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Effect of feeding *Moringaoleiferahay* on performance, lactation, and nitrogen balance in lactating *Nili Ravi* buffaloes in semi-arid areas of South Asia

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Abstract

The present study was conducted in semi-arid areas to examine the effect of feeding *Moringaoleifera* hay (MOH) on intake, digestibility, milk yield and its composition in lactating *Nili Ravi* buffaloes. Eight buffaloes of *Nili Ravi* breed were selected from the dairy herd on the basis of nearly similar lactation stage and body weight in the experiment. In this trial, buffaloes were blocked by parity and randomly assigned within block to one of two treatments for the duration of 17 weeks. An isonitrogenous and isocaloric concentrate was formulated and fed as a part of ration to all buffaloes with same quantity. While in the remaining part of the ration, one group was offered ad *libitum Medicago* sativa hay (MSH) and other group was provided MOH, respectively. Animals were fed at the rate of3% of their body weight per day.Dry matter (DM) intake was higher in buffaloes fed MOH diet than in those fed MSH diet. Digestibility of DM, organic matter, crude protein, neutral detergent fiber, acid detergent fiber and ether extract were significantly higher in buffaloes fed MOH diet as compared to MSH diet. Milk yield and 4% fat corrected milk, solid corrected milk, milk protein, and solid not fat were higher in buffaloes fed MOH diet than in those fed MSH diet; however, milk fat percent, milk fat yield (kg/day), lactose, total solids, specific gravity and milk pH were not affected by the treatments. The findings of the present study indicate that feeding MOH as a part of the ration not only has increased nutrients intake, digestibility and nitrogen balance but also improved milk production in lactating *Nili Ravi* buffaloes in semi-arid areas.

Key words: *Moringaoleifera*, Dry matter intake, Digestibility, Milk production, Milk composition, Nitrogen balance, Buffaloes

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Introduction

In the semi-arid areas, due to water scarcity the problem of availability of the nutritious forage for the animals is limited. The situation becomes more severe in days of famine and water shortage creating severe malnutrition among animals. Thus, to overcome this situation in the tropics, drought resistant tree and shrubs can be a better alternative source of animal forage. *Moringaoleifera* is a drought resistant tree with nutritious leaves and pods as source of forage for livestock in the semi-arid areas.

Moringaoleifera, originated in the northwest region of India, Pakistan and south of Himalayan mountains, is one of the potential tree forages has been used as fodder or vegetables since ancient times(Odee, 1998). It grows in all sorts of soil and naturally drought resistant and mostly grows even during the scarcity period of the fodder (Becker, 1995). Its leaves have high content of crude protein (CP), essential vitamins, minerals and amino acids (Makkar and Becker, 1997; Gidamis et al., 2003). Nevertheless, the potential benefits and actual worth of the tree as inclusion in ruminant feeding (Akinbamijo et al., 2004) have not been yet fully exploited. Rocha and Mendieta (1998) supplemented *Moringa oleifera* leaves to dairy cows at the rate of 0.3% of their body weight, and observed an increase in milk yield of 5.7 kg per cow per day, that was 13% higher as compared to the control diet. In another research study, *Moringa* leaf meal at various levels of 10, 20, or 30% of dry matter (DM) was used as substitution for cotton seed cake, and recorded that milk production was significantly increased by 1.4, 0.9 and 0.8 kg per cow per day, respectively (Sarwatt et al., 2004). Although,there were no effects observed on total solids, fat and CP content of the milk by substituting cotton seed cake with *Moringa oleifera* leaf meal.

Feeding effect of various levels of *Moringa oleifera* leaves on intake, digestibility, milk production and milk composition in Creole dairy cows was investigated by Reyes et al. (2006) in Nicaragua and found that DM intake (DMI) as well as milk production increased with various level of supplementation with 2 and 3 kg DM of *MoringaOleifera*alongwith basal dietas compared to control diet. Apparent digestibility coefficients of DM, organic matter (OM), CP,neutral detergent fiber (NDF) and acid detergent fiber (ADF) were increased. Nevertheless, milk fat, total solids and CP and organoleptic characteristics were not significantly affected.

