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Comparison of Fodder Species with or without Nutrient Supplementation for Paddy Straw-based Dairy Cattle Production in Hills of Nepal

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Abstract: Productivity of crossbred dairy cattle in the milk production pockets of Nepali hills are considerably low due to their severe undernourishment in the paddy straw-based feeding regimes. An experiment was carried out at on-farm of Tanahun district in order to compare popular fodders (*Ficus semicordata* cv. Montana S.M. Amatya and *Pennisetum purpureum* K. Schumach. cv Mott) with and without nutrient supplementation via the urea-molasses-mineral block (UMMB) for milk yield, milk fat content and lactometer reading. The experiment was conducted in a 2×2 factorial arrangement of Completely Randomized Design (CRD) with 10 replications. The milking cattle of Jersey crossbred from third to fifth parities with similar milk yields and stages of lactation were taken as the experimental animals. The results of the study showed that Rai khanayo (*F. semicordata*) fodder performed better ($p<0.01$) than Napier (*P. purpureum*) for milk yield, milk fat content, and lactometer reading. Likely, significantly enhanced ($p<0.05$) milk yield with better fat content and lactometer reading were obtained for the UMMB supplemented group. Feeding 10 kg of *F. semicordata* fodder with 300 g of UMMB supplementation, 10 kg of rice straw and 2 kg of wheat bran as the daily ration improved the milk yield, milk fat content, and lactometer reading considerably ($p<0.05$) than other treatment combinations in the farmers' field. These simple and practical technologies can rigorously be used for the substantial improvement of the milk yield and its constituents of crossbred dairy cattle, and also for their health in the hills of Nepal.

Keywords: *Ficus semicordata*; Milk yield; Milk constituents; *Pennisetum purpureum*; Urea-molasses-mineral block; Wheat bran.

INTRODUCTION

Crop residues, crop by-products, and less nutritive fodders are the major feed resources for the milch animals in the dairy pockets of the middle hill regions (up to 1500 masl) of Nepal. Not only in hills but crop residues and crop byproducts also constitute the larger part of the dairy cattle feeding packages all over the country which supplies approximately 40% of the total energy (Hayashi 2005; Osti 2020; Sharma 2020). Among these feed resources, paddy straw is the dominant crop residue and wheat bran is the most popular crop byproduct. Wheat bran, mostly alone, is used as the concentrate feed. Likewise, chiefly paddy straw and wheat bran with occasional supplementation of little corn or green fodder or tree leaves constitute the feeding packages in most of the dairy farms in the middle hills of Nepal (Ghimire 2013; Osti 2020). It is severely deteriorating the dairy animals' health status and decreasing their productivity, and also drastically reducing the life of the animals on their farms. The situation of low plane of nutrition is being further critical owing to the continuously increasing numbers of high-productive dairy cattle breeds like Jersey, Holstein Friesian, and their crossbreds in those areas. These dairy pockets need empirical feeding technologies based on their own local resources to improve the feeding regimes for their dairy cattle (Hayashi 2005; Osti 2020; Sharma 2020).

Rai khanayo (*Ficus semicordata* var. montana S.M. Amatya) is one of the most popular fodder trees in the western hills of Nepal (Ghimire 2013). Likewise, the Napier (*Pennisetum purpureum* K. Schumach.) is another

very widespread fodder in the middle hills of Nepal for year-round fodder supply. Mott is a perennial bunch variety of Napier that produces excellent fodder yield (Ruiz et al. 1992) and is commonly cultivated in the western hills of Nepal. The farmers of the western hills are cultivating these fodders for irregular and little supplementations to their dairy animals (Amatya et al. 2018; Singh and Singh 2019; Osti 2020; Tamang et al. 2020). In order to improve the health and productivity of the farmers' cattle herds, selection of more nutritive fodders along with fortification of their rations are the better strategies to improve animal performance and health. But, the information on comparative performances of those fodders for the animal interface is scanty (Singh and Singh, 2019).

