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Research Article

Effect of replacing maize fodder with maize silage on feed intake, digestibility and milk yield of early-lactation Nili Ravi buffaloes

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Abstract

The objective of current study was to assess the effect of replacing maize fodder with maize silage on productive performance of early-lactation buffaloes. Sixteen primiparous Nili Ravi buffaloes in early lactation (40±10 days in milk), with similar milk yield were randomly divided into 4 treatment groups (4 animals /group). Feed was offered ad libitum as a total mixed ration (TMR) with forage to concentrate ratio of 60 to 40% on dry matter basis. The dietary treatments included control (MFA; maize fodder 60% of TMR), MS20 (20% maize silage + 40% maize fodder), MS40 (40% maize silage + 20% maize fodder), and MSA (maize silage 60% of TMR). Treatments continued for 90 days. The results revealed that highest dry matter intake was recorded in MFA (17.99 ± 0.06 kg/d; mean ± SE) and lowest in MSA (16.22 ± 0.07). Similar pattern was observed for crude protein, neutral detergent fiber and acid detergent fiber intakes. Dry matter digestibility was highest in MFA (64.49 ± 0.54 %) and lowest in MSA (60.17 ± 0.75). Daily milk yield was significantly (P<0.05) higher in MFA (8.97 ± 0.12) followed by MS20 (8.61 ± 0.09), MS40 (8.45 ± 0.10), and MSA (8.31 ± 0.07). The MFA and MS20 groups had lower fat (6.76 ± 0.10 and 6.76 ± 0.11 %) compared to MS40 and MSA (7.18 ± 0.14 and 7.17 ± 0.12 %). In conclusion, the buffaloes fed on TMR with lower silage levels performed better than buffaloes on higher silage levels.

Keywords: Buffaloes; Digestibility; Maize silage; Milk yield

Introduction

Buffalo (*Bubalus bubalis*) is the major dairy animal in Pakistan, contributing about 67% of total milk production in the country [1]. Most of the buffaloes are raised in rural areas in small herds (< 3 animals) and are fed seasonal fodders or cereal crop leftovers. In peri urban areas, the dairy buffalo is kept for commercial purposes and raised on wheat straw based TMR along with small quantity of fresh fodder. The seasonal fodder production poses a challenge for dairy farmers to feed their animals when fodder supply is limited especially during summer (May-July) and winter (November - January) months [2]. Silage is a viable solution to ensure fodder supply during lean periods [3].

Despite benefits of silages, it has been reported that the DM intake was lower in silage fed dairy cows due to the fermentation products causing lower pH in silages [4]. Also, DM content of silages might also affect the DM intake in dairy cattle [5]. In dairy buffaloes, the silage feeding has not been extensively researched [6]. Under such scenario, a study was needed to explore the effect of fodder replacement with silage in lactating dairy buffaloes.

The objective of present study was to investigate the effect of maize fodder replacement with maize silage on productive performance in lactating dairy buffaloes.

Materials and methods

Experimental animals and housing

The experiment was carried out at Buffalo Research Institute, Pattoki, District Kasur, Pakistan. The experiment was started on October 20, 2013 and ended on January 20, 2014. Sixteen primiparous Nili Ravi buffaloes in early lactation (40±10 days in milk) having similar milk yield were selected from the herd. The buffaloes were kept in naturally ventilated shed and were individually tied. The partitions were made at manger to record individual feed intake and rubber tubs were provided for free access of water. Before the start of the experiment, all animals were vaccinated and dewormed according to the farm protocol.

Treatment diets

The selected buffaloes were randomly divided into 4 treatment groups with 4 animals in each group. The feed was offered ad libitum as a TMR with forage to concentrate ratio of 60 to 40% on dry matter basis. The dietary treatments included control (MFA; maize fodder 60% of TMR), MS20 (20% maize silage and 40% maize fodder), MS40 (40% maize silage and 20% maize fodder), and MSA (maize silage, 60% of TMR). The treatment diets were offered for 90 days. The experimental diets differed in roughage source with varying level of silage whereas concentrate was similar for all TMRs. The chemical composition of all 4 diets is presented in (Table 1).

Feed intake, milk production and milk composition

The TMR was prepared daily and measured quantity was offered twice a day (morning and evening) at ad libitum (10% feed refusal) to each animal. The feed refused was collected every morning before offering fresh feed. Dry matter intake and milk yield were recorded daily, milk samples were collected weekly and analyzed for fat, protein and lactose by milk analyzer (Lactoscan-S, Milkotronic Ltd., Bulgaria).

The intake of DM, CP, NDF and ADF for each animal was recorded daily, whereas, body weights of all animals was taken monthly. Milk yield was recorded daily (morning and evening).

Digestibility trial

Three days digestibility trial was carried out in the last week of experiment as described by [7]. One animal from each group was randomly selected for the trial. Fecal grab samples were collected for every 3 h interval during 24 h with a total of 8 samples daily [8]. For each collection, 50 g of sample was weighed and composited to form one sample per animal.

