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Effect of gradual replacement of dry forage fraction with maize silage on feed intake, milk yield and composition of Azikheli Buffalo in Northern Khyber Pakhtunkhwa

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Abstract

The aim of the study was to assess the effect of gradual replacement of forage fraction of the ration with maize silage (MS) on feed intake, milk yield and composition of lactating Azikheli buffalo in district Swat. Twenty-four primiparous Azikheli buffaloes in early lactation (60±15 days in milk), with similar live body weight (450±30), and milk yield were randomly divided into four treatment groups (6 animals/group) under randomized complete block design. The basal diet was a mixture of dry roughages (maize Stover 60%, rice straw 20% , wheat straw 20%). The four dietary treatments were included control T1 (forage fraction (FF) 100%: MS 0%), T2 (FF 66%: 33% maize silage), T3 (FF 50%; MS50%), T4 (FF 33%: MS66%). Additional to the basal diet a total of 2.5kg/day of concentrate feed was provided to each treatment group. The feeding trail was continued for a period of 60 days. The data was analysed through using analysis of variance technique and means were separated for significance by using Duncan's multiple range test. The result shows that maize silage inclusion in the ration reduce dry matter intake as compared with dry forages and high DMI was observed at MSO 14.2kg/day and lowest at MS66 (12.5kg/day). Similar trend was recorded for NDF and ADF contents of the ration. Silage inclusion with replacement of forage fraction significantly increased milk yield and high milk yield was achieved at MS66 (8.10 liters/day) as compared to MS0 (5.90 liters/day). No significant effect on milk composition was observed except fats contents which was slightly reduced with increasing maize silage fraction. it was concluded from the study that maize silage inclusion in the ration of Azikheli buffalo improved milk yield up to 2.10 liters per day during green fodder scarcity periods in Northern Khyber Pakhtunkhwa Pakistan.

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Introduction

In Pakistan Buffalo (*Bubalus bubalis*) is the major dairy animal in the country with a total population (41.2 Millions), contributing about 66.8% (37,256 thousand tons) of total milk production in the country (GOP., 2020). There are three major buffalo breeds in Pakistan named: Nili Ravi, Kundi and Azikheli. The latter is the more neglected one due to limited scientific work conducted on this breed. Due to rapid growth rate of the buffaloes in the country, currently Pakistan ranked second in the globe in buffalo population (FAO STAT., 2015). This huge number of buffaloes places enormous pressure on limited feed resources on the declining land for fodders and the average density/hectare land increased from 1.7 to 2.7 for large animals during the year 2002 to 2009 (FAO STAT., 2015). Average animal productivity in smallholder system is almost one-third of the optimum level of the breed potential. This is primarily due to inadequate nutrition and associated health problems and because of poor feed supply from mixed livestock-crop and extensive systems which do not match with the high demand of quality feed for these animals.

In Pakistan major population of the buffaloes are raised in small herds (< 5 animals) particularly in rural areas and fed on crop residues and seasonal feed resources as compared to pari urban areas where animals are kept on total mix ration (TMR). The main feed resources in Pakistan consist of crop residues, forages, grazing land, grains and industrial by-products of oilseeds and cereals. Crop residues supply (58.8%), which constitutes the bulk of feed DM, is followed by fodder (23.8%). grazing shares 9.2% of the feed DM supply. The remaining 8.2% DM is contributed by grains and agro-industrial by-products. Feed availability is not constant in different parts of the country and varies considerably (Habib *et al.,* 2008). Conversely, in the province of Khyber Pakhtunkhwa, crop residues are classified as the major feed and constitute 55%-66% of the feed inventory with variable proportions 9%-28% supplied by cultivated fodder, and the least contribution (2%-20%) comes from grazing lands. Such unequal distribution of feed resources among different parts of the country is causing large movements of feedstuffs within the country in support of different livestock production systems.

