

## EFFECT OF BYPASS FAT SUPPLEMENTATION ON MILK YIELD IN LACTATING COWS AND BUFFALOES

Adnan Mobeen<sup>1</sup>, Muhammad Riaz<sup>1</sup>, Syed Hassan Raza<sup>1</sup>, Muhammad Sharif<sup>1</sup> and Muhammad Umar Yaqoob<sup>2,\*</sup>

<sup>1</sup>Institute of Animal and Dairy Sciences, University of Agriculture, Faisalabad-38040, Pakistan; <sup>2</sup>College of Animal Science, Zhejiang University, 866 Yuhangtang Road, Hangzhou 310058, China.

\*Correspondence author's e-mail: 11817048@zju.edu.cn

The present study was planned to cope with feed scarcity issue using bypass fat as a non-conventional feed resource. Twenty-four early lactating indigenous dairy animals comprising of twelve Nili-Ravi buffaloes and twelve Sahiwal cows were selected to determine the effect of bypass fat supplementation on daily milk yield, milk composition and change in body weight. These animals were randomly distributed in to four groups (G<sub>0</sub>, G<sub>1</sub>, G<sub>2</sub> and G<sub>3</sub>) having similar parity and milk yield. All the experimental animals were fed with basal ration (*Trifolium alexandrinum* + wheat straw) and concentrate in equal proportion (3kg day<sup>-1</sup> animal<sup>-1</sup>) in addition to 0, 250, 350 and 450g bypass fat animal<sup>-1</sup>day<sup>-1</sup>, respectively. Data collected for each treatment was analyzed under completely randomized design using MINITAB (2000) and the mean was compared using the Tukey's test (P<0.05). The data revealed a significant effect (P<0.05) on milk production and 3.14 kg day<sup>-1</sup> more milk was produced in group G<sub>2</sub> compared to control group. Fat corrected milk yield was also enhanced (P<0.05) from 8.25 (G<sub>0</sub>) to 12.36 kg day<sup>-1</sup> (G<sub>2</sub>). Milk composition in the sense of fat percentage was also improved [5.25 (G<sub>0</sub>) to 5.78 (G<sub>2</sub>)] significantly. While average protein content, SNF% and total solids% remained unaffected. Similarly, change in body weight was non-significant. Milk value (Rs./day) was significantly (P<0.05) increased from 512.25 to 747.75 in the group G<sub>0</sub> to G<sub>2</sub>. From present finding it could be concluded that dietary supplementation of bypass fat in indigenous dairy animals is a better option to increase the milk yield without compromising milk quality and animal health.

**Keywords:** Bypass fat, indigenous dairy animals, milk yield and composition, economics

### INTRODUCTION

Buffalo and cow are the key dairy animals which contribute about 60.85% and 35.92%, respectively, of total milk production in Pakistan (Economic Survey, 2016-17), to fulfill the country's needs. Dairy animals at the time of early lactation required more nutrients for their body needs and to maintain their health status. Commonly the lactating animals at early stage remain in negative energy balance because of insufficient supply of nutrients rich feed, which leads to an altered metabolic state which is associated with poor fertility and body weight loss (Fenwick *et al.*, 2008). In Pakistan vegetable oil is used by local dairy farmers to fulfil the energy requirement of animals. This oil may cause the physical and chemical changes in fermentation process and reduction in fibre digestion. In addition to this, ruminants have a very specific digestive system that would not tolerate the presence of oil in rumen and hence this energy feed must be able to stay inert to be digested in the later part of the system. To improve the energy availability to early lactating dairy animals bypass fats are the alternative sources which may not interfere with the process of fermentation and fiber digestion in the rumen. Fats are made inert by treating them with some salts e.g. calcium soap/salt of long chain fatty acid, which made a type

of rumen bypass fat especially for high milk-yielding dairy animals.