Sample preparation and chemical analysis

Feed, orts and fecal samples were dried in the oven at 60˚C for 72 h and analyzed for DM%, percent digestibility and proximate analysis. The samples were analyzed for CP [9], NDF, and ADF [10] at Animal Nutrition Laboratory, Ravi campus, UVAS. The gross energy of the feed samples was determined by IKA C-2000 Bomb Calorimeter, while metabolizable energy (ME) was calculated as 63% of the gross energy [11].

Table 1. Ingredients and chemical composition of four experimental diets

	Experimental diets[1]			
Ingredients (% of DM)	MFA	MS20	MS40	MSA
Maize fodder	60.00	40.00	20.00	------
Maize silage	-------	20.00	40.00	60.00
Cotton seed cake	04.00	04.00	04.00	04.00
Canola meal	10.00	10.00	10.00	10.00
Soybean meal	15.00	15.00	15.00	15.00
Maize grain	3.00	3.00	3.00	3.00
Rice polishing	5.00	5.00	5.00	5.00
Molasses	2.00	2.00	2.00	2.00
Minerals Mixture	1.00	1.00	1.00	1.00
Total (%)	100	100	100	100
DM (%)	25.6	28.5	32.0	35.6
Chemical composition (% of DM)				
Crude protein	16.93	16.69	16.45	16.21
Neutral detergent fiber	38.70	39.10	40.35	41.70
Acid detergent fiber	22.78	23.06	24.02	25.47
Gross energy (cal/g)	4037	3986	3968	3942

[1]Four experimental diets (60:40 forage: concentrate ratio; DM basis) i.e. MFA (maize fodder 60% of TMR), MS20 (20% maize silage and 40% maize fodder), MS40 (40% maize silage and 20% maize fodder), and MSA (maize silage 60% of TMR)

Statistical analysis

The collected data were analyzed by one-way ANOVA technique under completely randomized design using SAS (SAS 9.1.3 Portable; SAS Institute Inc., Cary, NC). Differences between treatment means were tested through Duncan's multiple range test.

Results

Feed intake, milk production and milk composition

Dry matter intake significantly decreased with increasing level of maize silage in TMR ($P < 0.05$; Table 2). The highest DMI was recorded in MFA (17.99±0.06 kg/d) followed by MS20 (17.81±0.06), MS40 (17.68±0.06) and MSA (16.22±0.07). A similar trend was observed for CP, NDF and ADF intake (Table 2).

The increasing level of silage in TMR negatively affected milk yield in dairy buffaloes (Table 2). The average milk yield was significantly ($P<0.05$) higher in MFA (8.97±0.12 kg/d) followed by MS20 (8.61±0.09), MS40 (8.45±0.10) and MSA (8.31±0.07; Table 2). The milk composition showed contrary trends as that of milk yield (Table 2). Milk fat % increased with increasing silage inclusion in TMR. Milk fat was higher in MS40 and MSA (7.18±0.14 and 7.17±0.12) treatment groups, and lower in MFA and MS20 groups (6.76±0.10 and 6.76±0.11), respectively (Table 2). Similarly, solid not fat (SNF), protein, and lactose were also significantly ($P<0.05$) higher in silage based TMR groups as compared to fresh fodder group (Table 2).

Digestibility

Dry matter digestibility decreased with increasing level of silage in TMR (Table 2). Dry matter digestibility was significantly ($P<0.05$) higher in buffaloes fed MFA diet (64.49±0.54%) followed by MS20 (62.07±0.20), MS40 (60.81±0.45) and MSA (60.17±0.75; Table 2). The CP digestibility was significantly ($P<0.05$) higher in MFA diet (72.90±0.32%) compared to all others (Table 2). All the three silage-based diets had similar CP digestibility (Table 2). Similarly, highest NDF digestibility (53.07±0.50%) was observed in MFA group followed by MS20 (51.78±0.29), MS40 (50.93±0.34) and MSA (50.67±0.18; Table 2).

Table 2. Performance of Nili Ravi buffaloes fed different levels of Maize silage

	Experimental diets[1]			
Item	MFA	MS20	MS40	MSA
DM, kg/d	17.99±0.06[a]	17.81±0.06[b]	17.68±0.06[b]	16.22±0.07[c]
CP, kg/d	3.23±0.01[a]	3.19±0.02[b]	3.15±0.01[c]	2.86±0.01[d]
NDF, kg/d	9.48±0.06[a]	9.44±0.04[a]	9.23±0.08[b]	8.75±0.04[c]
ADF, kg/d	4.58±0.01[a]	4.51±0.02[b]	4.35±0.02[c]	4.27±0.02[d]
Milk yield, kg/d	8.97±0.12[a]	8.61±0.09[b]	8.45±0.10[bc]	8.31±0.07[c]
Milk composition%				
Fat	6.76±0.10[b]	6.76±0.11[b]	7.18±0.14[a]	7.17±0.12[a]
SNF	10.15±0.05[b]	10.32±0.07[a]	10.37±0.05[a]	10.35±0.05[a]
Protein	3.94±0.02[b]	4.05±0.03[a]	4.06±0.02[a]	4.06±0.03[a]
Lactose	5.31±0.03[b]	5.45±0.04[a]	5.47±0.02[a]	5.44±0.03[a]
Ash	0.83±0.003[b]	0.84±0.006[a]	0.84±0.003[a]	0.84±0.004[a]
Digestibility%				
DM	64.49±0.54[a]	62.07±0.20[b]	60.81±0.45b[c]	60.17±0.75[d]
CP	72.90±0.32[a]	70.89±0.28[b]	70.70±0.27[b]	70.11±0.27[b]
NDF	53.07±0.50[a]	51.78±0.29[b]	50.93±0.34[bc]	50.67±0.18[c]

