Bangladesh Journal of Animal Science
Journal homepage: http://www.banglajol.info/index.php/BJAS

Effect of value addition to rice straw on the nutritional improvement and milk productivity of dairy cattle

MM Islam[1], A Akter[1], M Salauddin[1,2], MN Sultana[1] and MM Uddin[1*]

[1]Research group: Dairy Nutrition, Economics, Environment and Marketing under the Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh; [2]Bangladesh Milk Producers Cooperative Union Ltd., Lahirimohonpur, Ullahpara, Sirajgonj

Abstract

The objective of this study was to evaluate the physical and chemical value addition to rice straw on nutritional quality improvement of rice straw and its effect on milk productivity and composition. Twelve crossbred milking cows (Frisian Cross) of mid-lactation stage and second parity, having average initial body weight of 398.72 ± 42.22 kg and milk yield of 6.42± 0.78 kg were assigned to three treatment group (each group has 4 animals) and one control group. Four treatments were considered: T_0 (control): loose rice straw + green grass + concentrate; T_1: value addition to rice straw through chopping (physical) + green grass + concentrate; T_2: value addition to rice straw through urea and molasses without chopped (Chemical) + green grass + concentrate; and T_3: value addition to rice straw through urea molasses with chopping (Physical and chemical) + green grass + concentrate. The results revealed that T_2 was significantly ($p<0.05$) higher than T_0, T_1 and T_3 where total DM intake was 13.44± 0.26, 12.96±0.38, 12.47±0.16 and 12.06±0.31 for T_2, T_0, T_3 and T_1, respectively and the same was found for Crude protein. The daily milk yield was higher in T_3 (8.12±0.30 kg/day) and followed by T_0 (7.30±0.23 kg/day), T_1 (6.61±1.35 kg/day) and T_2 (6.78±0.09 kg/day) but daily milk yield gains were 0.31, 0.11, 1.44 and 1.46 kg in T_0, T_1, T_2, and T_3' respectively and differences were highly significant ($p<0.01$) among the groups. Milk composition of fat (4.40, 3.97, 4.90 and 4.10%), Protein (3.88, 3.69, 3.98 and 3.72%), SNF (8.42, 8.69, 8.49 and 8.13) and TS (12.57, 12.34, 12.96 and 11.90) in T_0, T_1, T_2 and T_3, respectively. There was significant difference ($p<0.01$) where the cows supplemented with UMS without and with chopping recorded SNF. Further study might be needed to estimate the economics of the value addition for enhancing the adoption of this technology at farm level through development of entrepreneurship.

Keywords: milk yield, SNF, fat, value addition, rice straw

 Bang. J. Anim. Sci. 2020. 49 (1):55-62

Introduction

Bangladesh has 1.47 million of dairy farms of which 41% are the household farms (small scale) belonging 29% cows of the total cows (IFCN, 2019). Bangladesh dairy has been transforming from livelihood-oriented to more enterprise-driven dairy which might require improved feeding system for sustaining the production (Uddin *et al.* 2020).The productivity of milk has not yet reached to expected level simply due to shortage of quality feed throughout the year and use of low-quality rice straw apart from poor genetics. Three most used feed ingredients for dairy cattle are rice straw, green grass and wheat bran (Uddin *et al.* 2013). However, the price for those three ingredients has been increasing rapidly while the price for milk is not increasing in the same pace. Rather, the milk price has decreased by 17% and feed price has increased by 3.7% which cause an increase in the cost of milk production by 15% during corona virus (Covid-19) crisis (Uddin *et al.* 2020). This mismatch between input and output price have substantial negative effect on the achievement of sustainability of dairy farming. Along with this crisis, the dairy farmers also have been facing the scarcity of the rice straw during monsoon.

