Original Article Buffalo Bulletin (April-June 2022) Vol.41 No.2

EFFICIENCY OF FEED CONVERSION AND MILK YIELD IN MURRAH BUFFALOES FED WITH LINSEED AND LINSEED OIL

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Received: 12 January 2021
Accepted: 1 June 2022

ABSTRACT

The present experiment was carried out to study the influence of feeding linseed and linseed oil on feed conversion and milk production efficiency (gross efficiency of milk production and gross protein efficiency) in lactating Murrah buffaloes. For this purpose, 18 lactating Murrah buffaloes were grouped in control (T_0), T_1 and T_2 (06 animals in each) on basis of average live weight (516.55±9.53 kg), milk yield (7.50±0.3 kg), fat percentage in milk (6.70±0.29%) and lactation stage (2 weeks after parturition). Murrah buffaloes in all three groups were fed a same ration, consist of available green fodder, wheat straw and concentrate (69.03:30.97; roughage: concentrate ratio) to fulfill their nutrient requirement for maintenance and milk production of experimental Murrah buffaloes. In the treatment group (T_1) 250 g/d linseed oil and 570 g/d whole linseed (T_2) was supplemented with basal ration. The experimental feeding to the Murrah buffaloes was started 15 days after parturition and continues for 60 days. However, the experimental data were taken for the period of 6 months (i.e. 180 days). A 7 days digestion trial was conducted at the last of feeding experiment to know the digestibility of nutrient. The milk production, 4% FCM yield, SCM yield, ECM yield, change in body weight, dry matter intake and roughage to concentrate ration didn't differ significantly between groups. No significant difference was observed in nutrient intake (TDN and CP) between groups. The digestibility of organic nutrient also didn't differ significantly among experimental groups. The average gross efficiency of milk production was 26.51% and average gross protein efficiency of milk production was 36.49% and didn't differ significantly. The average feed conversion efficiency as milk yield (kg) / DMI (kg) was 0.61, FCM yield(kg) / DMI (kg) was 0.86, average ECM yield (kg) / DMI (kg) was 0.89 and average SCM yield (kg) / DMI (kg) was 0.85 in lactating Murrah buffaloes. It was concluded that feeding linseed and linseed oil in lactating Murrah buffaloes didn't affect the milk production efficiency (gross efficiency of milk production and gross protein efficiency) and feed conversion efficiency.

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Keywords: *Bubalus bubalis*, buffaloes, efficiency, lactating, Murrah buffaloes, linseed, milk production, nutrient intake

INTRODUCTION

India is having highest buffalo population i.e. 109.85 million (20th Livestock Census) in the world. More than half of the total buffaloes of the world is found in India and they are of milk type buffaloes. India is highest milk producer in the world since 1997 and BAHS (2019) reported that milk production was 187.74 million tonnes in 2018 to 2019. Buffaloes yielding nearly half of total milk produced in India and average milk yield of buffalo was 5.23 kg/day. Buffaloes are very important in providing nutritional and livelihood security for most of rural people in India. In India, more than half of the world's buffaloes are found. Madhya Pradesh has a large livestock population of 40.63 million animals and ranks third in India in terms of total milk production with 159.11 lakh MT in 2018 to 2019.

The efficiency of utilisation of dietary energy for milk production and feed conversion efficiency differ significantly within and between breeds, parity, season, and days in milk (Zamani, 2005) depending upon their physiological stage *viz*. stage of lactation, parity, and stage of gestation (Blake and Custodio, 1984), type of feed and fodder used and environmental conditions in which animals are reared. Therefore, the present study was planned to find out the effect of linseed and linseed oil supplementation on feed conversion efficiency and milk production efficiency (gross efficiency of milk production and gross protein efficiency) in lactating Murrah buffaloes.

