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EFFECT OF FEEDING DIFFERENT SOURCES OF SUPPLEMENTAL FAT ON NUTRIENT INTAKE, MILK PRODUCTION AND COMPOSITION IN LACTATING NILI-RAVI BUFFALOES

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Four early lactating Nili-Ravi buffaloes were fed four diets either contained no added fat or had tallow, poultry fat or mustard oil at 3% of dietary dry matter in an experiment conducted in a 4x4 Latin square design. Intakes of DM, OM, CP, ADF and NDF decreased (p<0.05) in buffaloes fed supplemental tallow or poultry fat than those fed control or mustard oil. Intake of EE was lower in control and higher in those fed mustard oil. Intakes of NE_L and DE were higher (p<0.01) in buffaloes fed mustard oil versus those on control, tallow or poultry fat. Average daily yields of milk, FCM, SCM and ECM were higher (p<0.01) in buffaloes fed different fat sources than those on control. Milk fat percentages and yields increased (p<0.01) with dietary tallow than those fed poultry fat, mustard oil or control diet. Total solids contents were higher for buffaloes fed supplemental tallow versus those fed the control, poultry fat or mustard oil diets. The milk protein, lactose, solids-not-fat, ash, specific gravity and GE of milk fat did not differ significantly ((p>0.05) in control versus those fed fat from various sources, whereas feeding different sources of supplemental fat increased daily solids-not-fat yield.
Keywords: Fat feeding, nutrient intake, milk production and composition, buffaloes

INTRODUCTION

Water buffalo is a tropical animal and thrives well in irrigated areas, where it has easy access to water and plenty of fodder. The buffalo under tropical and sub-tropical conditions has shown high yield of milk rich in fat and total solids, which is used for various dairy purposes (butter, ghee and dahi) in addition to the preparations and manufacture of other dairy foods including infant foods. The dairy industry in Pakistan is buffalo oriented. Pakistan inhabits 29.0 million buffaloes. Buffaloes in milk contribute 58% of the total milk produced in the country (Anonymous, 2008). Research studies on different aspects of buffalo production have been going on for the last several years. Studies have been conducted to compare the efficiency of utilization of different feedstuffs by buffalo. It is considered superior to cow because it digests feed more efficiently than do cattle, particularly when feed is of poor quality and is high in cellulose; buffalo milk is, therefore, comparatively cheaper to produce (Fahimuddin, 1989). Moreover, buffalo takes less time to adjust to changes in the diet composition as compared to the cow.

During early lactation, dairy animals are in negative energy balance for first 8 to 12 weeks because energy intake is insufficient to meet the energy requirement (Onetti and Grummer, 2004). To overcome this negative energy balance, energy density of the diet is to be increased with excessive grain and/or concentrate feeding; however, this often causes undesirable ruminal fermentation and depresses milk fat synthesis, whereas supplemental fat tends to increase energy density of the diet without causing negative impact on rumen fermentation associated with excessive grain and/or concentrate feeding (Nawaz *et al.*, 2007a). Annual production of vegetable oils and animal fat in Pakistan is 0.81 and 0.47 million tonnes, respectively (Anonymous, 2008). Since little research has been undertaken on feeding of various fats and oils to lactating buffaloes to meet energy requirements, it was thus appropriate to study the comparative feeding value of different locally available fat sources in lactating buffaloes. A study was, therefore, conducted to investigate the effect of feeding different sources of supplemental fat on nutrient intake, milk production, milk composition and body weight gains in early lactating Nili-Ravi buffaloes.

MATERIALS AND METHODS

A study was conducted in a 4 x 4 latin square design at the R.M. Akram Animal Nutrition Research Center, University of Agriculture, Faisalabad, Pakistan to determine the comparative nutritive value of three promising fat sources. Four early lactating Nili- Ravi buffaloes of approximately the same age, lactation number, lactation stage, body weight and milk yield were used in the trial. Four experimental diets (Table 1) either contained no added fat or had tallow, poultry fat

Table 1. Percent ingredients and nutrient composition of the experimental diets containing tallow, poultry fat or mustard oil