One of the potential options for dairy development is to improving feeding management that includes the nutritionally improved quality rice straw in the daily ration. The typical ration of dairy cattle in Bangladesh is consisting of rice straw from 47-67% (Uddin *et al.* 2013). Rice straw is considered as the most important sources of roughage in Bangladesh. The recent survey results revealed that 89% of the farmers use rice straw in their dairy cattle ration (Islam, 2019). The quality of the roughage and efficient feeding management plays the

***Corresponding author**: mohammad.uddin@bau.edu.bd

central role in improving the milk production. The negative feed balance scenario (Khan and Sarker, 2014; Uddin *et al.* 2017) has driven the feed scientist to develop alternative feeding management, which is technologically, economically, and environmentally feasible and meeting the nutritional requirement for the cattle. Treating rice straw both physically and chemically has been proven as promising technology which has been tested on-station for its effective use at farm level. However, scanty of research has been done to evaluate its use at on-farm level, particularly on dairy farming. Even it is done but it has not been properly extended to the farm level. The farmer, on the other side, is not adopting this technology because of limited information about the benefits of value-added straw, high labour cost, lack of labour availability and high price of molasses. The limited technical knowledge has also been impeding this technology to be adopted at farm level. Considering this, this study has been undertaken to conduct the value added rice straw feeding trial on-farm in order to demonstrate the efficacy of this technology and to develop the capacity of the farmers as well as motivate the farmers to continue this technology after the experiment. Another motivation for study was to investigate the actual reasons, why are the farmers not using this proven technology?

Materials and Methods

Selection of the study areas and typical dairy farms

The study was conducted in a typical family farm which was located in Ullahpara Upazilla under the Sirajgonj district (use geographical information system for location). This district is the highest milk producing region in the country. The district was mainly characterized by the high density of cattle (dairy cattle population with higher proportion of dairy farms following intensive production system (Uddin *et al.* 2011). The vast majority (over 70 per/cent) of 'dairy' cattle are kept in herds with an average of 3.5 animals (Hemme *et al.* 2004). The on-farm feeding trial was conducted in Ullahpara upazilla.

Experimental trial

The experiment was conducted in two phases: The first phase was the treatment of straw for nutritional value addtion and feeding of dairy cows and the second phase was laboratory analyses of value added straw and analyis of milk sample. Treatment of straw and related activities were carried out on-farm which is located in Lahirimohanpur, Ullapara, Sirajganj.

Table 1: Layout of the experiment on evaluation of the use of value added straw

Parameter	Treatements			
	T_0	T_1	T_2	T_3
Number of cows	3	3	3	3
Breed	Frisian Crossbred	Frisian Crossbred	Frisian Crossbred	Frisian Crossbred
Average age (year)	4.5	5.0	5.25	7.5
Average body weight Kg)	357.67	413.33	372.58	451.3
Milk Yiled (Kg/cow)	7.16	6.5	5.33	6.67
Duration (days)	21	21	21	21
Ration	Loose rice straw +Green Grass +concentrate	Chopped rice straw + Green Grass+concentrate	Urea Molasses treated straw without chopping+Green Grass+concentrate	Urea Molasses treated straw with chopping + Green Grass with concentrate

T_0 (control): loose rice straw + green grass + concentrate; T_1: value addition to rice straw through chopping (physical)+ green grass + concentrate; T_2: value addition to rice straw through urea and molasses without chopped (Chemical) + green grass + concentrate; and T_3: value addition to rice straw through urea molasses with chopping (Physical and chemical) + green grass + concentrate.

Layout of the Experiment

Twelve dairy crossbred cows were seleted for this study following Completely Randomized Design (CRD). The animals were divided into four groups while each group consists of three cross-bred (Frisian Cross bred) lactating dairy cows. All groups of dairy cows received common concentrate mixture containing wheat bran, khesari bran and compound feed. The experimental layout is given in Table 1.

Collection of experimental materials

Wheat bran, khesari bran, compound feed and common salt were purchased from the local market and mixed properly. Rice straw was collected from Milk Vita Ltd. Commercial fertilizer grade granulated urea (NH_2-CO-H_2N, 46%N) and commercial cane molasses were purchased from local market. The composition of molasses and urea are presented here- Molasses: DM-77.0%, Sugars-46.0%, CP-3.7%, NFE-87.50%, Ash-9.0%, OM-91.0%, ME-9.3 MJ/Kg. Urea: DM-98.0%, CP-266.0% (Premier molasses and urea, 2006).

Experimental Feed Preparation and Feeding

Preparation of concentrate mixture

A hand-made concentrate mixture was prepared using the proportion of 38.8% wheat bran, 38.8% compound feed, 19.4% khesari bran, 3% salt and mineral source specially, calcium carbonate.