MATERIALS AND METHODS

The present study was carried out to see the influence of feeding linseed and linseed oil on feed conversion efficiency and milk production efficiency in lactating Murrah buffaloes in Jabalpur district (M.P., India). Eighteen nursing Murrah buffaloes were classified into three groups: Control (T0), T1, and T2 based on their average body weight (516.55±9.53 kg), milk output (7.50±0.3 kg), fat (6.70±0.29%), and lactation stage (2 weeks post-partum). All Murrah buffaloes were fed the same ration, which included wheat straw, green grass, and concentrate. Table 1 shows the chemical composition of the concentrate mixtures in Control (T0), T1 and T2, berseem, and wheat straw, as determined by established procedures (AOAC, 2012). To meet the requirements for maintenance and production, buffaloes in the Control (T0) group were given a mix ration consisting of wheat straw, green fodder, and concentrate (69.03:30.97; roughage: concentrate ratio) (ICAR, 2013). The treatments were either a basal ration supplemented with 250 g/d linseed oil (T1) or 570 g/d whole linseed (T2). The feeding of experimental diets began 15 days after delivery, and the entire experiment lasted 60 days. The data, on the other hand, was kept for 180 days. After the feeding trial, a 7-day digesting trial was done to determine the nutrient's digestibility. At milking time in the morning and evening, buffaloes were given a weighed quantity of concentrates, followed by roughage (dry + green) feeding. For exercise, the animals were let go in the surrounded paddock for around 1 to 2 h each day. All the experimental buffaloes were fed individually. The allocated amount of feed, fodder and concentrates offered and left over were collected next morning from manger and feed intake was recorded by difference. Clean and fresh water was made freely available. Body weight of each experimental animal was taken before start of experiment and at the end of experiment using electronic weigh bridge available at livestock farm, Adhartal to know the body weight changes during experiment. The weighing was done before feeding and watering of animals in the morning.

McDonald *et al*. (2002) evaluated the gross efficiency of milk production using the assumptions that 1 kg 4% FCM contained 750 Kcal and 1 kg TDN contained 3600 Kcal ME. The gross milk production efficiency (ME) was computed as follows:

The formula published by Jumah *et al*. (1965) was used to calculate gross protein efficiency (GPE) for milk production:

Feed conversion efficiency is used to measure the efficiency of utilization of feed nutrients by animals. In lactating animals, it was calculated by using the formula given by Robinson and Erasmus (2010):

i. (Milk yield (kg))/(Dry matter intake (kg))

ii. (Fat corrected milk yield (kg)) / (Dry matter intake (kg))

iii. (Fat corrected milk yield(kg)) / (Dry matter intake(kg))

vi. (Solid corrected milk yield (kg)) / (Dry matter intake (kg))

Fat corrected milk yield

Rice *et al*. (1970) provided the following formula for calculating fat corrected milk (FCM) yield:

$$4\%\ \text{FCM (kg)} = (0.4\times\text{Milk yield in kg}+15\times\text{Fat yield in kg})$$

Solid corrected milk (SCM) yield

Rice *et al*. (1970) provided the formula for calculating solid corrected milk (SCM) yield:

$$\text{SCM (kg)} = 12.3\ (F) + 6.56\ (SNF) - 0.0752\ (M)$$

Where; F = weight of fat in milk;

SNF = solid not fat yield (kg);

M = milk yield (kg).

Energy corrected milk (ECM) yield

The following equation, developed by Tyrrell and Reid (1965), was used to convert whole milk to ECM:

$$\text{ECM(kg)}=(\text{Milk yield}\times 0.3246)+(\text{Fat yield}\times 12.86)+(\text{Protein yield}\times 7.04)$$

Individual buffalo milk production is recorded in the morning and evening and collated on a daily basis. The data collected during the experiment were analysed using SPSS software and the Randomised Block Design (RBD) approach provided by Snedecor and Cochran (1994). (14.1 version).