Gargouri *et al.* (2006) found the positive effects of feeding calcium (Ca<sup>+</sup>) salt of fatty acids (FAs) on dairy animals in early lactation. They observed maximum response with the addition of 150-300g day<sup>-1</sup> of bypass fat in dairy animal's ration. Maeng *et al.* (1993) reported that feeding 3% bypass fat to dairy cows enhanced the milk production from 18.88kg day<sup>-1</sup> to 22.48kg day<sup>-1</sup>. Similarly, improved milk yield was achieved by providing poly unsaturated FAs (calcium-fatty acids) to lactating cows (Reis *et al.*, 2012; Rabiee *et al.*, 2012). However, there was no adverse effect observed on nutrient usage by supplementing calcium soap up to 800-1000g day<sup>-1</sup> on dry matter bases (Alexander *et al.*, 2002). Keeping in the view of previous studies it was hypothesized that bypass fat could reduce the effect of negative energy balance and enhance the milk yield without any negative effect on milk composition. The present study was designed to assess the response of lactating cows and buffaloes in terms of their milk production and composition against bypass fat supplementation.

## MATERIALS AND METHODS

The research was directed at Livestock Research Station, University of Agriculture Faisalabad, Pakistan. In this study, twenty-four (n=24) early lactating indigenous dairy animals with twelve Nili-Ravi buffaloes and twelve Sahiwal cows having similar parity and same level of milk production were selected and randomly distributed into four groups (G<sub>0</sub>, G<sub>1</sub>, G<sub>2</sub> and G<sub>3</sub>) with six animals per group. All the farm level safety measures were done in sense of deworming and vaccination. The experimental dairy animals were distributed in an individual stall with similar climatic situation of that shed.

All the experimental animals were fed with basal ration (*Trifolium alexandrinum* + wheat straw) *ad libitum* twice daily. Fresh water was provided thrice daily and concentrate was supplemented @ 3kg animal<sup>-1</sup> before every milking. Bypass fat was offered as an energy source with 0g day<sup>-1</sup> animal<sup>-1</sup> in group G<sub>0</sub>, 250g day<sup>-1</sup> animal<sup>-1</sup> in G<sub>1</sub>, 350g day<sup>-1</sup> animal<sup>-1</sup> in G<sub>2</sub> and 450g day<sup>-1</sup> animal<sup>-1</sup> in G<sub>3</sub> in concentrate, respectively.

All the animals in this research trial were weighed just before the starting of the experiment and thereafter on weekly bases to determine the change in body weight. Daily (morning + evening) milk production was recorded. For analysis of milk composition, composite milk (250 ml) of two consecutive milking (morning + evening) per animal was collected weekly and analyzed in dairy laboratory of Institute of Animal and Dairy Sciences.

Proximate analysis of concentrate along with bypass fat is showed in Table 1. DM% was determined by drying the sample at 110°C, while ash was determined by combustion at 550°C for 6h (AOAC, 2005). Fat was determined through Soxhlet apparatus by extraction with ether. Nitrogen contents were found by following Kjeldahl method and protein% was calculated by multiplying with factor 6.25. Milk fat percent was determined by Gerber method and milk protein% was determined by Kjeldahl method (Davide, 1977). While, Fleischmann's formula was followed to determine total solids and solid not fat (SNF).

Data collected for each treatment was analyzed under completely randomized design using MINITAB (2000) and the mean was compared using the Tukey's test (P<0.05).

**Table 1. Approximate analysis of concentrate along with bypass fat offered to animals in different groups (%).**

Nutrients	G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	G <sub>3</sub>
Dry matter	86.06	87.54	89.01	90.05
Crude protein	18.60	17.32	15.29	15.20
Ether extract	03.40	04.30	05.10	05.70
Crude fiber	05.25	04.50	04.30	04.20
Ash	05.16	06.13	07.44	08.30