Enriching the quality of the diets through nutrient fortification is widely used to improve dairy cattle production and their health (De Vries and Kaylegian 2018; Osti 2020). The use of urea-molasses-mineral block (UMMB) is one of the proven, very popular, and effective methods to fortify the ruminant rations, especially when ruminants rely on crop residue and crop byproducts, and the productivity is greatly constrained (Sansoucy 1995; Garg et al. 1998; Singh and Singh 2003; Misra et al. 2005). Besides a source of additional nutrients, UMMB supplementation improves the utilization of crop residues and green fodders in ruminants (Upreti et al. 2010; De Vries and Kaylegian 2018). The study was thus carried out to evaluate the performance of *F. semicordata* and *P. purpureum* fodders with and without UMMB supplementation for milk yield and milk constituents (Fat and SNF content) in the farmers' field of Nepal's Tanahun district.

MATERIALS AND METHODS

The experiment was conducted in the farmers' field of Tanahun District. Two milk producers' co-operatives, Pragati Milk Producers' Cooperative, Purkot and (28°04'31"N and 84°26'56"E and 838 masl) and Chandra Surya Milk Producers' Cooperative, Jamune (27°59'11" N and 84°11'28"E and 585 masl), were involved in the study. Altogether 40 milking animals (F1 crossbreds of Jersey cattle) of third to fifth parities with similar milk yield and lactation stages were selected from those two co-operatives. The experiment was conducted in Completely Randomized Design (CRD) in 2×2 factorial arrangements with 10 replications. Factor A had two levels of fodder species (*F. semicordata* and *P. purpureum*) whereas UMMB supplementation and no supplementation were the levels of factor B. The experiment was conducted for four-week duration from October to November, the season with the availability of the limited number of fodders. Prior to experiment, a 14-day adaptation was done to the animals in their respective experimental diets.

The experimental diets for an animal day^{-1} were prepared by;

Diet 1= 10 kg *F. semicordata* fodder+ 10 kg paddy straw + 2 kg wheat bran+300 g UMMB

Diet 2= 10 kg *F. semicordata* fodder+ 10 kg paddy straw + 2 kg wheat bran without UMMB supplementation

Diet 3= 10 kg *P. purpureum* fodder + 10 kg paddy straw + 2 kg wheat bran+300 g UMMB

Diet 4= 10 kg *P. purpureum* fodder + 10 kg paddy straw + 2 kg wheat bran without UMMB supplementation

The fresh fodders were offered two times a day during morning and evening hours after they consumed the mixture of chopped paddy straw and wheat bran. Likewise, the block of the UMMB used in the experiment was 3 kg mass, and each block was used for 10 days, allowing them to lick 300 g UMMB day^{-1}, as recommended by Nepal Agricultural Research Council (AND 2002). Prior to beginning the experiment, the UMMB was manufactured and the farmers were also trained for its proper use. The blocks were prepared by using the protocol recommended by Nepal Agricultural Research Council (AND 2002). The ingredients of a block were; urea (10%), molasses (32%), mineral mixture (6%), rice police (28%), soybean cake (8%), calcium oxide (6%), bentonite (5%) and common salt (5%). The nutrient compositions of the ingredients used in the experimental diets are presented in Table (1).

Table 1. Nutrient composition of the ingredients and the ration constituents of the different experimental diets.

Feed resource	Nutrient composition				
	DM	CP	NDF	ADF	TA
F. semicordata fodder	27.46	12.12	63.12	52.44	12.46
P. purpureum fodder	22.43	10.44	65.12	41.96	8.47
UMMB	82.62	33.84	10.51	5.52	18.21
Paddy Straw	92.73	3.61	74.95	46.22	14.32
Wheat Bran	85.69	14.76	38.32	11.60	5.22

DM= Dry matter, CP=Crude protein, NDF= Neutral detergent fiber, ADF=Acid detergent fiber, TA= Total ash, UMMB= Urea-molasses-mineral block

The observations were recorded daily on feed offered, feed refused, milk yield, milk fat content, and lactometer reading for 28 days. The DM, CP, NDF, ADF and TA content in the feed ingredients were determined in the laboratory of Animal Nutrition, NARC according to the Official Methods of Analysis of the Association of Official Analytical Chemist (AOAC, 1980; AOAC, 1990) and Goering & Van Soest (1970). The fat content and lactometer reading of the milk samples were recorded in their respective cooperatives. The fat content and lactometer readings were determined by the Gerber method and Specific Gravity Method, respectively as described by James (1995). The jamovi Version 1.2 (The jamovi Project 2020) was used for data analysis. The model used was;