RESULTS AND DISCUSSIONS

The effect of linseed and linseed oil on average milk yield, body weight, dry matter intake, roughage to concentrate ratio and nutrient intake (TDN and CP) has been calculated and presented in Table 2. In this investigation, there was no significant change in milk yield (P>0.05) at the start of experiment and during the course of experiment between groups. Tewatia *et al*. (2014) found no significant difference (P>0.05) in milk output in Sahiwal cows given linseed or linseed meal. Similarly, Dhiman *et al*. (2000); Lunsin *et al*. (2012); Benchaar *et al*. (2015) in cows in lactating buffaloes also found no significant difference in milk production when fed linseed/linseed oil. Furthermore, Allen (2000) found that adding hydrogenated fat and oilseeds at roughly 23 and 30 g/kg DM added fat, respectively, has no influence on dry matter consumption, which could help explain why dairy cows given linseed oil/linseed have lower milk output. The difference in body weight between groups and within groups was non-significant (P>0.05) at the beginning and end of the trial since all diets met the nutritional needs of the animals and were equally palatable to all. Petit *et al*. (2001) found similar results in Holstein cows fed two dietary fat supplements based on either solvent extracted flaxseed meal or whole flaxseed treated with formaldehyde 9 weeks after birth. In present study the dry matter intake from roughage and concentrate, roughage to concentrate ratio, crude protein and total digestible nutrient intake did not differ (P>0.05) significantly between groups from each other as all the experimental diets were same in composition. Our results are in favour with study conducted by Tewatia *et al*. (2014) who also stated that nutrient intake (DCP and TDN) was similar among treatments, due to similar dry matter intake (DMI) of Sahiwal cows fed on linseed and linseed meal. Ramteke (2012) supported present results that average daily digestible crude protein intake (DCPI) was statistically similar (P>0.05) in bypass fat (15 g/kg of milk yield) fed group in early lactating buffaloes. Similar results were also found in the study conducted by Shankhpal *et al*. (2009) who reported that supplementation of bypass fat in dairy cows did not change CP and TDN intake. Contrary to present findings, Shelke and Thakur (2011) reported high (P<0.05) digestible crude protein intake (DCPI) in the rumen protected fat (2.5% of DMI) fed animals as compared to Control group. Ramteke (2012) found that in experimental nursing buffaloes during the post-partum period, the average daily total digestible nutrients intake (TDNI) was significantly (P = 0.01) greater in the bypass fat fed group (15 g/kg of milk output) than in the Control group. Nutrient intake of animals differed with different life stage, physiological stage, species, breed and also depend on the production status of animal.

Effect of linseed and linseed oil on digestibility (%) of nutrients has been given in Table 3. In present study digestibility of nutrients were not affected due to the low level (1.9%) of oil supplement (calculated as % to DM intake) in control as well linseed or linseed oil treatments groups and this level has not affected the rumen environment. Therefore, no significant (P>0.05) difference in the digestibility of DM, CP, EE, CF, NFE and nutrient density (DCP and TDN %) between the linseed or linseed oil supplemented diets when compared with Control group. Digestibility of nutrient were not affected may be due to that in our study the level of oil feeding (calculated as percentage to DM intake) was lower (1.9%) in linseed oil and linseed treatment groups. When the forage portion of the diet consisted primarily or entirely of non-cereal forages, other studies found no effect of linseed oil supplementation (4% DM) on DM digestion (Bu *et al*., 2007).

Benchaar *et al*. (2012) found that supplementing linseed oil at 2, 3, or 4% DM to nursing dairy cows fed a complete mixed ration with a R:C of 50:50 had no influence on DM digestibility, which is similar to our findings. The literature on the effects of a low-fat diet and lipid supplementation on total-tract digestibility is mixed. Ueda *et al*. (2003) investigated the effect of linseed oil supplementation on ruminal digestion in dairy cows fed a variety of diets. Total-tract digestibility of DM and OM was higher with supplementary linseed oil, as were total-tract digestibility of NDF and ADF. When crushed linseeds (3.7% added fat) were fed to a barley

Table 1. Chemical composition of concentrate mixtures, berseem and wheat straw on dry matter basis (%).