Various studies were conducted in cows to observe the effect of inclusion of only *Moringa oleifera* leaves as supplementation on milk production and composition but the effect of feeding adlib hay from *Moringa oleifera* plant (leaves combined with flowers and shoots) on changes in milk production and composition have not investigated yet in buffaloes in the semi-arid areas of South Asia. There is need to investigate inclusion of *MoringaOleifera* hay on *adlib* basis in the semi-arid areas in the diet of buffaloes to know any changes in milk production and composition. Therefore, the objective of this study was to evaluate the *adlib*DMIof *Moringa Oleifera* plant hay and its effect on nutrient digestibility, milk production, milk composition, and nitrogen balance in early lactating *Nili-Ravi* buffaloes in the semi-arid areas of South Asia.

Materials and Methods

Location and experimental animals

This experiment was conducted at White Gold Dairy Farm in district Faisalabad located at 31° 25' 0" North, 73° 5' 0" East in Pakistan. The climate of Faisalabad features a hot desert climate (BWh) inKöppen-Geiger classification. The day temperature of this area in summer rises up to 45 °C and in winter falls to 5 °C.The average rainfall is only about 300 mm and is highly seasonal with approximately half of the yearly rainfall takes place in July and August.

Eight Buffaloes of *NiliRavi* breedwere selected from the dairy herd on the basis of nearly similar lactation stage and body weight in the experiment. All of the selected buffaloes were in the range of 2nd week of lactation after calving (early lactation). The buffaloes in the experiment were weighed at the beginning of the trial and confined to individual, divided into two groups with well-ventilated stalls. Before the start of the trial all animals were drenched with same dewormer and sprayed with negavan against internal and external parasites, respectively. All animals were vaccinated against foot and mouth disease (FMD). The buffaloes used to exercise daily in a common area, while individual boxes were cleaned, and when walking to the milking. In the presence of the calf all the buffaloes were hand milked.

Feeding Management of Buffalo

Non competitive individual feeding and housing was provided as described by Nikkhah (2013).*Medicago Sativa* (*Alfalfa)*, 60 days of age was utilized for hay production. Mechanical tools and tractor were used for preparation of hay according to standard procedures. Fodder of *Medicago Sativa* was cut with a harvester and sun dried for 4 hours in the field, then it was baled, and stored in a storeroom. Plant of *Moringa oleifera* including leaves and soft shoots was harvested by means of a machete, then chopped in to pieces of approximately 2 cm length and then sun dried to convert into hay form.

Diet I

Randomly selected four buffaloes in blocks were offered diet I which was composed of *Medicago Sativa* (*Alfalfa)* hay (MSH) with water *adlibitum*. AlongwithMSH, buffaloes were provided isocaloric and isonitrogenous concentrates. The composition and proportion of ingredients in the concentrate is given in the Table 1.

Diet II

Remaining four buffaloes weretreated with diet II which was consisted of hayfrom *MoringaOleifera* (MOH) with water *adlibitum*. Isocaloric and isonitrogenous concentrate wasalso provided, in addition to MOH in the same quantity as the first group. The total amountof *Medicago Sativa* (*Alfalfa)*, and*Moringa* leaves and stem offered,kgDM/ buffalo/day was 3% DM of their Body weights (same for all buffaloes).

Table 1. Ingredients of the concentrate

Ingredients	%
Maize Broken	12
Wheat Bran	24
Rice Polishing	10
Cotton Seed Cake	25
Maize Gluten Meal 30%	20
Cane Molasses	6
Mineral Mixture*	1
Dicalcium phosphate	1
Urea	1
Total	100

*Composition of Mineral Mixture mg /% ; Sulphur 0.75%, Zinc 9600mg, Sodium 5.9mg, Selenium 10mg, Calcium 25.50%; Phosphorus 12.775%; Potassium 100mg, Manganese 1500mg, Magnesium 6000mg,Iron 1500mg, Iodine 325mg, copper 1200mg, cobalt 150mg.

Table 2. Chemical composition of thediets

FRACTIONS(%)	MSH[1]	MOH[2]	Concentrate	SEM[3]
DM	19.050	33.160	84.000	17.081
OM	89.600	86.200	91.600	1.365
CP	19.400	23.510	20.960	1.037
EE	2.000	5.040	2.500	0.815
ADF	31.000	23.460	21.410	2.525
NDF	40.000	30.500	34.340	2.389
ASH	10.400	13.800	8.400	1.365
DDM	64.751	70.624	72.221	1.967
DDI	3.00	3.934	3.494	0.233
RFV	150.583	215.401	195.640	16.610

[1]MSH= Medicago sativa; [2]MOH= Moringa Oleifera;[3]SEM= standard error of mean, DDM = Digestible Dry Matter, DDI = Digestible Dry Matter Intake, DMI = 120 ÷ %NDF, RFV = Relative Feed value, RFV = (%DDM × %DMI) ÷ 1.29.

