supplemental fat often stimulate increased milk production because of increased energy intake, improved efficiency of utilization of energy, or both (Maiga and Schingoethe, 1997). Bypass fat in the form of calcium salts of fatty acids (Palm oil and others) has been known to increase energy density of the ration without adversely affecting the DM intake and digestibility (Naik *et al.* 2009) and also help to increase milk yield (Erickson *et al.* 1992) and milk fat percentage or both (Chouinard *et al.* 1998). Several workers studied responses to supplementation of bypass fat has been reported to increase milk and FCM yields in lactating buffaloes (Thakur and Shelke, 2010) and milk fat percentage in dairy cows (Sirohi *et al.* 2010). The positive effect of feeding Ca salt of fatty acid was more evident at the early lactation in buffaloes (Garg *et al.* 2002). Little information is available regarding the effect of feeding bypass fat in field conditions which has practical applicability. Therefore an attempt was made to assess the effect of dietary supplementation of calcium salt of palm oil fatty acids as bypass fat on productive performance, body weight and economic efficiency in dairy buffaloes in field condition.

MATERIALS AND METHODS

Experimental design and diet

A field trial was conducted for the period of 3 months in Jadakheria and Polisimal village of Limkheda Taluka in Dahod district of Gujarat (India) to study the effect of feeding bypass fat on body weight, milk production, milk quality and cost of production in early lactating buffaloes. Forty early lactating buffaloes in their 2^{nd} to 3^{rd} lactation were divided in two equal groups in completely randomized design (CRD) based on their body weight (Avg. body weight 311.92±6.45 kg) and milk production (Avg. milk yield 4.5 liters). The health of animals was good without any illness. All the animals were dewormed and disinfested for ectoparasites before start of the experiment adopting standard protocol. Control group (CON) was fed with a basal diet without any supplement and treatment group (BYFAT) was fed with basal diet supplemented with calcium salt of long chain fatty acids (palm oil fatty acids) as bypass fat at 20 g/kg milk yield.

All the animals were maintained at the livestock owner's farms under field condition. In accordance with their routine feeding and managemental schedule records were maintained for further use. The basal diet consisted of paddy straw along with wheat and maize grains. Bypass fat was added and mixed in wheat and maize grains uniformly in morning and fed individually to each animals of treatment group. The roughage: concentrate ratio of the diet was tried to be maintained at 60:40. Information on fortnightly body weight changes, amount and type of feeds and fodder offered to buffaloes, milk production and fat % were collected for individual animal.

Sample collection and analysis

Feed samples were collected from each group fortnightly. They were dried in a forced air oven at 70 ˚C for overnight, ground through a 2 mm screen in a Wiley mill and stored till laboratory analysis. The feed samples were analyzed for proximate principles as per AOAC (1995). Animals were hand milked twice daily (7.00 hrs and 18.30 hrs) and the yields were recorded. The milk samples were drawn at fortnightly intervals from individual animals during both times of milking. After thorough mixing, a sample of 100-150 mL was taken by means of a dipper and transferred to a sample bottle with rounded corners (to avoid lodging of the milk solids) up to 3 / 4^{th} level, and then bottle was corked tightly by a rubber stopper. The sample bottles were labeled properly and dispatched to laboratory in an ice box. Milk samples were stored at 4 ˚C until further analysis. Milk samples were warmed in water bath at 38 ˚C and mixed well for homogenous solution. The samples were analyzed for milk fat content (ISI 1977). For the conversion of whole milk into 6% fat corrected milk (FCM), the equation derived by Rice (1970) was used:

$$6\%\ FCM\ (kg) = (0.4\ M + 15\ F) / 1.3$$

Where:
M: milk yield in kg.
F: weight of fat contained in it.

Body weight changes

The heart girth (HG) of experimental buffaloes in inches was recorded for two consecutive days before feeding and watering at the beginning and thereafter every fortnight during the experiment. The respective body weights were calculated employing Mullick's formula (Sastry, 1983).

Body weight (kg)= [25.156 (HG)-960.232] / 2.2

Calculation of economics

The cost of feeding per animal was calculated from the data of feed intake and prevailing procurement price of individual feed ingredients. The realizable receipt was calculated based on the milk procurement price (Rs./kg fat) declared by local cooperative milk collection center. The return over feed cost was calculated taking difference of the realizable receipt by sale of milk and the total feed cost. The net return (Rs./head/90 days) was worked out taking into consideration the difference in return over feed cost over the control group.