Particulars	**Concentrate mixture**			**Berseem**	**Wheat straw**
	T_0	T_1	T_2		
Moisture	6.72	6.76	6.87	13.35	90.86
OM	90.35	90.60	90.79	88.35	91.11
CP	19.89	19.78	20.02	15.90	3.29
EE	4.53	4.59	4.57	2.20	1.39
CF	6.82	6.56	6.71	20.55	35.79
Ash	9.65	9.40	9.21	11.65	8.89
NFE	59.11	59.67	59.49	49.70	51.64

Table 2. Effect of linseed and linseed oil on nutrient intake of Murrah buffaloes.

Items		T_0	T_1	T_2
Average milk production (kg/d)		7.78±0. 81	7.92±0.77	7.89±0.78
Average 4% FCM yield		10.91±0.94	11.19±1.05	11.17±0.99
Average SCM yield		10.74±0.97	11.04±0.98	10.98±0.96
Average ECM yield		11.34±1.01	11.60±1.12	11.60±1.07
Average BW (kg)		517.33±14.01	529.17±11.80	508.42±21.75
Change in BW (g/d)		+14.77	+37.05	+8.33
Average DMI (kg/d)	Roughage	8.62±1.03	9.08±1.14	8.94±0.94
	Concentrate*	4.07±0.39	4.06±0.46	3.81±0.32
	Total	12.69±0.27	13.15±0.21	12.75±0.25
Roughage: Concentrate		67.92 : 32.08	69.07 : 30.93	70.11 : 29.89
CP requirement, g/d (500 kg, ICAR 2013)		1479.72	1497.08	1493.36
CP intake (g/d)		1318.15±12.67	1324.45±14.87	1336.04±11.95
TDN requirement, kg/d (500 kg, ICAR 2013)		7.30	7.36	7.35
TDN intake (kg/d)		8.64±0.93	8.68±1.03	8.86±0.87

*Includes concentrate mixture and 250 g linseed oil in T_1 and 570 g of linseed in T_2.

Table 3. Effect of linseed and linseed oil on digestibility (%) of organic nutrients in Murrah buffaloes.

Organic nutrients	**T_0**	**T_1**	**T_2**
DM	67.98±2.81	66.30±1.38	68.43±1.63
CP	67.76±1.87	68.25±1.56	68.39±0.63
EE	78.44±1.51	79.42±0.67	78.96±1.10
CF	58.69±1.21	60.05±1.20	59.07±0.96
NFE	71.85±0.54	70.01±0.92	71.27±0.47

Table 4. Effect of linseed and linseed oil on gross efficiency and gross protein efficiency of milk production of Murrah buffaloes.

Attributes	**T_0**	**T_1**	**T_2**	**Average**
Gross efficiency of milk production (%)	26.29±2.03	26.90±2.22	26.35±3.02	26.51±0.33
Gross protein efficiency of milk production (%)	35.93±4.91	37.22±5.10	36.32±4.45	36.49±0.66

Table 5. Effect of linseed and linseed oil on feed conversion efficiency of Murrah buffaloes.

Feed conversion efficiency	**T_0**	**T_1**	**T_2**	**Average**
Milk yield (kg) / DMI (kg)	0.61±0.01	0.60±0.02	0.62±0.02	0.61±0.01
FCM yield (kg) / DMI (kg)	0.86±0.02	0.85±0.04	0.88±0.02	0.86±0.01
ECM yield (kg) / DMI (kg)	0.89±0.02	0.88±0.04	0.91±0.02	0.89±0.17
SCM yield (kg) / DMI (kg)	0.85±0.02	0.84±0.04	0.86±0.02	0.85±0.01

silage-based diet in dairy cows, Beauchemin *et al.* (2009) discovered a decrease in DM digestibility.