Ingredients	A Control	B Tallow	C Poultry fat	D Mustard oil
Mott grass	46.82	40.60	40.42	40.42
Wheat straw	11.72	12.42	12.39	12.39
Cottonseed cake	13.24	14.05	14.00	14.00
Maize oil cake	13.47	14.29	14.25	14.25
Wheat bran	14.04	14.88	15.17	15.17
Tallow	-	3.00	-	-
Poultry fat	-	-	3.00	-
Mustard oil	-	-	-	3.00
Dicalcium phosphate	0.72	0.76	0.77	0.77
Total	100	100	100	100
Dry matter %	33.62	36.70	36.77	36.78
Organic matter%	91.17	91.39	91.39	91.39
Crude protein %	12.50	12.50	12.50	12.50
Ether extract %	3.50	6.50	6.50	6.50
ADF %	27.70	26.41	26.50	26.50
NDF %	47.54	45.60	45.55	45.55
DE Mcal/kg DM	2.19	2.43	2.43	2.43
NEL Mcal/kg DM	1.42	1.50	1.50	1.50
Calcium %	0.54	0.53	0.53	0.53
Phosphorus %	0.41	0.42	0.42	0.42

DM = Dry matter ADF = Acid detergent fibre NDF = Neutral detergent fibre
NEL = Net energy of lactation DE = Digestible energy

or mustard oil at 3% of dietary dry matter (DM) were formulated and were fed as total mixed ration according to nutrient requirements of dairy animals. The trial consisted of four periods of 21 days each, the first 14 days were allowed for adjustment to a diet followed by 7 days for sample collection. Buffaloes were individually fed diets *ad libitum* twice daily i.e. 05 and 17 hours in a tie-stall barn. The feed offered and refused was recorded daily and proportionate samples were taken during the last 7 days of each trial, which were composited to have one sample each per buffalo per period. Dry matter was determined by drying the samples in a forced draught hot air oven at 60°C for 48 hours. Composited dried samples of feed offered and refused were ground through a 1 mm screen in a Wiley mill and were stored at -20°C until analyzed for organic matter (OM), crude protein (CP), ether extract (EE), ash (600°C for 8 h), acid detergent fiber (ADF), and neutral detergent fiber (NDF) content.

Buffaloes were milked twice a day and milk production was recorded at each milking throughout the trial. Individual milk samples were taken at each milking during the last 7 days of each trial in 50 ml plastic vials each containing approximately 50 mg of potassium dichromate ($K_2Cr_2O_7$). The milk samples were composited daily for each buffalo according to milk production to provide one sample each per buffalo per period and were stored at -20°C until analyzed for milk fat percentage, protein, lactose, total solids, solids-not-fat and ash content. The specific gravity of milk was determined using a lactometer. The buffaloes were weighed during first three days and last three days of each experimental period to record changes in body weights (BW). The data were subjected to analysis of variance using a 4x4 latin square design (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

The effect of feeding different sources of supplemental fat on nutrient intake, milk production, milk composition and body weight gains was investigated. The findings are presented in the following sections.

Nutrient intake

The average daily intakes of DM, DM as percentage of BW, OM, CP, EE, ADF, NDF, NE_L (Mcal/d) and DE (Mcal/d) are given in Table 2. Total DM intake and DM as a percentage of BW for buffaloes fed supplemental tallow and poultry fat were significantly lower ($p < 0.01$)

Table 2. Average daily nutrients intake by buffaloes fed diets containing different sources of supplemental fat

Item	Diets				SEM
	A Control	B Tallow	C Poultry fat	D Mustard oil	
DM (kg)	13.8 a	12.7 b	12.9 b	14.2a	0.200
DM (% BW)	3.12 a	2.88 b	2.93 b	3.23 a	0.046
OM (kg)	12.6 a	11.6 b	11.8 b	13.0 a	0.185
CP (kg)	1.72 a	1.59 b	1.61 b	1.78 a	0.025
EE (kg)	0.48 c	0.83 b	0.84 b	0.93 a	0.012
ADF (kg)	3.81 a	3.39 b	3.42 b	3.77 a	0.058
NDF (kg)	6.55 a	5.79 b	5.88 b	6.48 a	0.092
NEL (Mcal/day)	19.6 b	19.0 b	19.4 b	21.4 a	0.298
DE (Mcal/day)	30.1 b	30.8 b	31.4 b	34.6 a	0.466