Statistical analysis

The data were analyzed statistically using standard methods (Snedecor and Cochran, 1994) for one way analysis of variance (ANOVA) using general linear model of SPSS version 12 and Duncan's multiple range test was applied to test the significance. Significance was declared when P value is less than 0.05.

RESULTS AND DISCUSSION

Chemical composition of the diet

Chemical composition of the diet is presented in Table 1. There was no difference in chemical composition of the diet between the two groups except for bypass fat in treatment group (BYFAT).

Milk yield and composition

The effect of feeding bypass fat on milk production and composition is depicted in Table 2.

It was suggested that addition of bypass fat supplement in the diet of medium and high producing lactating animals helps to meet their energy requirements fully to express their milk production potential (Sirohi *et al.* 2010). Accordingly, the average daily milk yield and 6% fat corrected milk (Figure 1) was significantly (P<0.01) increased in bypass fat supplemented buffaloes (5.68±0.17 L/d) compared to control (4.77±0.17 L/d).

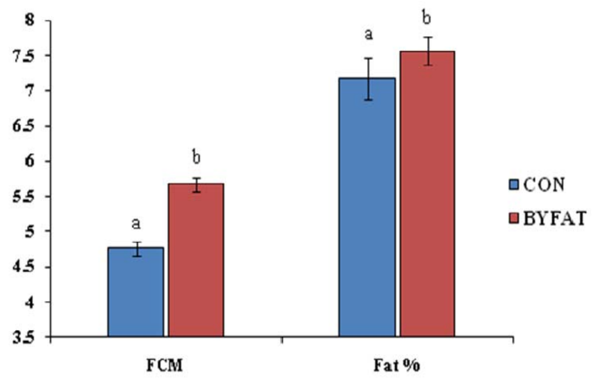

Figure 1 Influence of feeding bypass fat on FCM and milk fat % in buffaloes (CON: control group without bypass fat; BYFAT: bypass fat supplemented group)
Bars with different superscript [(a,b)] varies significantly (P<0.05)

Corroborating our results, feeding of Ca salt of palm oil fatty acids supplementation in the ration of lactating cows caused a substantial improvement in the milk yield, FCM yield and fat yield in milk of dairy cows (Purushothaman *et al.* 2008).

Table 1 Chemical composition (% on DM basis) of ingredients used in the basal diet

Nutrients	Maize grain		Wheat grain		Paddy straw	
	CON[1]	BYFAT[2]	CON	BYFAT	CON	BYFAT
Crude protein	9.82	9.75	12.84	12.11	5.02	4.86
Ether extract	8.54	8.38	1.27	1.23	2.16	2.08
Crude fibre	2.29	2.4	3.22	3.84	29.50	30.02
Nitrogen free extract	76.55	77.01	75.45	76.55	45.67	44.09
Total ash	2.8	2.46	2.22	2.43	17.65	18.95

[1] CON: control group.
[2] BYFAT: bypass fat (Ca salt of palm oil fatty acids) group.

Table 2 Influence of feeding bypass fat on milk production and economics in lactating buffaloes

Attributes [1]	T1	T2	SEM	P- value
Milk production				
Avg. milk yield	4.20[a]	4.81[b]	0.14	0.004
Fat yield	0.30[a]	0.36[b]	0.01	0.000
Economics of production				
Total revenue (Rs./day)	103.93[a]	125.66[b]	3.76	0.000
Return as % of feed cost	96.09	112.27	6.74	0.098
Feed cost per kg milk	12.96	12.63	0.42	0.587
Feed cost per kg FCM	11.42	10.73	0.37	0.195
Returns for sale of milk (Rs./day)	50.93[a]	66.46[b]	3.76	0.006

The means within the same row with at least one common letter, do not have significant difference (P>0.05).

Similarly, earlier study in lactating dairy animals showed significant increase in milk yield and milk fat content by feeding rumen protected fat (Garg and Mehta, 1998). The technology of bypass fat protects the nutrient from degradation and biohydrogenation in rumen with 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 (Krishna Mohan and Reddy, 2009). Increased milk yield observed in BYFAT group may be attributed to increased energy density of the ration resulting in reducing the deleterious effect of negative energy balance (Shelke and Thakur, 2011; Mervat-Foda *et al*. 2009). Higher milk production was also reported due to feeding of Ca salts of soya acid oil fatty acids to dairy buffaloes (Thakur and Shelke, 2010). Feeding of calcium salt of palm oil fatty acids and soybean oil fatty acids increased FCM in dairy cows and buffaloes respectively (Dhiman *et al.* 1995; Thakur and Shelke, 2010).