Table 4 shows the influence of linseed and linseed oil on the gross efficiency of milk production (percent) and gross protein efficiency of milk production (percent) of Murrah buffaloes. When comparing the linseed and linseed oil fed groups to the control group, the gross efficiency of milk production (percent) and gross protein efficiency of milk production (percent) of Murrah buffaloes differed non-significantly (P>0.05). Krishnamohan *et al.* (1975); Sharma *et al.* (2007) in Murrah buffaloes and Shah *et al.* (2012) in cross-bred cows find that the average gross efficiency of ME for milk production was between 19.1 to 30.6% for various types of roughages, which was similar to present findings (26.51%). In contrast to our findings, Kawalkar and Patle (1978) found that when fed complete feed, milk production efficiency was lower (18.54 to 20.11%) than when fed conventional feed. Daniel *et al.* (1989) stated that gross ME efficiency decreased significantly with advance of lactation because cows being less efficient in utilizing dietary nutrients for milk production with decline in their milk yield. In the current study, the average gross protein efficiency of milk production was 36.49%, which is comparable to previous works (Huhtanen *et al*., 2008; Castillo *et al*., 2000; Yan *et al*., 2006; Kirchgessner *et al*., 1994). They stated that proportion of nitrogen lost in urine was strongly related to dietary crude protein concentration. Avoid feeding diets with excessively high crude protein concentrations, especially excess ruminally degradable crude protein, to enhance milk protein efficiency and reduce nitrogen loss in manure, especially in urine.

The effect of linseed and linseed oil on feed conversion efficiency of Murrah buffaloes has been estimated as milk yield (kg)/dry matter intake (kg), fat corrected milk yield (kg)/dry matter intake (kg), energy corrected milk yield (kg)/dry matter intake (kg) and solid corrected milk yield (kg)/dry matter intake (kg) and are presented in Table 5. The feed conversion efficiency in the present experiment as milk yield (kg)/dry matter intake (kg), fat corrected milk yield (kg)/dry matter intake (kg), energy corrected milk yield (kg)/dry matter intake (kg) and solid corrected milk yield (kg)/dry matter intake (kg) didn't differ significantly (P>0.05) among the treatments. It might be due to no change in efficiency of feed use for FCM and ECM production with linseed oil/linseed supplementation and could be related to no change in energy concentration of the diets which apparently resulted in no change in FCM and ECM production. Similar to present findings, Beauchemin *et al.* (2008); Bu *et al.* (2007) reported that feed conversion efficiency was not affected by adding flaxseed or flaxseed oil (4%) supplementation in lactating dairy cows.

In contrary to our study, higher feed conversion efficiency was also reported (Crawford and Hoover, 1984; Petit, 2003; Eugene *et al*., 2008; Kholif *et al*., 2011; Benchaar *et al*., 2012; Benchaar *et al*., 2015) by addition of flaxseed and flaxseed oil in lactating cows. The increase in efficiency of feed uses for FCM and ECM production with linseed oil supplementation could be related to the increase in energy concentration of the diet which apparently supported high FCM and ECM production. Also, feed efficiency was decreased gradually with advanced of lactation. Galmessa *et al*. (2015) also observed increased milk production efficiency expressed in kg of 4% FCM per kg of DMI by supplementation of linseed (0.75 kg).

REFERENCES

Allen, M.S. 2000. Effects of diet on short-term regulation of feed intake by lactating dairy cattle. *J. Dairy Sci.*, 83**(7)**: 1598-1624. DOI: 10.3168/jds.S0022-0302(00)75030-2

Agustinho, B.C., L.M. Zeoula, N.W. Santos, E. Machado, E.H. Yoshimura, J.C.R. Ribas, J.M. Bragatto, M.R. Stemposki, V.J. dos Santos and A.P. Faciola. 2020. Effects of flaxseed oil and vitamin E supplementation on digestibility and milk fatty composition and antioxidant capacity in water buffaloes. *Animals*, **10**(8): 1-13. DOI: 10.3390/ani10081294

AOAC. 2012. *Official Methods of Analysis, Association of Official Analytical Chemist*, 19th ed., Washington, DC, USA.