## RESULTS

The research data obtained from experimental animals revealed that average milk production was increased in all the experimental groups except G<sub>0</sub>. Group G<sub>2</sub> (9.97±0.15) showed significantly (P<0.05) higher milk production as compared to remaining groups (Table 2). Average milk fat% was significantly (P<0.05) increased in all the bypass fat supplemented groups and G<sub>3</sub> (5.78±0.053) showed highest fat% as compared to other treatments. Average 4% fat corrected milk (FCM, kg day<sup>-1</sup>) production was improved (P<0.05) in the group with higher level (350 g animal<sup>-1</sup>) of bypass fat compared to remaining groups. While protein, SNF and total solids percent showed non-significant results in all the experimental groups. Average weight gains also showed non-significant improvements in all the experimental animals. Cost of kg<sup>-1</sup> milk production was different in different groups (Table 3).

**Table 3. Effect of bypass fat supplementation on cost of milk production.**

Parameter	Experimental treatments			
	G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	G <sub>3</sub>
Feeding Cost (Rs./day)	285.00	335.00	340.00	375.00
Milk yield (kg/day)	6.83 <sup>d</sup>	9.17 <sup>b</sup>	9.97 <sup>a</sup>	7.77 <sup>c</sup>
Milk value (Rs./day)	512.25	687.75	747.75	582.75
Milk Cost (Rs./kg)	41.73	36.53	34.10	48.26

G<sub>0</sub>, control group; G<sub>1</sub>, bypass fat supplementation 250g; G<sub>2</sub>, bypass fat supplementation 350g and G<sub>3</sub>, bypass fat supplementation 450g; Mean values in same row with different superscripts differ significantly (P<0.05).

**Table 2. Effect of bypass fat supplementation on milk yield and composition.**

Parameter	Experimental treatments			
	G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	G <sub>3</sub>
Avg. Milk yield (kg/day)	6.83±0.130 <sup>d</sup>	9.17±0.230 <sup>b</sup>	9.97±0.150 <sup>a</sup>	7.77±0.110 <sup>c</sup>
Avg. FCM (kg/day)	8.25±0.019 <sup>c</sup>	11.21±0.019 <sup>ab</sup>	12.36±0.019 <sup>a</sup>	9.93±0.019 <sup>b</sup>
Avg. Fat (%)	5.25±0.053 <sup>d</sup>	5.41±0.053 <sup>c</sup>	5.58±0.053 <sup>b</sup>	5.77±0.053 <sup>a</sup>
Avg. Protein (%)	4.39±0.150 <sup>b</sup>	4.47±0.150 <sup>b</sup>	4.74±0.150 <sup>a</sup>	4.50±0.150 <sup>ab</sup>
Avg. SNF (%)	9.60±0.321 <sup>ab</sup>	9.80±0.321 <sup>ab</sup>	9.66±0.321 <sup>b</sup>	10.10±0.321 <sup>a</sup>
Avg. Total Solids (%)	14.84±0.346 <sup>b</sup>	15.16±0.346 <sup>ab</sup>	15.23±0.346 <sup>b</sup>	15.85±0.346 <sup>a</sup>
Avg. Weight (kg)	460.16±24.00 <sup>a</sup>	453.56±24.00 <sup>a</sup>	451.84±24.00 <sup>a</sup>	433.50±24.00 <sup>ab</sup>

G<sub>0</sub>, control group; G<sub>1</sub>, bypass fat supplementation 250g; G<sub>2</sub>, bypass fat supplementation 350g and G<sub>3</sub>, bypass fat supplementation 450g; Mean values in same row with different superscripts differ significantly (P<0.05).

The maximum milk cost (Rs. 48.26) was observed in the group G<sub>3</sub> and lowest cost (Rs. 34.10) was found in group G<sub>2</sub>. The milk cost between group G<sub>1</sub> (Rs. 36.53) and G<sub>2</sub> (Rs. 34.10) did not showed any significant difference.