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 (Mid of October - late February) months Rasool *et al.* (1996). Therefore, to provide quality feed in the form of maize silage is the only possible way to overcome the gap of nutrient requirement and provision particularly during prolong fodder scarcity periods (Khan *et al.,* 2011). Despite several benefits of silage feeding in dairy cattle were reported, but there are very limited data available on silage feeding in dairy Buffalos (Ruiz *et al.,* 1992, Yahaya *et al.*, 2004, Sarwar *et al.*, 2005). Based on the above-mentioned issue the current study was designed by International Livestock Research Institute (ILRI) Researcher for the first time on Azikheli buffaloes with the man objectives to determine the effect of gradual inclusion of maize silage in the basal ration of lactating Azikheli buffalo in Northern Khyber Pakhtunkhwa District Swat.

Materials and methods

Experimental location, animal selection and design:

The current research study was conducted by the research team of International Livestock Research Institute (ILRI) at KhwazaKhela, Swat (native hometown of Azikheli buffalo breed) Northern Khyber Pakhtunkhwa Pakistan under the Agriculture Innovation Program (AIP) project fully funded by Pakistan Agriculture Research Council (PARC). The coordinates of KhwazaKhela Swat is 34°56′N 72°28′E, with humid subtropical region with an average temperature of 18°C with an annual rainfall of 969mm. July is the warmest month of the year with an average temperature of 28.1 °C. The coldest month January has an average temperature of 6.4°C (Khan *et al.*, 2013). The research study was started on October 15, 2017, and ended on December 15, 2017, in Sharan private buffalo dairy farm Shamak. Twenty-four (24) multiparous, early lactating (60 ±15 days) Azikheli buffalo having similar milk yield and live body weight (450 ±30kg) were randomly selected from a large herd of pure Azikheli buffalo's farm.

Individual buffalo were kept tied and kept inside the sheds of their respective groups. Each group animals were kept at their recommended mangers for easy recording of feed intake. For free access water in a tub of 120 liters capacity was kept in front of each buffalo near manger round the clock.

Feeding, and experimental diets

For proper experiment, the selected 24 buffaloes were randomly divided into 4 groups of 6 buffalo in each group under randomized complete block design (RCBD). The basal diet was a mixture of dry roughages (maize Stover 60%, rice straw 20% (Paddy), wheat straw 20%) and further supplemented with 2.5kg/day of concentrate mixture (1.5kg cotton seed cake, 0.5kg wheat bran, 0.5kg wheat bread) summarized in Table 1. The silage feed was included gradually in the forage fraction (FF) of the basal diet. The four dietary treatments were control T1 (FF100%: MS0%), T2 (FF 66%: MS33%), T3 (FF50%; MS50%), T4 (FF33%: MS66%) summarized in Table 1. Additional to these diets a total of 2.5kg/day of concentrate mixture feed was provided to each treatment group. The feeding trail was continued for a period of 60 days. The measured quantities of roughages feed were offered four time a day (8.00am, 12.00pm, 4pm and 8pm) and the concentrate portion of the ration was supplemented at the time of miking (morning and evening). The left-over feed residue was weighed early at the morning of each animals to calculate feed intake per day.

Table 1. Allocation of treatment , forage fraction of dry roughages, Maize silage, and concentrate.

Ingredients (% of DM)	MS0	MS33	MS50	MS66
Dry forages	100	66.66	50.0	33.33
Maize silage	-------	33.33	50.0	66.66
Total forage fraction	100	100	100	100
Cotton seed cake	1.50	1.50	1.50	1.50
Wheat Bran	0.50	0.50	0.50	0.50
Wheat Bread	0.50	0.50	0.50	0.50
Total concentrate/day	2.50	2.50	2.50	2.50

MS: Maize silage, DM: dry matter,

Sample preparation and chemical analysis

For chemical composition of the roughages, silage and concentrate feed, a total 6 samples were collected from each feed item and were analysed before the start of experiment and followed by monthly analysis. All the samples were initially analysed for chemical composition on (Near-Infrared Reflectance) NIR in laboratory of Animal Science Institute Islamabad, and then for wet chemistry all the samples were again analysed at laboratory of Animal Nutrition, the University of Agriculture Peshawar. The chemical composition was determined by the method of Association of Official Analytical Chemists (AOAC, 2000). Whereas the content of fiber neutral detergent fibre (NDF) and acid detergent fibre (ADF), were analysed as per Van Soest *et al.* (1991). The gross energy of the feed samples was determined by NIR and again on Bomb Calorimeter, while metabolizable energy (ME) was calculated as 63% of the gross energy (Mandal *et al.*, 2011).