SampleCollection and Measurement

According to the procedure described by Undersander et al. (1993), the DM of *Moringaoleifera* was analyzed twice per week by using a microwave oven. By the conventional method of difference between offered and rejected fodder by the animals, dailyfeed intake of individual buffalo was determined during each experimental period. Weight of the fodder was done before feeding. Before offering new fodder the next day, their refusals were collected and separately weighed.

Concentrate was offered at the rate of 5040 grams /buffalo perday on DM basis to all the buffaloes in both groups in addition to *adlibitum* respective fodders. Half of the concentrate was offered in morning hours while rest half was given at evening time during the milking of the Buffaloes. Samples from the concentrate were taken daily to determine its DM contents and preserved them for further analyses. Hay from *Medicago Sativa* (*Alfalfa)* and *Moringa oleifera*, offered to animal and rejected, were sampled daily and were stored in frozen form. Dry matter of the feed was determined in each experimental group at 65 °C for 48 hours and the obtained samples were stored for later chemical analysis. Milk production from each group of buffaloes was recorded two times per day at 07.30 h in the morning and 04.30 h in the evening, respectively. While in the presence of the calf all the buffaloes were hand milked.

In the 120 days of experimental period, individual samples of milk were collected and stored frozen. These milk samples were pooled to get one sample/buffalo/period at the end of the experimental period.

During the last four weeks, all faeces from each animal were collected manually for estimation of digestibility.

The collected faeces from each animal during this trial were put into a large container, properly weighed and mixed thoroughly then 5% of the collected faeces was taken as a sample and preserved by freezing.

Chemical Analysis

Collected samples of feed offered, refused and faeces were analyzed for OM, DM, CP, NDF, ADF, ash and ether extract (EE). Oven drying method was used to determine DM by exposing samples in oven for 6 hours at 105 °C. To determine ash, samples were kept for 8 hours at 550 °C, while total nitrogen (N) was examined by the semi micro kjeldahl procedure (Kass and Rodriguez, 1993) and according to the official methods of AOAC (1990), and then CP was calculated from resulting N content (CP=N × 6.25). The NDF and ADF were determined by the proposed procedure of Goering and Van Soest (1970). To examine apparent digestibility coefficient for DM, dietary intake of the feed ingredients and their amount recovered in the faeces was calculated. Collected milk samples were analyzed in the laboratory for fat by the Babcock method (Pereira, 1988), CP by the kjeldahl method and total solids according to AOAC (1990).

Experimental Design and Statistical Analyses

The randomized complete block design (RCBD) as an experimental design was used for the statistical analyses. During this experimental trial, in each period there were 3 weeks for adaptation to treatments and subsequent 14 weeks were for data collection. In the last week of each experimental period, animal feces were collected for digestibility estimation. This research trail contains two treatments:

1.*Medicago Sativa(Alfalfa)* hay + concentrate, **2.** *Moringaoleifera* hay+ concentrate. Analysis of the data was carried out using the t-test procedure in the Minitab Statistical Software Version 12.0 (Minitab, 1998).

Results

Effect of Feeding *MoringaOleifera* on Nutrients Intake

Dry matter intake of concentrate was the same for both groups while DMI of the hay was different in both groups. Results have shown in Table 3 that buffaloes in diet I consumed 7.58 kg MSH while intake of MOH in diet II has increased to 9.0 Kg, resulting in the difference of 1.42 kg of DM that was extra consumed by buffaloes consuming diet II. Dry Matter, OM, CP, EE, NDF and ADF intakes of the both diets have shown in Table 3. In MSH group the average daily intake of the diet by buffaloes was 12.62 kg. Buffaloes fed *adlib* MOH diet has significantly (P<0.05) higher total intake than the buffaloes fed *adlib* MSH diet. The difference in DM intake was 1.43 kg per day. Organic matter intake (OMI) in diet II was higher (12.38 kg per day; P<0.05) than in diet I (11.41kg per day). Result in Table 3 shows that OMI was increased 0.97 kg per head in diet II.