## DISCUSSION

A positive relationship was observed among milk production, FCM yield and bypass fat intake up to 350g bypass fat supplementation. These results are supported with kirovski *et al.* (2015), they observed that the level of milk production enhanced in the group where 300g cow<sup>-1</sup> day<sup>-1</sup> bypass fat was supplemented. Nasim *et al.* (2014) identified that rumen bypass fat and vegetable oil supplementation increased milk fat percentage with respect to control. Bypass fat feeding reduces the chances of negative energy balance in early lactation or at peak yield and it also improves efficiency of fatty acids absorption which ultimately increase the milk production. As explained in another study that feeding more energy and bypass fat to animals increase the energy density of feed which reduce the chance of negative energy balance (Rajesh *et al.*, 2014). Souza *et al.* (2014) also observed that 2850Kcal ME/kg dry matter intake was highly admirable to improve milk yield because it improved the lactation curve. Lactation length was improved by the bypass fat supplementation might be due to high energy intake and effect of lower stress during early lactation (Tyagi *et al.*, 2010) enhanced lactation length also increases the overall milk production. It is also recommended by previous studied that bypass fat supplementation improved milk yield (Gowda *et al.*, 2013; Mobeen *et al.*, 2017).

Similarly, milk fat% was enhanced by feeding bypass fat to animals as mentioned by Gulati *et al.* (2003) that dramatic increase in milk fat% was observed by feeding bypass fat to dairy animals. Barley and Baghel (2009) found significant increase in milk fat percentage through bypass fat feeding to buffaloes up to five weeks of experimental period. Increase in milk fat is due to more availability of readily absorbable fat at intestine which is not degraded or modulated in rumen due to its inert nature. Inert fat addition in the diet effectively increased the milk and fat yield in crossbred dairy cows (Garg *et al.*, 2012). But another study concluded that addition of rumen inert fat in the dairy cow's ration did not showed any significant results on milk composition including lactose contents, solids not fat and total solid (Wina *et al.*, 2014).

Average protein (%), total solids (%), SNF (%) and body weight gain showed non-significant (P>0.05) results among the experimental groups. Similar protein% among the treatments was also reported by Gulati *et al.* (2003). No significant effect was observed on total protein and solids (%) in study of Lohrenz *et al.* (2010) by rumen protected fat supplementation. Wrenn *et al.* (1978) fed bypass fat supplemented feed to lactating cows for 18 weeks postpartum, they also found no differences in milk protein. Hosam (2011)

experienced the similar results by finding no difference in average protein contents by feeding bypass fat supplemented diet. No significant improvements observed on milk protein and total solid (%) and by supplementation of bypass fat (Sharma *et al.*, 2016). Brundyn *et al.* (2005) found that bypass fat feeding in sheep has no significant effect on live weight gain compared to control group. Wadhwa *et al.* (2012) found increase in weight of cows by inert fat feeding but the difference was nonsignificant.

Maximum feeding cost (Rs. /day) was noticed at bypass fat supplementation level of 450g (Rs. 375.00) and minimum in control group (Rs. 285.00) while highest milk cost (Rs. /kg) was observed at supplementation level of 450g (Rs. 48.26) and lowest at 350g (Rs. 34.10). The improvement in profitability was noticed in all the fat fed groups except at supplementation level of 450g and maximum profit was obtained at 350g i.e. 31.40% more profit than control group. An extra profit of about Rs. 34.50/day was gained with the increasing of milk production by Naik *et al.* (2009). Similarly, about Rs. 39.66/day profit was achieved by improving the productive efficiency with bypass fat feeding in previous studies (Nawaz *et al.*, 2007; Parnerkar *et al.*, 2010). Iqbal *et al.* (2012) also stated the positive response in milk production and profitability by bypass fat feeding to lactating animals.

**Conclusion:** It was concluded that bypass fat supplementation at the rate of 350g per day is economical with significant improvements in milk yield and fat% without compromising the milk composition and weigh gain of indigenous dairy animals.

**Acknowledgement:** The authors are grateful to "M.J. Foods and Dairies" for providing bypass fat (MJ Synerlac) to carry out this experiment.