Milk yield and milk samples analysis

Milk yield of each buffalo of each group was milked twice a day (6am and 6pm) and milk production was recorded and weighted through digital balance and graduated jugs. Pool milk samples, of morning and evening milk were taken after cleaning and disinfection of teats and discharging the first few streams. Milk samples were collected in 100ml sterile plastic vials at weekly intervals through the experiment and transported to the laboratory of Veterinary Research and Disease Investigation center (VR &DIC) Balogram, Swat for analysis. The milk samples were analyzed for milk fats, proteins, lactose, ash, solid not fats (SNF), total solids and somatic cell count through milk analyzer (Lactoscan SA60-Milkotronic limited, Nova zagora, Bulgharia) and microscopic examination.

Statistical analysis

Data collected regarding nutrients intake, milk yield and its composition were analyzed statistically in

randomized completely block design using analysis of variance technique by Snedecor and Cochran (1994). Means were separated for significance by using Duncan's multiple range tests.

Results

Chemical composition of the ration

The chemical composition of the ration ingredients was given in Table 2. The dry matter (DM) contents of the Maize silage (MS) are 33.5g/100g, DM contents of the dry forage fraction are 92.3g/100g, and DM of the concentrate is 90.4g/100g. The Crude Protein (CP) contents of the maize silage are 7.30g/100g, CP of the concentrate mixture is 18.1g/100g and the lowest CP was recorded in dry forages fraction of the ration (4.29g/100g) summarized in Table 2. Similarly, the ADF and NDF contents were recorded high in dry forages fraction of the ration (69.7) and (46.3g/100g) and the lowest contents were recorded in maize silage (41.5) and (23.7g/100g). In term of Metabolizable energy (ME) value the highest value (2.50 Mcal/kg) was recorded in silage fraction of the ration, followed by concentrate mixture (2.01) and then forage fraction described in Table 2.

Table 2. Chemical composition of ration ingredients.

Ration Ingredients (% of DM)	DM	CP	NDF	ADF	ME Mcal/kg
Maize Silage	33.5	7.30	41.5	23.7	2.50
Maize Stover	92.7	4.80	68.7	46.5	1.93
Rice Straw (Paddy)	91.6	3.90	66.9	41.4	1.38
Wheat Straw	91.7	3.15	75.7	49.3	1.45
Cotton seed cake	92.0	22.3	47.5	33.7	1.90
Wheat Bran	88.5	12.1	41.7	16.3	2.44
Wheat Bread	89.2	11.6	45.5	24.3	1.90
Each portion in the Ration composition					
Maize Silage	33.5	7.30	41.5	23.7	2.50
Dry Forage fraction	92.3	4.29	69.7	46.3	1.70
Concentrate mixture	90.4	18.1	45.9	28.3	2.01

DM: dry matter, CP: crude protein, NDF: nutrient detergent fibre, ADF: acid detergent fiber, ME: Metabolizable energy

Experimental Ration composition

The ration composition is summarized in Table 3. High variation in the ration composition was recorded among the different level of silage inclusion in the ration. High DM was noted in ration MS0 as compared to the MS66. The content of CP in the ration MS66 was recorded maximum () followed by MS50, and MS33 while the lowest CP was recorded in MS0. In contrast the NDF level was found high in MS0 than MS66. Metabolizable Energy (ME) value were recorded high in MS66 (2.22 Mcal/kg) compared to MS0 (1.74 Mcal/kg).