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$$Y_{ij} = \mu + \tau_i + \delta_j + (\tau\delta)_{ij} + \epsilon_{ij}$$

Where,

Y_{ij} is the empirical mean response,
μ is the overall mean across all treatments,
τ_i is the effect of the i^{th} treatment,
δ_j is the effect of the j^{th} treatment,
$(\tau\delta)_{ij}$ is the interaction effect of the i^{th} and j^{th} treatments,
ϵ_{ij} is the error term

RESULTS AND DISCUSSION

The *F. semicordata* fodder yielded higher milk yield ($p<0.01$), better fat content ($p<0.01$) and lactometer reading ($p<0.01$) in comparison to *P. purpureum* (Table 2). In the experimental diets, *F. semicordata* fodder was leafier than *P. purpureum*, which could have better digestibility due to less hard stem tissues (Ammar et al. 1999; Tang 2008). Tolera and Sundstol (1999) and Ansah et al. (2013) reported that the harder stem portion of tall grasses (*P. purpureum*, *Zea mays* etc.) produced a greater amount of gas in the rumen. Paudel et al. (2017) also reported that the nutrients in the *F. semicordata* leaves are fairly better in digestibility in comparison to other popular fodder tree leaves. Moreover, different authors had reported that the *F. semicordata* fodder contains about 2-10 % condensed tannin on a dry matter basis (Subba 1998; Shah et al. 2019). The condensed tannin content in fodders up to 4% of its dry matter is preferable due to its assistance in bypassing the protein in the rumen (Upreti and Shrestha 2006; Shah et al. 2019), which prevents the degradation of CP in the rumen with higher protein precipitation activity or PPA (Wood et al. 1994; Shah et al. 2019). The higher dry matter, minerals, and crude protein contents with their better digestibility and tannin-assisted improved PPA could be the reasons associated for substantial enhancement ($p<0.01$) in the milk yield (by 12.26%), fat content (by 13.83%), and lactometer reading (by 14.69%) in the *F. semicordata* leaves-fed group during the experiment. On the other hand, the nutrients like CP could have degraded in the rumen and have not been utilized efficiently in the case of *P. purpureum* fodder. Another study also supports the present finding in which the author reported that the *P. purpureum* fodder had lower metabolizable energy that cannot meet the requirement of a dairy cattle of 600 kg (AFRC 1993).

Table 2. Effect of fodder species and UMMB supplementation on milk yield, fat content and lactometer reading at farmers' field of Tanahun district.

Main effects	Milk Yield, l day^{-1} (Mean±SD)	Fat content, % (Mean±SD)	Lactometer reading (Mean±SD)
A. Fodder species			
F. semicordata	11.72±1.37	4.69±0.26	29.20±0.86
P. purpureum	10.44±0.61	4.12±0.32	25.46±0.79
p-value	<0.01	<0.01	<0.01
B. UMMB supplementation			
Supplemented	11.66±0.99	4.85±0.28	27.84±1.96
Non-supplemented	9.73±0.11	3.99±0.35	25.15±2.01
p-value	<0.01	<0.01	<0.05

SD= Standard Deviation

Likewise, the animals supplemented with UMMB produced significantly higher ($p<0.01$) milk yield with better ($p<0.01$) fat content and lactometer reading ($p<0.05$) during the experiment in farmers' fields of Tanahun district. Similar results were reported by Upreti et al. (2010) in the hill management dairy cattle production in their study too. Another study conducted on the smallholder farmers' dairy cattle in Bangladesh revealed that feeding UMMB had increased milk yield by 32 to 33% (Akbar et al. 2006). The ruminants have the unique ability to convert non-protein nitrogen compounds (urea) to microbial protein of high biological value in presence of the readily available source of carbohydrates (Trishna et al. 2012). In addition to increasing milk yield and quality, supplementation of UMMB could upshot better reproductive performance and reduce the intercalving period of the animals (Cheng et al. 1993), which was not observed in the present study. But, the farmers involved in the present experiment reported their observations that the feeding of green fodders and UMMB had increased the health and body conditions of their dairy cattle to some extent during the short experimental period.