It was stated that bypass or inert fat supplementation to medium and / or high producing (10-20 kg/day) lactating crossbred cows is beneficial in terms of increasing milk production and fat corrected milk yield particularly in early lactation (Sirohi *et al.* 2010). Several studies have revealed that adding supplemental dietary fat in different forms like tallow, calcium salts of long-chain fatty acids and yellow grease to the diets of dairy cows in early lactation has often increased milk production (Boken *et al.* 2005). The supplementation of protected nutrients lowers stress during early lactation which support higher milk production (Sampelayo *et al.* 2004), this finding was also reported by Shelke and Thakur (2011) in buffaloes supplemented with bypass nutrients. The technology of bypass fat protects the nutrient from degradation and biohydrogenation in rumen with 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 (Krishna Mohan and Reddy, 2009). Preformed fatty acids of dietary origin can be incorporated directly into milk fat, reducing the energy cost for synthesizing fatty acids incorporated into milk, thereby sparing energy for other productive functions in the mammary gland (Schaufp and Clark, 1992). In contrast to reported results, milk yield and milk composition was unaltered but FCM (6.5%) yield and feed efficiency was improved ($P<0.05$) due to feeding of bypass fat in buffaloes (Ranjan *et al*. 2010). There was significant ($P<0.001$) improvement in milk fat percent and fat yield due to feeding of calcium salt of palm oil fatty acids (Table 1). The milk fat percent was 7.57±0.02 in BYFAT group which was more compared to that of 7.18±0.03 in CON animals (Figure 1). Similar to our results, earlier studies reported a clear cut rise ($P<0.01$) in milk fat due to supplementation of bypass fat in lactating dairy animals (Mishra *et al*. 2004; Garg *et al*. 2008). However, in contrast to our results in an earlier study there was no effect of feeding palm oil fatty acids on milk composition in lactating cows (Purushothaman *et al.* 2008).

Body weight changes

The effect of bypass fat on body weight is depicted in Figure 2.

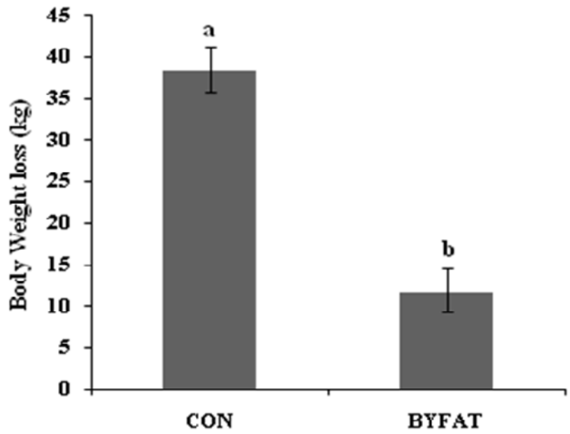

Figure 2 Body weight loss as influenced by feeding of bypass fat (CON: control group without bypass fat; BYFAT: bypass fat supplemented group) Bars with different superscript [(a, b)] varies significantly ($P<0.05$)

Feeding of fats is done to minimize the body weight loss and hasten body weight gain postpartum while maintaining milk production in dairy animals (Solorzano Kertz, 2005).

Feeding of calcium salt of palm oil fatty acids significantly ($P<0.05$) reduced loss in body weight (11.72±2.47 kg) compared to control animals (38.30±2.91 kg). The addition of fat in early lactation diets is commonly thought to improve energy balance by reducing body fat mobilization and use of supplemental dietary fat for milk production (Komaragiri *et al.* 1998).

This might be the possible reason for less loss of body weight in spite of high milk production in bypass fat supplemented group of buffaloes. In contrast earlier report has found no significant effect of feeding calcium salt of palm oil fatty acids on body weight change in dairy cows (Purshothaman *et al.* 2008).