Table 3. Chemical composition of experimental diet/ration.

Ingredients (% of DM)	MS0	MS33	MS50	MS66
Dry Forages	100.00	66.66	50.00	33.33
Maize silage	-------	33.33	50.00	66.66
DM	92.3	71.9	63.0	52.5
CP	4.29	5.30	5.80	6.70
NDF	69.7	59.7	55.6	50.1
ADF	46.3	38.0	34.8	30.3
Mcal/kg	1.74	1.96	2.06	2.22

DM: dry matter, CP: crude protein, NDF: nutrient detergent fibre, ADF: acid detergent fiber, ME: Metabolizable energy

Feed ration intake

The data of DM, CP, NDF intake due to gradual inclusion of silage in the forage fraction of the ration is summarized in Table 4. There was high variation in the intake of dry forages due to silage inclusion in the ration. DM and NDF intake were significantly reduced with increasing silage inclusion in the ration ($P < 0.05$; Table 4). The highest DM intake was observed in MS0 (14.2kg/day), followed by MS33 (13.2), M50 (12.7) and MS66 (12.5kg/day/head). However, the maximum CP and energy intake was recorded in MS66 as compared to MS0.

Table 4. Effect ff gradual inclusion of maize silage in the experimental ration of Azikheli buffalo on DM, CP intake.

Feed Item intake	MS0	MS33	MS50	MS66
Dry Forages DM%	12.0^{a}	7.50^{b}	5.00^{c}	3.00^{d}
Maize silage DM%	0.00^{d}	3.50^{c}	5.50^{b}	7.25^{a}
Concentrate intake DM (kg)	2.25	2.25	2.25	2.25
DMkg/day	14.2^{a}	13.2^{b}	12.7^{bc}	12.5^{c}
CP (kg)	0.93^{c}	1.00^{bc}	1.05^{b}	1.20^{a}
NDF (kg)	9.50^{a}	7.82^{b}	6.90^{d}	7.24^{c}
ADF (kg)	6.23^{a}	4.99^{b}	4.30^{c}	3.80^{d}

DM: dry matter, CP: crude protein, NDF: nutrient detergent fibre, ADF: acid detergent fiber, ME: Metabolizable energy

Milk yield, composition, and somatic cell count

Detail of milk yield liter/day, milk composition and somatic cell count (SCC)/ml is described in Table 5. The gradual inclusion of silage is a significant effect on milk yield and the maximum milk yield was recorded in the MS66 (8.10 liter/day) followed by MS50 (7.60), MS33 (6.80) and the lowest at MSO (5.90 liters/day). Silage inclusion in the ration has no significant effect on the milk composition except the fats contents of milk, which were reduce slightly (8.10 to 7.00) with increasing silage in the ration from MS0 to MS66. There has no effect of silage inclusion recorded on the SCC/ml in the ration of Azikheli Buffaloes.

Table 5. Effect of gradual inclusion of maize silage on milk yield and composition.

	MS0	MS33	MS50	MS66
Milk yield kg/day	5.90±0.10^{c}	6.80±0.07^{bc}	7.60±0.12^{b}	8.10±0.09^{a}
Milk Composition g/100gm				
Fat	8.10±0.10^{a}	7.60±0.12^{b}	7.40±0.11^{bc}	7.00±0.12^{c}
Protein	3.31±0.02	3.45±0.03	3.54±0.02	3.67±0.03
Lactose	4.97±0.04	5.03±0.03	5.05±0.03	5.05±0.03
Ash	0.80±0.02	0.82±0.003	0.85±0.003	0.83±0.002
SNF	9.42±0.05	9.70±0.07	9.84±0.05	9.87±0.05
Total Solids	17.12±0.07	17.0±0.06	16.94±0.10	16.90±0.12
SCC/ml (1000)	1x 10^{4}	1x 10^{5}	1x 10^{4}	1x 10^{5}

SCC; somatic cell count, SNF; solid not fats, MS; maize silage.