Means with the same superscript in a row show nonsignificant difference (P>0.05).
SEM = Standard error of means DM = Dry matter BW = Body weight
OM = Organic matter CP = Crude protein EE = Ether extract ADF= Acid detergent fibre
NDF = Neutral detergent fibre NEL = Net energy of lactation DE = Digestible energy

from those fed the control diet or the diet containing mustard oil. The results were in agreement with those of Onetti and Grummer (2004) who reported decreased DM intake in lactating dairy cows fed diets containing tallow, calcium salts of palm fatty acids and selected hydrolyzed tallow fatty acids. Nawaz *et al.* (2007b) also reported that dry matter intake was significantly lower ($p < 0.05$) in cows fed supplemental tallow than those fed the control diet. In contrast, some other workers reported that fish oil and sunflower oil diets decreased DM intake in lactating cows (Shingfield *et al.*, 2006). The DM intake response suggested that buffaloes fed tallow and poultry fat might need more time to adjust to diets compared to buffaloes fed the diet containing mustard oil or those on control. The average daily intakes of OM, CP, ADF and NDF varied with differences in DM intake (Table 2). Intake of EE increased in buffaloes fed supplemental fats and oil as compared to control, which was attributed to the addition of supplemental fat. Intakes of NE_L and DE were significantly higher ($p < 0.01$) in buffaloes fed diet containing mustard oil than for those on control or diets containing tallow and poultry fat. The chemostatic mechanisms might have been responsible for control of DM intake. These observations were in agreement with those of Nawaz *et al.* (2007a) who observed that when fat supplementation decreased DM intake, energy intake did not decrease. Noticeably, greater intakes of NE_L and DE in the mustard oil group were primarily due to high DM intake.

Milk production

Average daily milk production is given in Table 3. The average daily milk production (kg/d) was significantly higher ($p<0.01$) in buffaloes fed diets containing supplemental fat sources than those on control. Similar pattern of variation was reported by Weiss and Wyatt (2004) who observed that different supplemental fat sources were equally effective in increasing milk production in lactating dairy cows. Milk production appeared to increase with fat supplementation because of higher efficiency of milk synthesis. These findings supported those of Zheng *et al.* (2005) who observed that dietary supplementation with vegetable oils tended to increase milk yield in lactating cows, with highest milk yield in the cottonseed oil group compared to that of control. No significant differences were noted between buffaloes fed tallow and poultry fat and also between those fed poultry fat and mustard oil. The results revealed that the inclusion of supplemental fat in the diets of early lactating buffaloes improved FCM production. The higher FCM yields in buffaloes fed various supplemental fat sources were mainly due to higher milk yield and higher milk fat percentages. Production of solids corrected milk (SCM) and energy corrected milk (ECM) followed the same trend as was observed in case of FCM. Higher production of ECM in buffaloes having higher milk fat percentage and lower in those having lower milk fat indicated that ECM was affected mainly by milk fat content.

Milk composition

Milk composition is given in Table 3. Milk fat percentage was significantly (p<0.01) higher for buffaloes fed the diet containing tallow compared to those fed the control diet or diets containing poultry fat and mustard oil. Similar findings were reported by Srivastava *et al.* (1990) who observed a significant increase in the fat content of Murrah buffalo's milk due to feeding supplemental fat. The results were in agreement with those of Zheng *et al.* (2006) who found increased milk fat percentage in Holstein lactating cows fed diets containing different dietary sources of vegetable oils. Average daily milk fat yield was lower (p < 0.01) in buffaloes fed the control diet than in those fed diets containing different fat sources. Among the treatment groups, higher (p < 0.05) milk fat yield was found in tallow and poultry fat groups and differences within these groups were not significant. Higher daily milk fat yield was due to higher milk yields with higher milk fat content. Milk fat contents and yield were increased in animals fed tallow and poultry fat probably due to an increase in the exogenous supply of FA that were incorporated directly into milk fat. Depressions in milk fat percentage were found to be common when unprotected fat was fed, possibly because of decreased fiber digestion and lower ratios of acetate to propionate. In contrast, some other workers reported that milk fat percentage and yield did not decrease when dairy cows were fed oilseeds or oils high in polyunsaturated FA and unprotected from the ruminal environment.