Economic efficiency

The economics of production is given in Table 2. The cost of feed was low in control group (Rs. 53.00) as compared to treatment group (Rs. 59.20) but when compared to per kg production it was lower in BYFAT than CON. Although, feed cost per kg milk production and returns as percent of feed cost were numerically low, there was no significant difference in two groups due to intra group variations. Due to supplementation of bypass fat it is possible not only to increase unsaturated fatty acid content of milk but also income of dairy farmers owing to more milk production and fat content. Farmers are typically paid on the basis of the fat content of the milk they are producing, hence increase in fat percent and yield will lead to increase in revenue of the dairy farmers. The total revenue of milk production was significantly (P<0.001) improved in bypass fat supplemented buffaloes compared to control animals. The net returns on sale of milk was significantly (P<0.01) increased in BYFAT group as compared to CON buffaloes. Corroborating our finding, there was increase in economic returns due to increase in fat content of milk by feeding of bypass fat in lactating animals (Vidhate *et al.* 2006). During early lactation, buffaloes yielding daily 8-9 kg milk, when given bypass fat resulted in Rs. 26.61 more dairy returns per buffalo and receipt from sale of milk was also increased (Parnerkar *et al.* 2010). Similarly, Garg *et al.* (2002) found higher net average daily income by feeding 1.0 kg protected sunflower meal and 1.0 kg protected fat/protein to lactating cows. The daily revenue was increased by 8.52% and 13.58%, respectively.

CONCLUSION

It is concluded that feeding of calcium salt of palm oil fatty acids as bypass fat significantly increases milk production and fat percent. Body weight loss was reduced and economic returns were improved due to supplementation of bypass fat in early lactating buffaloes under field conditions.

REFERENCES

AOAC. (1990). Official Methods of Analysis. Vol. I. 15th Ed. Association of Official Analytical Chemists, Arlington, VA.

Boken S.L., Staples C.R., Sollenberger L.E., Jenkins T.C. and Thatcher W.W. (2005). Effect of grazing and fat supplementation on production and reproduction of Holstein cows. *J. Dairy Sci*. **88,** 4258-4272.

Chouinard P.Y., Girard V. and Brisson G.J. (1998). Fatty acid profile and physical properties of milk fat from cows fed calcium salts of fatty acids with varying unsaturation. *J Dairy Sci*. **81,** 471-481.

Dhiman T.R., Zanten K.V. and Satter L.D. (1995). Effect of dietary fat source on fatty acid composition of cow's milk. *J. Sci. Food Agric*. **69(1),** 101-107.

Erickson P.S., Murphy M.R. and Clark J.H. (1992). Supplementation of dairy cow diets with calcium salts of long-chain fatty acids and nicotinic acid in early lactation. *J. Dairy Sci*. **75,** 1078-1089.

Garg M.R. and Mehta A.K. (1998). Effect of feeding by pass fat on feed intake, milk production and body conditions of Holstein Friesian cows. *Indian J. Anim. Nutr*. **15,** 242-245.

Garg M.R., Sherasia P.L., Bhanderi B.M., Gulati S.K. and Scott T.W. (2008). Effect of feeding bypass fat supplement on milk production and characteristic of buffaloes. *Indian J. Dairy Sci*. **61,** 56-61.

Garg M.R., Sheresia P.L., Bhanderi B.M., Gulati S.K. and Scott T.W. (2002). Effect of feeding rumen protected nutrients on milk production in cows and buffaloes. *Indian J. Dairy Sci*. **56,** 218-222.

Goff J.P. and Horst R.L. (1997). Effects of the addition of potassium or sodium, but not calcium, to prepartum rations on milk fever in dairy cows. *J. Dairy Sci*. **80,** 176-186.

Indian Standards Institution (ISI). (1977). Determination of Fat by Gerber Method. IS: 1224, part I. Indian Standards Institution, New Delhi, India.

Kim Y.K., Schingoethe D.J., Casper D.P. and Ludens F.C. (1993). Supplemental dietary fat from extruded soybeans and calcium soaps of fatty acids for lactating dairy cows. *J. Dairy Sci*. **76,** 197-204.

Komaragiri M.V.S., Casper D.P. and Erdman R.A. (1998). Factors affecting body tissue mobilization in early lactation dairy cows. 2. Effect of dietary fat on mobilization of body fat and protein. *J. Dairy Sci*. **81,** 169-175.

Krishna Mohan D.V.G. and Reddy Y.R. (2009). Role of bypass nutrients in small holder animal production. Pp. 45-48 in Proc. Anim. Nutr. Asso. World Conf. NAAS complex, ICAR, New Delhi, India.