Table 3. Dry Matter Intake (DMI) as affected by feeding *Moringa oleifera* in comparison of Medicago sativa in early lactating *Nili-Ravi* Buffaloes

Parameters	Diets[1]		SE[2]
	MSH	MOH	
Feed offered (kg DM/day)			
Concentrate	5.04	5.04	0
Fodder	9.92	9.93	0.00
Total	14.96	14.97	0.00
Feed Intake (kg DM/day)			
Concentrate	5.04	5.04	0
Fodder	7.58 [b]	9.01 [a]	0.71
Total	12.62 [b]	14.05 [a]	0.71
Nutrient Intake (kg /day)			
DM	12.62 [b]	14.05 [a]	0.71
OM	11.41 [b]	12.38 [a]	0.48
CP	2.52 [b]	3.17 [a]	0.32
NDF	4.76	3.93	0.41
ADF	3.43	2.37	0.52
EE	0.32	0.63	0.15

[a,b]Means within same row sharing different superscripts differ significantly ($P< 0.05$)

[1]MSH = Medicago sativa hay, MOH=Moringa Oleifera hay.

[2]SE= standard error,

DM = Dry matter; NDF= Neutral detergent fiber; OM = Organic matter; ADF = Acid detergent fiber; CP = Crude protein; EE = Ether extract

Effect of Feeding *Moringa Oleifera*on Nutrients Digestibility

The result of the data presented in the Table 4, which shows that apparent digestibility coefficients of DM, OM, CP, NDF, ADF and EE of the MOH were significantly ($P<0.05$) higher than the MSH diet. MSH diet has DM digestibility (DMD) coefficient 60.48 as compared to the MOH diet that has 68.60. It is clear that DMDcoefficient has increased in buffaloes which were fed on MOH diet.

Organic matter digestibility (OMD) coefficient for MSH was 63.79 while for MOH was 70.91,respectively. It is evident from the data that OMD coefficient of MOH was high ($P<0.05$) to a difference value of 7.12 as compared to MSH.Coefficient of CP Digestibility (CPD) for MSH was 69.16 as compared to 80.07, in MOH, respectively. The results were significant ($P<0.05$) to a difference value of 10.91 between groups.Results of NDF digestibility coefficients and ADF digestibility coefficients were also high ($P<0.05$) 79.53, 77.16 in MOH as compared to 69.84, 67.86 in MSH with a difference value of 9.69 and 9.3, respectively. Coefficients of EE digestibility was also significant ($P<0.05$) 88.48 in MOH while in MSH was 77.16, respectively with a difference value of 11.32.

Table 4. Apparent digestibility coefficients as affected by feeding *Moringa oleifera* in comparison of *Medicago sativa* in early lactating *Nili-Ravi* Buffaloes

PARAMETERS	Diets[1]		SE[2]
	MSH	MOH	
Apparent Digestibility Coefficients (%)			
DM	60.4 [b]	68.6 [a]	4.06
OM	63.7 [b]	70.9 [a]	3.56
CP	69.1 [b]	80.0 [a]	5.45
NDF	69.8 [b]	79.5 [a]	4.84
ADF	67.8 [b]	77.1 [a]	4.65
EE	77.1 [b]	88.4 [a]	5.65

[a,b]Means within same row sharing different superscripts differ significantly ($P< 0.05$)

[1]MSH = Medicago sativa hay, MOH=Moringa Oleifera hay.

[2]SE= standard error,

DM = Dry matter; NDF= Neutral detergent fiber; OM = Organic matter; ADF = Acid detergent fiber; CP = Crude protein; EE = Ether extrat

Effect of *MoringaOleifera* on Milk Production and its Composition

Milk yield and milk composition for each diet is given in the Table 5. Milk yield and 4 % fat corrected milk (4% FCM), solid corrected milk (SCM), milk protein (MP), solid not fat (SNF) and solid not fat (SNF) as kg/day were significantly higher (P<0.05) in buffaloes fed MOH diet in comparison to those fed on MSH; however,milk fat percent milk fat (kg/day), lactose, total solids (TS), specific gravity and milk pH remained unaltered.

Effect of Feeding *MoringaOleifera* on Nitrogen Balance

Influences of MOH on the nitrogen balance were observed and the results are presented in the Table 6. The data in showed that MOH had also significant effect on nitrogen balance (P<0.05). Nitrogen intake, urinary nitrogen and total nitrogen excretion were increased (P<0.05). Fecal nitrogen, milk nitrogen and nitrogen balance were also significantly increased (P<0.05) in MOH as compared to FSH; however, milk nitrogen (% of intake) was not significant.