## REFERENCES

- AOAC. 2000. Official Methods of Analysis, 17<sup>th</sup> Ed. Inc., Maryland, U.S.A.
- Alexander, G., R.Z. Prabhakara and J.R. Prasad. 2002. Effect of supplementing sheep with sunflower acid oil or its calcium soap on nutrient utilization. Asian-Aust. J. Anim. Sci. 15:1288-1293.
- Barley, G.G. and R.P.S. Baghel. 2009. Effect of bypass fat supplementation on milk yield, fat content and serum triglyceride levels of Murrah buffaloes. Buffalo Bull. 28:173-175.
- Brundyn, L., T.S. Brand, A.V. Ferreira, B.B. Aucamp and A. Durand. 2005. Rumen inert fat or starch as supplementary energy sources for reproducing ewes grazing wheat stubble. J. Anim. Sci. 6:8-12.
- Davide, C.L. 1977. Laboratory Guide in Dairy Chemistry Practically. FAO Regional Dairy Development and

- Training Centre for Asia and Pacific, Dairy Training and Research Institute, University of Philippines.
- Economic Survey. 2016-17. Ministry of National Food Security & Research, Government of Pakistan.
- Fenwick, M.A., S. Llewellyn, R. Fitzpatrick, D.A. Kenny, J.J. Murphy, J. Patton and D.C. Wathes. 2008. Negative energy balance in dairy cows is associated with specific changes in IGF-binding protein expression in the oviduct. *Reprod.* 135:63-75.
- Garg, M.R., B.M. Bhandari and P.L. Sherasia. 2012. Effect of supplementing bypass fat with rumen protected choline chloride on milk yield, milk composition and metabolic profile in crossbred cows. *Ind. J. Dairy Sci.* 65:319-323.
- Gargouri, A., G. Caja, R. Casala and I. Mezghani. 2006. Lactational evaluation of effects of calcium soap of fatty acids on dairy ewes. *Small Rumin. Res.* 66:1-10.
- Gowda, N.K.S., A. Manegar, A. Raghavendra, S. Verma, G. Maya, D.T. Pal, K.P. Suresh and K.T. Sampath. 2013. Effect of protected fat supplementation to high yielding dairy cows in field condition. *Anim. Nutr. Feed Technol.* 13:125-130.
- Gulati, S.K., M.R. Garg, P.L. Serashia and T.W. Scott. 2003. Enhancing milk quality and yield in the dairy cow and buffalo by feeding protected nutrient supplements. *Asia-Pac. J. Clin. Nutr.* 12:61-63.
- Hafez, Y.M. 2012. Enhancing milk production in periparturient buffalo fed protected fat with and without vitamin ADE3 treatment. *Egypt. J. Anim. Prod.* 49:249-256.
- Hosam, first name? 2011. Effects of varying levels of protected fat on performance of Shami goats during early and mid-lactation. *Turk. J. Vet. Anim. Sci.* 35:67-74.
- Iqbal, A., J. Akbar, M. Abdullah and M. Sarwar. 2012. Feeding and economics aspect of supplemental fat in Sahiwal cows. *J. Anim. Plant Sci.* 22:55-58.
- Kirovski, D., B. Blond, M. Katic, R. Markovic and D. Sefer. 2015. Milk yield and composition, body condition, rumen characteristics, and blood metabolites of dairy cows fed diet supplemented with palm oil. *Chem. Biol. Technol. Agric.* 2:6.
- Lohrenz, A.K., K. Duske, F. Schneider, K. Nürnberg, B. Losand, H.M. Seyfert, C.C. Metges and H.M. Hammon. 2010. Milk performance and glucose metabolism in dairy cows fed rumen-protected fat during mid lactation. *J. Dairy Sci.* 93:5867-5876.
- Maeng W.J., J.H. Lim and S.R. Lee. 1993. Effects of calcium salts of long-chain fatty acids on ruminal digestibility, microbial protein yield and lactation performance. *Asian-Aust J. Anim. Sci.* 6:395-400.
