BJNRD (2023), 10(2): 1-7
Bhutan Journal of Natural Resources & Development

Article

www.bjnrd.org

Open Access

ISSN 2409–2797 (Print)
ISSN 2409–5273 (Online)

DOI: https://doi.org/10.17102/cnr.2023.86

Effect of Mixed Grass-Maize Silages on Milk Yield and Composition in Jersey Crossbred Cows

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Abstract

Silage feeding is a most popular and economical feed alternative for dairy farmers when feed resources are scarce and production costs increases. A study to evaluate the effect of feeding maize silage and grass mixed silage on milk yield and its composition in Jersey crossbred cows was conducted at the National Cattle Breeding Center, Bumthang district. Nine cows were randomly divided into three treatment groups: 18 kg/day of grass-mixed silage per cow per day (treatment 1, T1), 18 kg of maize silage per cow day (treatment 2, T2), and 18 kg of mixed grass (9 kg) and maize silage (9 kg) per cow per day (treatment 3, T3). Daily milk yield was recorded and milk composition was analyzed every after three days. The difference in milk yield among the treatments was significant ($p<.05$). The highest mean milk yield was from cows assigned to treatment 3 (4.39 ± 0.26 l per day) and the lowest was from cows assigned to treatment 2 (3.21 ± 0.31 l per day). Likewise, there was significance difference in milk composition among the treatments ($p<.05$). The cows assigned in treatment 3 had higher milk fat content (5.99 ± 0.32%) than those cows assigned in other treatments. It may be concluded that the mixed grass-maize silages is recommended for the dairy farmers because it increases milk yield and composition in cows.

Keywords: Grass silage, Jersey crossbred cows, maize silage, milk yield, milk composition.

Introduction

Livestock plays a significant role for the livelihoods of rural people all over the world, and it is strategically essential for food and nutritional security, including economic prosperity. It is becoming more structured in lengthy market chains that employ around 1.3 billion people and directly supporting the livelihoods of 600 million subsistence farmers in developing countries (Thornton, 2010). Likewise, livestock is a significant component of farming system in Bhutan, and it stands as one of the significant component of the nation's economy (Wangchuk & Dorji, 2008). According to Livestock Statistics (2020) approximately 80% of Bhutanese population reside in rural areas, with the majority of the Bhutanese people relying on subsistence agriculture farming. Most of the Bhutanese farmers keep cattle for several reasons, for example, milk, manure and draft.

Productivity of the cattle is determined by the type of feed and forage provided to them (Reddy & Vishweshwar, 2005; Larsen *et al.*,

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Received: September 8, 2023
Accepted: November 17, 2023
Published online: December 30, 2023
Editor: Nedup Dorji

2010), breed (Soyeurt *et al*., 2008; Palladino *et al*., 2010), lactation stage (Stoop *et al*., 2009), management (Coppa *et al*., 2013), and season (Heck *et al*., 2009). In general, animal feeds accounts for 50 - 70% of cost of production. In Bhutan, most dairy farmers do not experience forage shortage in summer because there are several major sources of forages such as fodder trees, crop residues and pastureland (Roder *et al*., 2001). However, in winter (December to March) Bhutanese farmers experience feed shortage and production costs is likely increase because farmers purchase concentrates and other supplements (Tamang *et al*., 2015). The milk yield of a dairy cow is estimated to be reduced by approximately 50% compared to the production capacity during the summer. Also, the body condition score of a dairy cow was observed to be poor (below 2.5). Nevertheless, Bhutanese dairy farmers stored about 70% of crop residues and surplus fodder as hay and silage during the lush season to meet the feed shortage during winter (Tamang *et al*., 2015). Conservation of forages such as silage is one of the most common and efficient alternatives to ensure availability of quality feed for the cows in winter (Kumar *et al*., 2019).

Silage making is a fodder conservation strategy in which green forages is fermented under anaerobic conditions (Yitbarek & Tamir, 2014), and forages containing high moisture (50 to 85%) and 30% dry matter are suitable materials for silage making (Borreani *et al*., 2018). Maize (*Zea mays*), cocksfoot (*Dactylis glomerata*), and Italian rye (*Lolium multiflorum*) are some of the common forages used by farmers for silage making in Bhutan (Wangchuk & Dorji, 2008). In recent years, there has been considerable interest in cultivating maize because it is palatable and is rich in nutrients especially carbohydrate which is free from anti-metabolites (Kumar *et al*., 2020), and maize can be cultivated under a wide range of environmental conditions and also has good ensiling qualities (Kolver *et al*., 2001). Cocksfoot is a perennial grass and is also valuable as a forage, and is used hay and silage making in temperate zones (Johnson & Thomson, 1995). Italian ryegrass is an annual grass grown in winter (Food and Agriculture Organization [FAO], 2020), and this grass is known for being a high-yielding and high-energy forages that is suitable for high milk producing dairy cow (Wilman *et al*., 1992).