Table 3. Milk production, milk composition and body weight gains in buffaloes fed diets containing different sources of supplemental fat

Item	Diets				SEM
	A Control	B Tallow	C Poultry fat	D Mustard oil	
Milk (kg/day)	10.6b	13.4a	12.7a	12.8a	0.375
FCM (kg/day)	16.0c	22.1a	20.1ab	19.5b	0.693
SCM (kg/day)	15.1c	20.9a	19.1ab	18.3b	0.653
ECM (kg/day)	15.0b	21.0a	19.4a	18.3a	0.759
Milk fat %	7.41c	8.38a	7.90 b	7.45c	0.116
Milk fat (kg/day)	0.78c	1.12a	1.00ab	0.96b	0.037
Milk protein %	3.97a	3.79a	3.86a	3.65a	0.101
Lactose %	4.14a	4.44a	4.38a	4.43a	0.213
Total solids %	16.47c	17.75a	17.27b	16.56c	0.108
SNF %	9.00a	9.37a	9.34a	9.01a	0.163
SNF (kg/day)	0.95b	1.26a	1.18a	1.15a	0.044
Ash (%)	0.99a	1.03a	1.10a	0.87a	0.066
Specific gravity	1.030a	1.028a	1.030a	1.029a	0.001
GE (Kcal/g of fat)	9.34a	9.45a	9.51a	9.40a	0.236
GE (Kcal/kg of milk)	1063 b	1221a	1224ab	1074 b	29.965
Total GE of milk (Mcal/day)	11.2c	15.7 a	14.2ab	13.7b	0.485
Gains in BW (kg/day)	0.22 c	0.35a	0.32a	0.30a	0.012

Means with the same superscript in a row show non-significant difference (P>0.05)
SEM = Standard error of means FCM = 4% fat corrected milk SCM = Solids corrected milk
SNF = Solids-not-fat ECM = Energy corrected milk GE = Gross energy BW = Body weight

Milk protein contents were not significantly (p > 0.05) different in buffaloes fed diets supplemented with various fat sources or control. However, an apparent lower milk protein percentage was observed in animals fed various fat sources as compared to the control group. These results supported the findings of Whitlock *et al.* (2006) who reported decreased milk protein content in lactating dairy cows fed diets containing supplemental fat. The present results were also in line with those of Shingfield *et al.* (2006) who noted decreased milk protein content in cow's milk fed diets containing fish oil and sunflower oil than those fed the control diet. Depression in milk protein in buffaloes fed fat was probably due to insufficient critical amino acids needed for milk protein synthesis with increase in milk production. Whitlock *et al.* (2006) suggested that increased plasma FA may be responsible for depressions in milk protein by decreasing concentrations of circulating growth hormone or dietary fat might have impaired amino acids transport. There were no significant (p > 0.05) increases in lactose from buffaloes fed diets containing various supplemental fat sources as compared to control. However, dietary fat might have spared some glucose from oxidation in the mammary glands, which might result in nonsignificant increase in lactose content in milk. These results supported the findings of Wu *et al.* (1993) who did not find any influence of three supplemental fat sources on percentage of lactose in cow's milk.

The contents of total solids were similar in buffaloes on control and those on diet containing mustard oil, but there was a significant ($p < 0.01$) increase in those fed diets containing tallow or poultry fat. Similarly, the total solids contents in the milk of buffaloes fed tallow were significantly higher ($p < 0.05$) than those fed poultry fat. Higher total solids contents in buffaloes fed tallow and poultry fat were due to higher milk fat percentages compared to control and those fed mustard oil because milk protein and lactose contents remained constant in all treatments. Solids-not-fat, ash, specific gravity and GE of milk fat (Kcal/g) did not differ significantly ($p > 0.05$) in control versus those assigned to diets containing different supplemental fat sources. Average daily production of SNF was higher ($p < 0.05$) in buffaloes fed various sources of supplemental fat than that of the control. Milk fat plays the major role in the variation of total solids, when fat is separated; SNF remains almost constant in buffalo's milk. These results supported the findings of Nawaz *et al.* (2007a) who found that adding different fat sources to the diet did not influence the content and production of milk SNF in Nili-Ravi buffalo.