Maiga H.A. and Schingoethe D.J. (1997). Optimizing the utilization of animal fat and ruminal bypass proteins in the diets of lactating dairy cows. *J. Dairy Sci*. **80,** 343-352.

Mervat-Foda I., Kholif S.M. and Kholif A.M. (2009). Evaluation of goat milk containing galactooligosaccharides after supplementing the ration with amino acids. *Int. J. Dairy Sci*. **4,** 27-33.

Mishra S., Thakur S.S. and Tyagi N. (2004). Milk production and composition in crossbred cows fed calcium salts of mustard oil fatty acids. *Indian J. Anim. Nutr*. **21,** 22-25.

Naik P.K., Saijpaul S. and Neelam Rani. (2007). Preparation of rumen protected fat and its effect on nutrient utilization in buffaloes. *Indian J. Anim. Nutr*. **24,** 212-215.

NRC. (2001). Nutrient Requirements of Dairy Cattle. 7th Ed. National Academy Press, Washington, DC, USA.

Parnerkar S., Kumar D., Shankhpal S.S. and Thube H. (2010). Effect of feeding bypass fat to lactating buffaloes during early lactation. Pp. 126-131 in Proc. of 7th Biennial Anim. Nutr. Asso. Conf., Orissa Univ. Agric. and Technol., Bhubaneswar, India.

Purushothaman S., Kumar A. and Tiwari D.P. (2008). Effect of feeding calcium salts of palm oil fatty acids on performance of lactating crossbred cows. *Asian-Aust. J. Anim. Sci*. **13(21),** 376-385.

Ranjan A., Sahoo B., Singh V.K., Shrivastava S., Singh S.P. and Rajesh K. (2010). Effect of bypass fat supplementation on productive performance and blood biochemicals of lactating Murrah buffaloes. Pp. 115-121 in Proc. of 7th Biennial Anim. Nutr. Asso. Conf., Orissa Univ. Agric. and Technol., Bhubaneswar, India.

Rice V.A. (1970). Breeding and Improvement of Farm Animals. Mc Graw Hill Bombay, India.

Saijpaul S., Naik P.K. and Neelam R. (2010). Effects of rumen protected fat on *in vitro* dry matter degradability of dairy rations. *Indian J. Anim. Sci*. **80,** 993-997.

Sampelayo M.R.S., Alonso J.J.M., Perez L., Extrenera F.G. and Boza J. (2004). Dietary supplements for lactating goats by polyunsaturated fatty acid rich protected fat. Effect after supplement withdrawl. *J. Dairy Sci*. **87,** 1796-1802.

Sastry N.S.R. (1983). Farm Animal Management and Poultry Production. Stosius Inc/Advent Books Division.

Schaufp D.J. and Clark J.H. (1992). Effects of feeding diets containing calcium salts of long-chain fatty acids to lactating dairy cows. *J. Dairy Sci*. **75,** 2990-3002.

Shelke S.K. and Thakur S.S. (2011). Effect of the quality of milk and milk products in murrah buffaloes (*Bubalus bubalis*) fed rumen protected fat and protein. *Int. J. Dairy Sci*. **6,** 124-133.

Sirohi S.K., Walli T.K. and Mohanta R.K. (2010). Supplementation effect of bypass fat on production performance of lactating crossbred cows. *Indian J. Anim. Sci*. **80,** 733-736.

Snedecor G.W. and Cochran W.G. (1994). Statistical Methods, 8th Ed. Iowa State University Press.

Solorzano L.C. and Kertz A.F. (2005). Rumen inert fat supplements reviewed for dairy cows. *Feedstuffs*. **77,** 1-5.

Thakur S.S. and Shelke S.K. (2010). Effect of supplementing bypass fat prepared from soybean acid oil on milk yield and nutrient utilization in Murrah buffaloes. *Indian J. Anim. Sci*. **80,** 354-357.

Tyagi N., Thakur S.S. and Shelke S.S. (2010). Effect of bypass fat supplementation on productive and reproductive performance in crossbred cows. *Trop. Anim. Health. Prod*. **41,** 1749-1755.

Vidhate P.G., Kokane R.D. and Hande S.T. (2006). Economic impact of feeding by-pass fat in crossbred cows. *J. Bombay. Vet. Coll*. **14,** 68-72.