[a,b,c]Values with different superscripts within a row are statistically different ($P < 0.05$).

[1]Four experimental diets (60:40 forage: concentrate ratio; DM basis) i.e. MFA (maize fodder 60% of TMR), MS20 (20% maize silage and 40% maize fodder), MS40 (40% maize silage and 20% maize fodder), and MSA (maize silage 60% of TMR)

Discussion

Feed intake, milk production and milk composition

The current findings of decreased DM intake for silage fed buffaloes were in line with previous studies conducted on buffaloes. The study on buffaloes **[6]** reported a decrease in DM intake in berseem silage fed lactating buffaloes. They attributed the decrease in DM intake to the presence of fermentation products in silage. Similarly, the replacement of Jambo grass (*Sorghum bicolour Sorghum sudanefe*) with Jambo grass silage in Nili Ravi buffaloes decreased DM intake of silage fed animals **[12]**. Likewise, a study **[4]** explained that low pH due to the fermentation products in silages might cause the decrease in DM intake. The replacement of maize fodder with maize silage had the same effect on DM intake as that of other silage crops. Decreased CP intake with increasing silage ratio was in accordance to what has been reported previously **[6, 12]**. The degradation of CP to non-protein nitrogen during ensiling process could explain the decreased CP intake in silage fed animals **[4]**. The higher NDF and ADF intake in high fodder groups (MFA and MS20) in present study was similar to previous findings **[6, 12, 13]**. The lower DM intake in silage-based groups might also have lowered the NDF intake. Decreased ruminal pH in silage fed diets might also have affected the degradation of NDF due to higher lactic acid contents and thus reduced NDF intake.

Higher milk yield in high fodder compared to high silage-based diet was in line to **[6]** who reported higher milk yield in berseem fodder compared to berseem silage diets. Likewise, a higher milk yield was reported in sorghum grass than sorghum silage **[12]**. Higher milk yield could be due to higher DM intake in fodder-based diets. Increased milk fat % in our study was similar to **[12]** who found higher milk fat in silage-based diets. The acetate is a major end product of lactate fermentation, the conversion of lactic acid content of silage-based diets to acetate might have improved the milk fat contents **[14]**. Increased protein content in current study was similar to **[15]** who found increase in milk protein concentration in silage fed diets and attributed that to efficient microbial protein synthesis.

Digestibility

The current results of lower DM, CP, and NDF digestibility in silage-based TMR were in line with previous studies [6, 12]. The higher digestibility in fodder-based diets could be due to higher concentration of soluble carbohydrates and lower lignin content in the fodder than that of its silage [16]. Also, low pH of silage due to lactic acid contents, decreased the ruminal pH and thus reduced hemicellulose and cellulose digestibility by depressing the growth of cellulolytic bacteria in the rumen of silage fed animal [6].

The DM, CP, NDF digestibility values were also in range as reported previously. A study [6] reported digestibility of DM as 64.8 and 62% and CP as 72 and 71.5% for berseem fodder and berseem silage, respectively. Similarly, about 71.3 and 71.1% CP digestibility was reported for oat fodder and oat silage, respectively [13]. Likewise, a study [12] reported 71.3 and 71.13% CP digestibility for jumbo grass and jumbo silage respectively. However, the current findings showed slightly higher DM digestibility than that of previous studies [12, 13]. The different fodders in their diets could explain that difference. However, it was evident from these findings that CP digestibility was more consistent than DM and NDF digestibility in buffaloes irrespective of fodder types.

Conclusion

The results of present study revealed that higher levels of silage in TMR negatively impacted DM intake and milk yield in buffaloes. However, increasing silage in buffalo diet increased fat and SNF content. The maize fodder can be replaced with maize silage in buffaloes for comparable performance.

Authors' contributions

Conceived and designed the experiments: Rafiuddin & JA Bhatti, Performed the experiments: Rafiuddin, Analyzed the data: MQ Shahid, M Ahmed & H Mustafa, Contributed materials/ analysis/ tools: MA Nasar, R Khan & A Khan, Wrote the paper: Rafiuddin, MQ Shahid & M Saadullah.

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