Although feeding silage is commonly practiced in private and government dairy farms in Bhutan, the effect of mixing grasses (Italian ryegrass, cocksfoot and maize) silages on milk yield and composition in dairy cows has not been substantially assessed. Hence, this study evaluated the effect of feeding mixed grass-maize silages as feed supplements during the feed shortage on milk yield and composition in Jersey crossbred cows.

Materials and Method

Study area

The feeding trial was conducted at the National Cattle Breeding Centre (NCBC), Chhokhor block located at 2770 masl with 27°33'31"N and 90°45'47" E. The centre offered a strategic advantage for conducting the trial, for example, lactating cows are at similar age under same management (s single household do not more cows of same age and lactation). Moreover, the center produces 400 - 500 metric tons of silages in a year, which comprises of grass-mixed silage (Italian ryegrass and cocksfoot), and also maize silage for feeding cows in winter.

Silage preparation

The maize forages were harvested when the moisture content was between 18 - 22% and dry matter content was between 30 - 35% using a mowing machine. The forages harvested were chopped into smaller pieces (2 - 4 cm in length). The chopped forages were filled into a silo, and tractors were run on top of the silo filled with forages to ensure the ensiled mass is under anaerobic conditions and to prevent fungal growth. Subsequently, a tarpaulin sheet

was placed over the silo and was furthered covered by a layer of soil to create an airtight seal to prevent gases exchange and also protect from pests. This step was also repeated for preparing Italian ryegrass and cocksfoot for making silages.

Experimental design and feeding

A completely randomized design consisting of three treatment groups was used to assess the effect of feeding mixed grass-maize silages on the milk yield and composition in Jersey cross. In this trial, nine Jersey cross cows (age between 4 and 5 years, mid lactation stage, parity 2 and 3, and a body condition score of 3) were selected from dairy herd. The selected cows were randomly assigned to three treatments. The feeding of the animals was carried out as per the feeding regime and standards adopted by the NCBC (cows were fed at 6:00 hr and 17:00 hr), which were calculated based on the dry matter requirement and total milk production per day:

Treatment 1: cows received 2 kg hay, 2.5 kg concentrate and 18 kg grass-mixed (Italian ryegrass and cocksfoot) silage per day,

Treatment 2: cows received 2 kg hay, 2.5 kg concentrate, and 18 kg maize silage per day, and

Treatment 3: cows received 2 kg hay, 2.5 kg concentrate, and 18 kg grass-maize silages (9 kg grassed-mixed, 9 kg maize silage) per day.

Fresh water was provided *ad libitum* to the cows throughout the trial. The feeding trial was carried out for 31 days, including an adaptation period of 7 days.

Milk yield and composition

At each milking (morning at 6:00 hr and evening at 17:00 hr), milk yield from each cow was recorded daily using a calibrated spring balance. An individual milk yield was recorded for 24 days. A total of 100 ml milk from individual cow was taken to determine milk composition (fat, protein, lactose and solids not fat) every three days. The milk sample from morning milking were maintained at 4 - 5°C in the refrigerator and was mixed with milk from evening milking at a ratio of 60:40 (60 ml morning and 40 ml evening). A milko tester was used to evaluate the fat, protein, solid not fat (SNF) and lactose content of the milk under temperature ranging from 35 - 40^{o}C, which was achieved through the use of electric water bath.

Silage

About 250 g silage was collected from five different sites within a silo. These silage samples collected was sealed in zip-lock plastic bag to prevent moisture loss and nutrient degradation due to prolonged exposure to atmosphere. The silage samples were analysed at the Animal Nutrition laboratory, National Development Centre for Animal Nutrition, Bumthang. The dry matter of silages were determined by hot air oven drying, crude protein by Kjeldahl micro digestion, crude fat by solvent extraction method and ash by dry ashing open system.

Data analysis

The data was entered into Microsoft Excel 2013, which was exported to Statistical Product and Service Solutions International Business Machines Corporation version 26 for analysis. The normality of the data was checked by using a Shapiro-Wilk test, which did not show deviation (p>.05). A One-Way ANOVA was performed to compare the milk yield among treatments. Furthermore, a Tukey HSD post-hoc test was performed when ANOVA results showed a significant different at p<.05.

Results and Discussion

Silage nutrient composition

Upon nutrient analysis, the grass-mixed silage contained 195 g/kg dry matter, 145 g/kg crude protein, 2 g/kg crude fat, and 94 g/kg ash. The maize silage constitutes of 155 g/kg dry matter, 151 g/kg crude protein, 2g/kg crude fat, and 55

g/kg ash. The grass-mixed silage has more DM (19.5%) and ash (9.4%) content than the maize silage (DM, 15.5%; ash, 5.5%), however, the CP (grass-mixed, 14.5%; maize, 15.1%) and CF (grass-mixed, 2%; maize, 2%) was close in two silages. In present study, the CP and ash content in maize silage was higher than those reported by Baldinger *et al*. (2014) for maize silage (CP, 7.5 %; ash, 3.3%). The differences in CP and ash content in maize silages in two studies probably is attributed to the time of harvest of maize for silage preparing, for example, researchers reported that the CP content decreases as the maize matures (Baldinger *et al*., 2014; Khan *et al*., 2014). In this study, the maize plants were harvested before plant reached maturity and ensiled without sufficient wilting because the maize plants were more vulnerable to army worm infestation (Gurung, per comm.). As a consequences, the DM and CF in maize silages in this study was lower than the Baldinger *et al*. (2014).