Table 5. Milk production and milk composition as affected by feeding *Moringa Oleifera*in comparison of *Medicago Sativa*in earlylactating *Nili-Ravi*buffaloes

Parameters	Diets[1]		SE[2]
	MSH	MOH	
Milk (kg/d)	10.7[b]	13.7[a]	1.52
4% FCM (kg/d)	16.2[b]	18.8[a]	1.30
SCM (kg/d)	16.1[b]	19.8[a]	1.82
Milk Fat %	7.4	6.4	0.50
Milk Fat (kg/d)	0.7	0.8	0.04
Milk Protein %	4.6[b]	5.3[a]	0.33
Lactose %	4.6	4.7	0.06
Total Solid %	17.6	17.4	0.09
SNF %	10.2[b]	11.0[a]	0.40
SNF (kg/d)	1.0[b]	1.5[a]	0.20
Ash %	0.9	0.9	0.00
Specific Gravity	1.0	1.0	0.00
Milk p H	6.8	6.7	0.01

[ab]Means within same row sharing different superscripts differ significantly *(P<0.05)*

[1]MSH = Medicago sativahay, MOH=MoringaOleiferahay.

[2]SE= standard error,

4% FCM= 4 % Fat corrected milk; SNF = Solid not fat; SCM = Solid corrected milk.

Table 6. Nitrogen Balance as Affected By Feeding Moringa Oleifera In Comparison Of Medicago Sativa In Early Lactating *Nili-Ravi* Buffaloes

PARAMETERS	Diets[1]		SE[2]
	MSH	MOH	
Nitrogen Intake (g/day)	374.1[b]	394.1[a]	10.01
Fecal N,(g/day)	96.9[b]	104.7[a]	3.9
Fecal N, % of Intake	25.9	26.5	0.33
Urinary N (g/day)	184.9[b]	186.2[a]	0.63
Urinary N,% of Intake	49.4	47.2	1.1
Milk Nitrogen (g/day)	65.8[b]	71.6[a]	2.9
Milk Nitrogen (% of Intake)	17.6	18.1	0.29
N balance (g/day)	26.4[b]	31.5[a]	2.58

[ab]Means within same row sharing different superscripts differ significantly (P<0.05)

[1]MSH=Medicago sativa hay; MOH=*MoringaOleifera* hay

[2]SE= standard error.

Discussion

In the this experiment,contents of CP, EE and ash in*Medicago sativa* hay (MSH) were lower than the average concentration of CP,EE and ash constituents in *Moringaoleifera* hay (MOH), whereas contents of ADF and NDF were relatively higher in MSH diet. The range of CP in *MoringaOleifera*(235g/kg DM) is in agreement within the range (218 g/Kg to 292g/Kg) as reported by other investigators (Stelwagen, 2003; Chandan,2006, Mendieta-Araica et al., 2011; Makkar and Becker,1996, 1997). The average concentration of NDF and ADF in MOH were 305 g/Kg and 234 g/Kg, respectively. These values are within the range of 219 g/Kg to 684 g/Kg and 228 g/Kg to 360 g/Kg as reported by other researchers (Malik et al., 1967; Gupta et al., 1989; Becker, 1995; Makkar and Becker, 1996, 1997; Oliveira et al.,1999; Sanchez et al., 2006). The slightly lower CP and higher NDF and ADF than the reported results were due to the MOH diet consisted of major leaves mixed with minor part of the twigs of *Moringa Oleifera* plant.

During this study, the higher DMI of forage and nutrients as well as apparent digestibility coefficients values were recorded for buffaloes fed adlib MOH diet. This can be attributed to the possible effect of the high digestible CP contents in *MoringaOleifera* (Fahey et al., 2001). Likewise, Goodchild and McMeniman (1994) determined that when plants rich in protein were added at level of 20-50% in the diet of animals, an increase of 10-45% of total dry matter intake was observed. Similar results were reported by Reyes et al. (2006) who described that *Moringa oleifera* had increased DM intake from 8.5 to 10.2 and 11.0 kg DM/day with the supplementation of 2 kg and 3 kg DM of *Moringa*, respectively. Another probable reason of the increased DMI of MOH diet is due to low NDF and ADF concentration in *Moringa oleifera* as compared to *Medicago sativa* that also enhanced the intake.