Body weight gains

Body weight gain (kg/d) was significantly higher ($p < 0.01$) in buffaloes fed diets supplemented with fat than that of control (Table 3). Inclusion of fat as an energy supplement to the diets of lactating buffaloes improved BW gain. Nawaz *et al.* (2007a) also reported that mean body condition score (BCS) of buffaloes increased when supplemental tallow was fed during early lactation. However, Markus *et al.* (1996) reported that BW and BCS were not influenced significantly by the addition of tallow or sunflower seeds in the diets of early lactating dairy cows. In the present study, the DM intakes seemed fairly sufficient to meet the requirements for maintenance and production of early lactating buffaloes.

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REFERENCES

Anonymous. 2007. Pakistan Economic Survey. Government of Pakistan, Finance Division, Islamabad.

Fahimuddin, M. 1989. Domestic Water Buffalo. 2nd Ed. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.

Markus, S.B., K.M. Wittenberg, J.R. Ingalls and M. Undi. 1996. Production responses by early lactation cows to whole sunflower seed or tallow supplementation of a diet based on barley. J. Dairy Sci. 79: 1817-1825.

Nawaz, H., M. Yaqoob and M. Abdullah. 2007a. Effect of feeding supplement tallow on the performance of lactating Nili-Ravi buffaloes. Turkish J. Vet. and Anim. Sci. 31: 389-398.

Nawaz, H., M. Abdullah, M. Yaqoob and S. Ayub. 2007b. Effect of feeding tallow on nutrient digestibility, rumen fermentation and blood metabolites in cows. Indian Vet. J. 84: 1267-1272.

Onetti, S.G. and R.R. Grummer. 2004. Response of lactating cows to three supplemental fat sources as affected by forage in the diet and stage of lactation: a meta-analysis of literature. Anim. Feed Sci. Technol. 115: 67-82.

Pantoja, J., J.L. Firkins, M.L. Eastridge and B.L. Hull. 1996. Fatty acid digestion in lactating dairy cows fed fats varying in degree of saturation and different fiber sources. J. Dairy Sci. 79: 575-584.

Shingfield, K.J., C.K. Reynolds, G. Hervas and J.M. Griinari. 2006. Examination of the persistency of milk fatty acids composition responses to fish oil and sunflower oil in the diet of dairy cows. J. Dairy Sci. 89: 714-732.

Srivastava, A., M.P. Mathur and V.D. Mudgal. 1990. Influence of feeding protected fat to buffaloes on some enzymes in milk. Indian J. Dairy Sci. 42: 354-355.

Steel, R.G.D., J.H. Torrie and D.A. Dicky. 1997. Principles and Procedures of Statistics–A biometrical approach. 3rd Ed. McGraw Hill Book Co. Inc., New York, USA.

Weiss, W.P. and D.J. Wyatt. 2004. Digestible energy values of diets with different fat supplements when fed to lactating dairy cows. J. Dairy Sci. 87:1446-1454.

Whitlock, L.A., D.J. Schingoethe, A.A. AbuGhazaleh, A.R. Hippen and K.F. Kalscheur. 2006. Milk production and composition from cows fed small amounts of fish oil with Extruded Soybeans. J. Dairy Sci. 89: 3972-3980.

Wu, Z., J.T. Huber, F.T. Sleiman, J.M. Simas, K.H. Chen, S.C. Chan and C. Fontes. 1993. Effect of three supplemental fat sources on lactation and digestion in dairy cows. J. Dairy Sci. 76: 3562-3570.

Zheng, H.C., J.X. Liu, J.H. Yao, Q. Yuan, H. . Ye, J. A. Ye and Y.M. Mu. 2005. Effects of Dietary sources of vegetable oils on performance of high-yielding lactating cows and conjugated linoleic acids in milk. J. Dairy Sci. 88: 2037-2042.