- Mobeen, A., M. Riaz and M.U. Yaqoob. 2017. Effect of bypass fat supplementation on the performance of Sahiwal dairy cows. *Int. J. Agric. Biol.* 19:423-426.
- Minitab 17 statistical software. 2000. [Computer software]. State College, PA: Minitab, Inc. Available online at [www.minitab.com](http://www.minitab.com)
- Naik, P.K., S. Saijpal and R. Neelam. 2009. Effect of ruminally protected fat on *in vitro* fermentation and apparent nutrient digestibility in buffaloes (*Bubalus bubalis*). *Anim. Feed Sci. Technol.* 153:68-76.
- Nasim, S., M.A. Jabbar, Saima, M.Z.U. Khan, M.N. Haq, M. Imran and A.D. Yasir. 2014. Lactation response to the supplementation of fats and niacin in Nili-Ravi buffaloes. *J. Anim. Plant Sci.* 24:16-19.
- Nawaz, H., M. Yaqoob and M. Abdullah. 2007. Effect of feeding supplemental tallow on the performance of lactating Nili-Ravi buffaloes. *Turk. J. Vet. Anim. Sci.* 31:389-398.
- Parnerkar S., D. Kumar, S.S. Shankpal and H. Thube. 2010. Effect of feeding bypass fat to lactating buffaloes during early lactation. 7<sup>th</sup> Biennial Anim. Nutr. Assoc. Conf., Orissa Univ. Agric. and Technol., Bhubaneswar, India.
- Rajesh, G., S. Mahendra, A.K. Roy and S. Singh. 2014. Effect of prilled fat supplementation on milk yield, composition and plasma hormones in early lactation crossbred cows. *J. Biol. Innov.* 4:216-224.
- Rabiee A.R., K. Breinhild, W. Scott, H.M. Golder, E. Block and I.J. Lean. 2012. Effect of fat additions to diets of dairy cattle on milk production and components: A meta-analysis and meta-regression. *J. Dairy Sci.* 95:3225-3247.
- Reis M.M., R.F. Cooke, J. Ranches and J.L. Vasconcelos. 2012. Effects of calcium salts of polyunsaturated fatty acids on productive and reproductive parameters of lactating Holstein cows. *J. Dairy Sci.* 95:7039-7050.
- Sharma, S., M. Singh, A.K. Roy and S. Thakur. 2016. Effect of pre-partum prilled fat supplementation on feed intake, energy balance and milk production in Murrah buffaloes. *Vet. World* 9:256-259.
- Souza, D.R., C.R. Alcalde, C.A. Lopes, D. Oliveira, B.S.D.L. Molina, F.D. Assis, F.D. Macedo, L.C. Gomes, B. Hygino and A.P.S. Possamai. 2014. Lactation curves and economic results of Saanen goats fed increasing dietary energy levels obtained by the addition of calcium salts of fatty acids. *R. Bras. Zoo. Tec.* 43:73-79.
- Tyagi, N., S.S. Thakur and S.K. Shelke. 2010. Effect of bypass fat supplementation on productive and reproductive performance in crossbred cows. *Trop. Anim. Health Prod.* 42:1749-1755.
- Wina, E., Y. Widiawaty, B. Tangendjaja and I.W.R. Susana. 2014. Supplementation of calcium-fatty acid to increase milk production and performance of lactating dairy cow. *Indones. J. Anim. Vet. Sci.* 19:287-293.
- Wadhwa, M., R.S. Grewal, M.P.S. Bakshi and P.S. Brar. 2012. Effect of supplementing bypass fat on the performance of high yielding crossbred cows. *Ind. J. Anim. Sci.* 82:200-203.
- Wrenn, T.R., J. Bitman, R.A. Waterman, J.R. Weyant, D.L. Wood, L.L. Strozinski and J.N.W. Hoover. 1978. Feeding protected and unprotected tallow to lactating cows. *J. Dairy Sci.* 61:49-58.