Moreover, Reyes et al.(2006) reported that DMI of *Moringa Oleifera* increased due to more availability of essential nutrients to rumen microbes and enhancing the microbial activity.According to Minsonet et al. (1993) the roughages with low quality have low CP concentration while high concentration of fiber. Therefore, DMI of low quality roughages is less as compared to high quality roughages due to physical capacity of the rumen than by physiological mechanisms and digestibility. Gebregiorgis et al. (2011)added that supplementation with dried *Moringa* leaves to a basal diet of *rhodes grass* hay was improved DM intake.Increase in DMI in buffalo feeding on MOH was due to high protein level (23.5%) as compared to MSH(19.4%). Church and Santos(1981) and Guthrie and Wagner(1988) reported that protein supplementation increased total DMI in diets with low quality roughage.

Values for apparent digestibility coefficients of DM, OM,CP,NDF,ADF and EE of the buffaloes fed *Moringa oleifera* hay were significantly (P<0.05) higher than the *Madicago sativa* fed buffaloes. Similar results were found by Reyes et al. (2006) who described that coefficients for apparent digestibility of DM, OM, CP, NDF and ADF had increased in the diets supplemented with *Moringa oleifera.* Gebregiorgis, Negesse and Nurfeta(2011) reported that the digestibility of dietary CP increased with increasing levels of *Moringa* leaves. Present study also support the digestibility of CP, as the intake level of CP in buffaloes

feeding on *Moringaoleifera* hay is high (3.17kg/day) as compared to buffaloes feeding on *Medicago sativa* hay (2.52kg/day). Supplementation of *Moringaoleifera* had increased apparent digestibility coefficients of DM, OM, CP, NDF and ADF. Digestibility is also improved in MOH group by feeding *Moringaoleifera* as it has low NDF (Reyes et al., 2006) as compared to *Medicago sativa.*

To explain this phenomenon, two hypothesis have been proposed. According to first hypothesis *Moringaoleifera* contains substrate that provided buffaloes more ammonia, amino acids and peptides which enhanced activity of ruminalmicrobes (Garza, Owens & Welt, 1991). Second hypothesis describes that protein in the diet of animal has an effect on rate of passage through rumen and also on rumen motility. (Kil and Froetschel, 1994). Moreover, the increased apparent CP digestibility has directly correlation with CP intake. Therefore, generally digestibility of CP increases as intake of CP increases in ruminants due to the fact that metabolic fecal N generally makes up a larger part of fecal N at low intakes than at high intakes (Wheeler et al., 1995).

The milk production was high in the buffaloes fed adlib *Moringa* hay as compared to *M.sativa* fed animals. Buffaloes who were fed *Moringa* adlib had 3.05 kg more milk production. This result was in agreement with Reyes et al. (2006) who reported milk production was enhanced 1.8 Kg and 2.0 Kg with the supplementation of 2Kg and 3Kg *Moringa oleifera*, respectively and ultimately higher milk production was recorded in the *Moringa*supplemented cows as compared to control diet. Same findings were observed by Sarwatt, Milang'ha, Lekule and Madalla (2004) according to them, *Moringaoleifera* has positive effect on the environment of rumen due to enhanced microbial output and its protein having good bypass characteristics led to increased milk Production in cows.The current results obtained with adlib feeding of *Moringaoleifera*hay are also in agreement with Rocha and Mendieta (1998) and Foidl, Mayorga and Vásquez (1999), who reported that 13% and 30%, respectively higher milk production was observed in cows which were supplemented with Moringa oleifera with a basal diet of *Hyparreniaruffa* grass or *Sorghum vulgare* straw.

Protein level in milk increased (P<0.05) up to 5.33% in buffalo fed on MOH as compared to 4.67% in MSH diet, this result was according to sporndly (1989a) who reported that increase in dietary CP had increased milk protein yield. These resultswere supported byDePeters and Cant (1992) who demonstrated that milk protein was increased 4% to 10% in milk as compared to control diet when cows were fed diet containing CP 180 g /kg DM. Reyes et al. (2006) also described the similar findings that CP in milk of cows increased due to feeding of *Moringa* over the control diet. According to Spörndly (1989a) a correlation exist between dietary CP and yield of milk protein, a protein deficient diet will not only reduce protein in the milk by 1 to 2g/Kg of milk but may also decrease in milk production.