Beauchemin, K., S.M. McGinn, C. Benchaar and L. Holtshausen. 2008. Crushed sunflower, flax, or canola seeds in lactating dairy cow diets: Effects on methane production, rumen fermentation, and milk production. *J. Dairy Sci.*, **92**(5): 2118-2127. DOI: 10.3168/jds.2008-1903

Beauchemin, K., T.A. McAllister and S. McGinn. 2009. Dietary mitigation of enteric methane from cattle. *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources*, **4**(35):1-18. DOI: 10.1079/PAVSNNR20094035

BAHS. 2019. *Livestock Population 20th Livestock Census.* Basic Animal Husbandry and Fisheries Statistics, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India, New Delhi, India.

Benchaar, C., P.G.A. Romero, P.Y. Chouinard, F. Hassanat, M. Eugene, H.V. Petit and C. Cortes. 2012. Supplementation of increasing amounts of linseed oil to dairy cows fed total mixed rations: Effects on digestion, ruminal fermentation characteristics, protozoal populations, and milk fatty acid composition. *J. Dairy Sci.*, **95**(8): 4578-4590. DOI: 10.3168/jds.2012-5455

Benchaar, C., F. Hassanat, R. Martineau and R. Gervais. 2015. Linseed oil supplementation to dairy cows fed diets based on red clover silage or corn silage: Effects on methane production, rumen fermentation, nutrient digestibility, N balance, and milk production. *J. Dairy Sci.*, **98**(11): 7993-8008. DOI: 10.3168/jds.2015-9398

Blake, R.W. and A.A. Custodio. 1984. Feed efficiency: A composite trait of dairy cattle. *J. Dairy Sci.*, **67**(9): 2075-2083. DOI: 10.3168/jds.S0022-0302(84)81548-9

Bu, D.P., J.Q. Wang, T.R. Dhiman and S.J. Liu. 2007. Effectiveness of oils rich in linoleic and linolenic acids to enhance conjugated linoleic acid in milk from dairy cows. *J. Dairy Sci.*, **90**(2): 998-1007. DOI: 10.3168/jds.S0022-0302(07)71585-0

Castillo, A.R., E. Kebreab, D.E. Beever and J. France. 2000. A review of efficiency of nitrogen utilisation in lactating dairy cows and its relationship with environmental pollution. *J. Anim. Feed Sci.*, **9**(1): 1-32. DOI: 10.22358/jafs/68025/2000

Chilliard, Y. 1993. Dietary fat and adipose tissue metabolism in ruminants, pigs, and rodents: A review. *J. Dairy Sci.*, **76**(12): 3897-3931. DOI: 10.3168/jds.S0022-0302(93)77730-9

Chung, Y.H., M. He, S. McGinn, T. McAllister and K.A. Beauchemin. 2011. Linseed suppresses enteric methane emissions from cattle fed barley silage, but not from those fed grass hay. *Anim. Feed Sci. Technol.*, **166-167**(23): 321-329. DOI: 10.1016/j.anifeedsci.2011.04.022

Crawford, R.J. and W.H. Hoover. 1984. Effects of particle size and formaldehyde treatment of soybean meal on milk production and composition for dairy cows. *J. Dairy Sci.*, **67**(9): 1945-1952. DOI: 10.3168/jds.S0022-0302(84)81528-3

Daniel, S.J., Q.Z. Hason, H.N. Pandey and V.N. Murty. 1989. Nutrient utilization of milk products in crossbred cows. *Indian Journal of Dairy Science*, **33**: 3-7.