Interaction effects

The interaction effects of different levels of fodder species and UMMB supplementation were also significant on the milk yield ($p<0.01$), milk fat content ($p<0.05$), and lactometer reading ($p<0.05$). The *F. semicordata* fodder-fed group with UMMB supplementation produced the best milk yield with significantly enhanced fat content ($p<0.05$) and lactometer reading ($p<0.05$) than other treatment combinations.

The supplemented nutrients more often greatly influence the utilization of the crop byproducts and fodder resources (De Vries and Kaylegian 2018). Several authors have reported that UMMB supplementation can improve the feed intake and digestibility of straws and fodders (Habib 1991; Hendratno 1991). Fodder intake and dry matter digestibility were obtained higher in UMMB supplemented groups of Sahiwal cattle when fed with Berseem (*Trifolium alexandrinum* L.) or Maize (*Zea mays* L.) as green fodder in another experiment too (Khanum et al. 2006). The UMMB supplement can contribute in meeting the nutrient requirements of livestock and rumen

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microbes as well. It acts as the source of several important nutrients, such as rumen degradable and undegradable (bypass) protein, degradable carbohydrates, non-protein nitrogen, and some minerals (Roxas 1997).

Table 3. Interaction effects of different levels of fodder species and UMMB supplementation on milk yield and its constituents at the farmers' field of Tanahun district.

Treatment effects	Milk Yield, l day^{-1} (Mean±SD)	Fat content, % (Mean±SD)	Lactometer reading (Mean±SD)
F. semicordata fodder with UMMB supplementation	12.55±0.29^{a}	4.85±0.17^{a}	29.72±0.15^{a}
P. purpureum fodder with UMMB supplementation	10.96±0.39^{b}	4.32±0.55^{b}	27.98±0.14^{ab}
F. semicordata fodder with no UMMB supplementation	9.96±0.16^{b}	4.31±0.02^{b}	25.95±0.17^{b}
P. purpureum fodder with no UMMB supplementation	7.96±0.44^{c}	3.67±0.57^{c}	25.46±0.79^{b}
p-value	<0.01	<0.05	<0.05

SD= Standard deviation, Means bearing different superscripts in the same column differ significantly at a 5% probability level

While limited feeds are apparent in Nepali hills, there is also a limitation to the efficient utilization of the crop residues, crop by-products, and fodder resources (De Vries and Kaylegian 2018). Rearing the dairy animals in the paddy straw and wheat bran-based diet without any fodder or nutrient supplementation is severely reducing the health and productivity of those animals in these areas. The findings of this study could have the greater importance in the dairy cattle pockets of middle hills of Nepal. Inclusion of better performing fodder in their diet and supplemented with UMMB helps in overcoming malnutrition or undernutrition, increases the production at the farm level, and generates better returns for dairy farmers (Upreti et al. 2010; Trishna et al. 2012). The study revealed that the present feeding regimes and strategies of crossbred dairy cattle in middle hills of Nepal could be improved through simple interventions of selection of better performing fodders with nutrient supplementations via UMMB in their rations, which are also recommended by several authors for different contexts and locations (Hayashi 2005; Osti, 2020; Sharma 2020).

CONCLUSION

The present study in the farmers' field revealed that the Rai khanayo (*Ficus semicordata* var. montana S.M. Amatya) is superior fodder to Napier (*Pennisetum purpureum* K. Schumach. cv Mott) for improving the milk productivity with better milk fat and SNF content. Feeding *F. semicordata* fodder with UMMB supplementation along with paddy straw and wheat bran substantially improved milk productivity and milk constituents of Jersey crossbred cattle in the study. The inclusion of this feeding package (Diet 1) in the feeding strategy can improve the plane of nutrition for undernourished crossbred dairy cattle in the dairy packets of the middle hills of Nepal, which could be a milestone for enhancing the milk yield with better milk fat and SNF content in those areas. The promotion of the package of these simple technologies can make a substantial contribution to milk production and improve the health of the crossbred dairy cattle in the middle hills of Nepal.

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