Effects on milk yield

The mean milk yield from the cows in treatment 3 (4.39 ±0.26 l per day) was comparastivley higher than those cows in treatment 1 (3.95±0.27 l per day) and in treatment 2 (3.21±0.31 l per day) (F (2, 69) = 106.80, p<.001). The higher milk yields from cows assigned to treatment 3 in this feeding trial is in line with Dewhurst (2013) and Khan *et al*. (2015) findings who reported milk yield increases in cows when mixed grass-maize silages was fed. This increase in milk yield in cows fed with mixed grass-maize silages enhanced feed intake and increase milk yield (Phipps *et al*., 1992). The higher milk yields from cows in treatment 3 could be attributed to balanced nutrient intake received from mixed grass-maize silages, which probably was not when cows were either fed grass or maize silage alone. Another plausible explanation could be that the maize silage has high metabolizable energy, which enhance DM intake and consequently increase milk yield in cows (Khan *et al*., 2015). Also, Kumar *et al*. (2019) suggested that the high sugar content in maize silages enhance palatability and feed intake. Higher milk yield in cows receiving treatment 1 compared to treatment 2 could also be due to higher nutrient content in grass mixed silage (Cocksfoot and Italian ryegrass). The leafy Italian ryegrass produces extremely high quality and palatable fodder appropriate for high-producing dairy cows due to its high fiber digestibility (NDF), high relative forage quality (RFQ), and palatability (Pavinato *et al*., 2014). Overall, the milk yield in this study was higher compared to earlier report of 2.95 l per day in Bhutan in winter (Wangdi *et al.,* 2014).

Effects on milk composition

The milk composition of cows assigned in different treatments is shown in Table 1. There was significant difference in the mean

Table 1. Milk composition in different group

Milk composition	Treatment		
	Grass silage (T1)	Maize silage (T2)	Grass-maize mixed silage (T3)
Fat (%)	5.37 ± 0.20[a]	4.86 ± 0.44[b]	5.99 ± 0.32[c]
Protein (%)	3.19 ± 0.03[a]	3.10 ± 0.08[b]	3.21 ± 0.03[c]
SNF (%)	8.83 ± 0.08[a]	8.58 ± 0.20[b]	8.90 ± 0.11[c]
Lactose (%)	4.84 ± 0.04[a]	4.69 ± 0.12[b]	4.88 ± 0.07[c]

The fat content among three treatments (F (2, 15) = 17.138, p<.001). The mean fat content was recorded the lowest in cows assigned to

treatment 2 (4.86±0.44%), while the highest cows from treatment 3 (5.99±0.32%). The cows receiving maize silages (treatment 2) contained the lowest fat content which is in line with Khan *et al*. (2015) findings and they reported that the replacement of grass silage with maize silage in the animal feed altered the milk fatty acid profile in cows and results in decreased milk fat. Conversely, cows assigned to treatment 3 showed increased fat percentage in milk, which is likely to have resulted due to inclusion of maize silage in the feeding regime along with the grass-mixed silage. This present findings corresponds with findings of Baldinger *et al*. (2011), where feeding maize silage in combination with grass silage increased the fat content in milk.

Likewise, there was significant difference in the mean protein content among the treatments (F (2, 15) = 8.512, p=.003). The inclusion of maize silage in grass-mixed silage seems to have improved the milk protein by 1.2 %, and both increase in milk production and protein content contributed in protein yield (Khan *et al*., 2015). Moreover, the cows assigned to treatment 3 showed comparably higher SNF and lactose than the cows assigned in other treatments (p<.05). The increased SNF content from cows assigned to treatment 3 aligns with the findings of Dewhurst (2013), which probably indicates that the SNF content in milk improves when cows were fed mixed grass-maize silages compared to those cows fed either grass or maize silage alone.

Conclusion

The nutritional analysis of the grass-mixed and maize silage revealed that the crude protein content of the maize silage was higher than that of the grass silage, but grass-mixed silage contained higher dry matter. The milk yield and composition in cows fed with mixed grass-maize silages were higher than those cows fed either grass-mixed or maize silage alone. Hence, equal quantity of grass and maize silages is recommended for feeding cows in order to optimize the performance of dairy cows for dairy farmers during feed shortage.

Acknowledgement

The authors would like to express deepest gratitude to the Manager, Mr. Padam Bdr Gurung, Mr. Nanda Ghallay and staffs of NCBC for providing the space to conduct feeding trial and their assistance. Also, we further thank Mr. Rinzin Wangchuk and Mrs. Yeshi Tshomo, of the National Animal Nutrition Lab, Bumthang for their kind support.

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