Dhiman, T.R., L.D. Satter, M.W. Pariza, M.P. Galli, K. Albright and M.X. Tolosa. 2000. Conjugated linoleic acid (CLA) content of milk from cows offered diets rich in linoleic and linolenic acid. *J. Dairy Sci.*, **83**(5): 1016-1027. DOI: 10.3168/jds.S0022-0302(00)74966-6

El-Diahy, Y.M., M.A.A. El-Hamd and M.A. Elshora. 2016. Effect of flaxseed oil supplemention during pre and postpartum on some physiological parameters and productive performance of Friesian cows. *Egyptian Journal of Nutrition and Feeds*, **19**(1): 1-15. DOI: 10.21608/EJNF.2016.74859

El-Hamd, M.A., Y.M. El-Diahy, M.M. El-Maghraby and M.A. Elshora. 2015. Effect of flaxseed oil on digestibility, blood parameters, immuno-response and productive performance of suckling Friesian calves. *Journal of Animal and Poultry Production*, **6**(12): 755-765. DOI: 10.21608/jappmu.2015.52963

Eugene, M., D. Masse, J. Chiquette and C. Benchaar. (2008). Meta-analysis on the effects of lipid supplementation on methane production in lactating dairy cows. *Canadian Vet. J.*, **88**(2): 331-337.

Galmessa, U., S. Prasad, A. Kumaresan, P.S. Oberoi, R.K. Baithalu, U. Neelam and A.K. Dang. 2015. Modulation of milk fatty acid profile, milk yield and composition through supplementation of omega-3 fatty acid in transition cow's diet. *Journal of Science and Sustainable Development*, **3**(1): 25-38. Available on: https://krishi.icar.gov.in/jspui/bitstream/123456789/60645/1/UlfinaGalmessaetal.2015_JSSD.pdf

Huhtanen, P., J.I. Nousiainen, M. Rinne, K. Kytola and H. Khalili. 2008. Utilization and partition of dietary nitrogen in dairy cows fed grass silage-based diets. *J. Dairy Sci.*, **91**(9): 3589-3599. DOI: 10.3168/jds.2008-1181

Jumah, H.F., B.R. Poulton and W.P. Apgar. 1965. Energy and protein utilization during lactation. *J. Dairy Sci.*, **48**(9): 1210-1214. DOI: 10.3168/jds.S0022-0302(65)88429-6

Kawalkar, V.N. and B.R. Patle. 1978. Utilization of nutrients from complete rations by cross-bred (Holstein x Tharparkar) lactating cows. *Indian J. Anim. Sci.*, **48**(4): 251-254.

Kholif, S.M., T.A. Morsy, A.A. Abedo, N. El-Bordeny and M.M. Abdo. 2011. Milk production and composition, milk fatty acid profile, nutrients digestibility and blood composition of dairy buffaloes fed crushed flaxseed in early lactation. *Egyptian Journal of Nutrition and Feeds*, **14**(3): 409-418.

Kirchgessner, M., W. Windisch and F.X. Roth. 1994. The efficiency of nitrogen conversion in animal nutrition. *Nova Act. LC.*, **70**: 393-412.

Krishnamohan, D.V.G., R.C. Katiyar, S.K. Ranjhan and P.N. Bhatt. 1975. Efficiency of utilization of metabolizable energy and nitrogen for milk production in exotic and cross bred cows fed on different roughages. *Indian J. Anim. Sci.*, **45**: 521-524.

Lunsin, R., M. Wanapat and P. Rowlinson. 2012. Effect of cassava hay and rice bran oil supplementation on rumen fermentation, milk yield and milk composition in lactating dairy cows. *Asian Austral. J. Anim.*, **25**(10): 1364-1373. DOI: 10.5713/ajas.2012.12051

McDonald, P., R.A. Edwards and J.F.D. Greenhalgh. 2002. *Animal Nutrition*, 6th ed. Prentice Hall, New Jersey, England. 543p.

Petit, H.V., R.J. Dewhurst, J.G. Proulx, M. Khalid, W. Haresign and H. Twagiramungu. 2001. Milk production, milk composition and reproductive function of dairy cows fed different fats. *Can. J. Anim. Sci.*, **81**: 263-271. DOI: 10.4141/A00-096

Petit, H.V. 2003. Digestion, milk production, milk composition, and blood composition of dairy cows fed formaldehyde treated flaxseed or sunflower seed. *J. Dairy Sci.*, **86**(8): 2637-2646. DOI: 10.3168/jds.S0022-0302(03)73859-4

Ramteke, P.V. 2012. *Effect of feeding bypass fat prepartum and during early lactation on productive and reproductive performance of buffaloes*. M.V.Sc. Thesis, (Animal Nutrition), Anand Agricultural University, Anand, India.