Discussion

This study was conducted for the first in the history of Azikheli buffaloes production in the northern Khyber Pakhtunkhwa. Silage feeding was never practiced on Azikheli buffalo by the local farmers. The basic feeding regime of these buffaloes in the scarcity period (Mid October to early march) of the year is dry forages which includes , maize stover, rice straw, wheat straw and a small amount of concentrate mixture (Wheat bread, wheat bran and cotton seed cake) without knowing the composition of the dry roughages. The main theme of the study was to adopt the farmers to feed their animals with quality silage in the scarcity period of the year, because the farmers were reluctant to this new feed in their feeding regime. Therefore, a very small amount of maize silage was included in the ration of Azikheli buffalo ration.

The routine practice feed ingredients of Azikheli buffalo were dry roughages which were poor in nutritive value and high in dry matter (DM). Therefore, the inclusion of maize silage in the forage fraction of the ration reduced the DM intake. This is because of low DM in silage than the dry forages. Similar finding of decreased DM intake due to silage inclusion reported by earlier studies of (Sarwar *et al.*, 2005) on lactating buffaloes. They attributed the decrease in DMI may be due to the high fermentation products in the silage. In another study conducted on jumbo grass (*Sorghum bicolour Sorghum sudanefe*) silage on Nili ravi buffalo, a reduction in the DMI was recorded (Tauqir *et al.,* 2009). The current study result was in lined with the earlier findings of (Ruiz *et al.,* 1992) that might be due to low pH of the silage product. Increase in the CP intake in current study is due to the high CP of the silage than maize stovers, and rice straw. The results are not accordance to the previous studies conducted by (Sarwar *et al.*, 2005: Tauqir *et al.*, 2009), which is due to the difference in basal diet of the buffalo ration as compared to rice straw, maize stover and wheat straw which are low in CP. In contrast the NDF and ADF intake in high level of maize silage group reduced than control group. The results are supported by the data presented by (Sarwar *et al*, 2005: Khan *et al.*, 2006: Tauqir *et al.,* 2009). It might be due to the lower level of ADF and NDF in maize silage compared to the dry forages. Moreover, the reduction in NDF intake may also be due to low ruminal pH, in maize silage di*et al*so affected the NDF degradation due to higher lactic acid contents.

In current study high milk yield was achieved with high silage-based diet than dry forage ration, which might be due to high energy and CP value of maize silage than the dry forages. That might also improve the digestibility of overall ration. Although similar studies were not conducted on milk yield in the past. The (Sarwar *et al.*, 2005: Tauqir *et al.*, 2009) reported higher milk yield in berseem and sorghum fodders compared to berseem silage diets. But in current study the basal diet is very low in nutrients compared to maize silage.

Naturally Azikheli buffalo milk are famous for high fats contents than other Pakistan buffalo and cattle breed. The inclusion of maize silage in the ration has not significantly affected the milk composition except milk fats, which might be due to the high dry forages ration as compared to maize silage. The other possible reason may be the high level of acetic acid in the dry forages as compared to maize silage which reduced the fats contents of the milk. Although the results presented by (Tauqir *et al.,* 2009) found higher milk fat in silage-based diets as compared to berseem fodder. The acetate is a major product of lactate fermentation, the conversion of lactic acid content of silage-based diets to acetate might have improved the milk fat contents (Chamberlain and Robertson 1992).

Conclusion

It was concluded from the findings of the current study that quality maize silage may be included in the forage fraction of Azikheli buffalo in the green fodder scarcity period for maximum milk yield and quality. A total of 2.20 liters of milk increased were achieved in current study with the 66% replacement of dry forages with maize silage in the ration. Therefore, farmers may be advised to replace the poor-quality dry forages (Rice straw, wheat straw and maize stover) with high quality maize silage in the ration of Azikheli buffaloes in northern Khyber Pakhtunkhwa Pakistan.

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Disclosure statement

The authors declare that they have no conflict of interest.

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