In the current experiment, lactose, milk fat percentage, total solids, specific gravity, milk pH and organoleptic characteristics, color, smell and taste were not significant (P>0.05). Same result were also observed by Reyes et al. (2006) who reported that milk fat, TS and organoleptic characteristics, color, smell and taste, were not significantly different between the *Moringa* fed and control diet.. The same trend was

reported by Huhtanen (1994) that when CP is increased in the diet above the normal level then it has generally varying effects on milk fat content.

Mainly two types of factors contribute into any changes in milk composition which ar**e** nutritional and non-nutritional. There are many non-nutritional factors that cause changes in milk composition but the most important ones are disease, age of cow, lactation stage, breed of cow, individual variation within breed, and cow milking techniques (Oldham and Sutton, 1979; McDonald, Edwards and Greenhalgh, 1988). Due to Nutritional factors desirable changes in milk composition and yield may induce more rapidly as compared to non-nutritional factors in cows (Bwire, 2002). Variation in Milk fat and protein content can be upto level of 50 % due to effect of nutritional factors and yields of milk components are also influenced (Freeden, 1996).

Feeding of adlib *Moringa oleifera* hay to buffaloes,a positive nitrogen balance ($P<0.05$) was recorded as compared to *Medicago sativa* hay fed buffaloes. A linearly increasing trend ($P<0.05$) was noticed in nitrogen intake, urinary nitrogen, total nitrogen excretion, fecal nitrogen, milk nitrogen and nitrogen balance in MOH as compared to FSH , however milk nitrogen (% of Intake) was not significant ($P>0.05$).The increased nitrogen intake is probably due to increased CP intake in the animals fed *Moringaoleifera* (Fadiyimu, A.A., Alokan, J.A., and Fajemisin, A.N. (2010). Increased ($P<0.05$) urinary nitrogen is in agreement with Ahamefule et al. (2006) and Fadiyimu, A.A. et al., 2010,who reported that digestion of nitrogen is directly linked with inclusion level of *Moringa* oleifera hence values for digestion of nitrogen noted for the diet supplemented with *Moringa* were higher significantly ($P<0.05$) than the control. This result proposes that the buffaloes who utilized additional N by adlib feeding of *Moringaoleifera* was completely digested and absorbed in the rumen. This fact perhaps is due to the more solubility of the protein moiety of the *Moringa oleifera* than that of the control diet.

Brookeret et al.(1995) explained this phenomenon so that when feed is offered to ruminants high in soluble plant protein, then mostly N metabolism occur in the rumen as compared to lower digestive tracts which lead to the production of excess ammonia N than the requirements of rumen microbes. The animal converts excess ammonia N into urea and excreted in to urine not utilized by the bacteria. It indicates that more rumen ammonia would be produced with the adlib feeding of *Moringa oleifera* in the diet which would have increased as N intake increases. This probably can explain that why significantly higher ($P<0.05$) values of urinary nitrogen, total nitrogen excretion, fecal nitrogen, milk nitrogen and nitrogen balance were recorded as the feeding of *Moringa oleifera* hadincreased to adlib level in this study.

The lower difference was observed between proportion of nitrogen intake to fecal excretion and secretion of N into milk as compared to N excretion via urine. These results are in agreement with (Monteils et al., 2002) who reported that when ingested diet has more than 130 g CP /kg DM then the nitrogen recovered in the milk was significantly higher as compared to low CP diet. In the current experiment the total N intake in buffaloes fed adlib *Moringaoleifera* was 394.16 g/day which is much higher and leading to more N secretion into milk. These results were in accordance with the conclusions of Spanghero and Kowalski's review (1997) who reported that due to deviation of digestible nitrogen intake about 50% of the deviation of

nitrogen losses in the urine can be accounted, however only 20% of the deviation is accounted for by nitrogen levels in the milk.

Conclusions

In the water scarcity areas of semi-arid zones in the South Asia, *Moringaoleifera* hay as an alternative source of forage fed *adlibitum* to lactating *Nili Ravi* buffaloes has significantly increased dry matter intake, digestibility of nutrients, nitrogen balance, milk yield, milk protein, and solid not fat without affecting on other parameters of milk composition (milk fat, Lactose, total Solids, Specific gravity and pH).

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Conflicts of Interest

The authors declare no competing financial interest.

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