Rice, V.A., F.N. Andrew, E.J. Warnick and J.E. Legates. 1970. *Breeding and Improvement of Farm Animals*, 6th ed. Tata Mc Graw Hill Publishing Co., Bombay, India.

Robinson, P.H. and L.J. Erasmus. 2010. Feed efficiency and lactating cows: Expressing and interpreting it, p. 289-295. *In The 31st West Nutrition Conference on Challenging Conventional Nutrition Dogma*. Animal Nutrition Association, Saskatoon, Saskatchewan, Ottawa, Canada.

Sankhpal, S.S., R.S. Gupta, S. Parnerkar and A.J. Dhami. 2009. Effect of supplementation of bypass fat on feed intake and digestibility of nutrient in lactating crossbred cows. *In Proceedings of Animal Nutrition Association World Conference*, New Delhi, India. p. 69.

Sehgal, J.P., A. Dey and S. Kant. 2018. Developing feeding module for increasing milk production in Murrah buffaloes (*Bubalus bubalis*). *Buffalo Bull.*, **37**(1): 45-50. Available on: https://kuojs.lib.ku.ac.th/index.php/BufBu/article/view/80/325

Shah, D., R.S. Gupta, R.P.S. Baghel and A. Khare. 2012. Efficiency of utilization of dietary energy for milk production in lactating crossbred cattle (*Bos indicus*). *Veterinary Research Forum*, **3**(3): 213-216.

Sharma, P., R.S. Gupta and R.P.S. Baghel. 2007. Efficiency of utilization of dietary energy for milk production in lactating Murrah buffaloes (*Bubalus bubalis*). *Buffalo Bull.*, **26**(4): 138-143.

Shelke, S.K. and S.S. Thakur. 2011. Economics of feeding rumen protected fat and protein to lactating Murrah buffaloes. *Indian Journal of Animal Nutrition*, **28**(3): 278-282.

Snedecor, G.W. and W.G. Cochran. 1994. *Statistical Methods*, 8th ed. Oxford and IBH Publishing Co., Kolkata, India.

Tewatia, B.S., V.S. Panwar and D.S. Dahiya. 2014. Effect of feeding linseed and linseed meal on milk production and fatty acids profile of milk fat in Sahiwal cows. *Haryana Veterinarian*, **53**(2): 92-95. Available on: https://www.luvas.edu.in/haryana-veterinarian/download/harvet-Dec2014/4.

pdf

Tyrrell, H.F. and J.T. Reid. 1965. Prediction of the energy value of cow's milk. *J. Dairy Sci.*, **48**(9): 1215-1223. DOI: 10.3168/jds.S0022-0302(65)88430-2

Ueda, K., A. Ferlay, J. Chabrot, J.J. Loor, Y. Chilliard and M. Doreau. 2003. Effect of linseed oil supplementation on ruminal digestion in dairy cows fed diets with different forage: Concentrate ratios. *J. Dairy Sci.*, **86**(12): 3999-4007. DOI: 10.3168/jds.S0022-0302(03)74011-9

Yan, T., J.P. Frost, R.E. Agnew, R.C. Binnie and C.S. Mayn. 2006. Relationships among manure nitrogen output and dietary and animal factors in lactating dairy cows. *J. Dairy Sci.*, **89**: 3981-3991. DOI: 10.3168/jds.S0022-0302(06)72441-9

Zamani, P. 2005. *Different measures of energetic efficiency of lactation and estimation of their genetic parameters in Holstein dairy cattle*. Ph.D. Thesis, Department of Animal Science, University of Tehran, Iran.