Preparation of chopped rice straw

A plastic sheet was spread over the soil, then rice straw was collected from straw pile and chopped into pieces by chopper machine and storage on the sheet.

Preparation of urea molasses straw without chopped

At first urea, molasses and straw were weighed out separately. A polyethylene sheet was spread over the soil, then the straw was scattered on the polyethylene sheet. Urea was then put in a dish and dissolved thoroughly with water. Molasses was added with urea solution and mixed thoroughly by a stick. Urea molasses solution was poured into a watering can from the dish and sprayed over the straw and mixed properly by hand. This was left for half an hour and then fed to the animals.

Preparation of urea molasses straw with chopped

Rice straw was collected from straw pile and chopped into pieces by chopper machine. At first urea, molasses and chopped straw were weighed out separately. Preparation urea molasses without chopped and with chopped followed same procedure.

Feed intake

Every morning and evening before feeding the animals, each feed was weighed carefully and total quantity of feed supplied to individual animals was recorded. From the second day of feeding trial, before supplying feed to the animals, the amount of refusals of the feed of the previous day was collected, weighed and recorded, The feed refused by each group of animals during 24 hours was deducted from the feed supplied to the animals on matter basis and was recorded as the daily dry matter intake by the animal.

Data recording and parameters studied

Every day at 6:00AM left over of feed ingredients if any was weighed out using digital weighing balance and were recorded as feed intake. Subtracting the residues left from the supplied amount. Throughout the period feed samples were taken from the supplied and refusal part weekly to make the composite sample for calculating the nutrient supplied and intiike.

Sample collection and storage

Both milk and feed sample were collected during the entire period of experiment at the field. The feed samples were weighted as fresh basis, and data were recored and transported through air tight package to the Animal Nutrtion Analytical laboratory for further analysis. The milk samples were collected from the farm and transported and stored in the Milk Vita Laboratory.

Chemical analysis of feed and milk compostion

Chemical analysis for crude protein (CP), crude fiber (CF), ether extract (EE), Ash and nitrogen free extract (NFE) were done with respective samples of feed and faeces following the methods of (AOAC 2010) as well as neutral detergent fiber (NDF) and acid detergent fiber (ADF) of feedstuff were also analyzed. Hemicellulose was calculated from the difference between NDF and ADF. Milk compostion such as fat, protein, Solids-not-Fat (SNF) was analysed milk vita quality laboratory. All the samples were analyzed in duplicate and mean values were recorded.

Statistical analysis

All of the data were manged Microsfot 365 version 2020 and all statistical analyis was done by using STATA 2012.

Results and Discussion

The chemical composition of the experimental feed consisting of with and without valued added straw is depicted in the Table 2. The percent composition varied depending on feed type, in which the contents of CP were higher in the concentrate ingredients and lower amount in roughage feed ingredients which is quite usual but the interesting to observe here is that when rice straw is exposed to either physical or chemical value addition, nutritional level especially protein content has been increased substantially.

The relatively higher contents of CP, in the concentrate feed ingredients than in straws revealed their paramount nutritional importance to augment ruminants on poor quality roughages. It was seen from the table that loose and chopped rice straw contained 5.92 and 6.09% crude protein which was increased by physical value addition (chopping) and chemical value addition (Urea and molasses).Addition of small amount of energy source increased the microbial nitrogen synthesis (Osuji *et al.* 1993) which is also reflected in this study as the CP content increment in the urea and molasses treated may be due to the readily available energy from the molasses and high crude protein content from urea, which was used by the micro-organisms for their growth and increased microbial protein in rumen of rice straw. Microbial nitrogen supply increased with increasing the supply of nitrogen, fermentable carbohydrate and probably the other essential nutrients (Tolera and Sundstol, 2000), where molasses may serve the major supply of these essential nutrients. Ahmed *et al* (2003) observed that urea treatment improved CP content of rice straw from 2.68 to 8.70%. The increases of CP content due to urea treatment supported by Saadullah *et al* (1981). The CP content in UMS with loose and chopped rice were 10.15% and 12.24% respectively. The higher protein content of UMS with chopped straw might be due to the fact that due chopping, the surface of the straw becomes more to absorb more urea solution than the non-chopped straw.

Chemical value-added straw combined with physical value addition increased CP content of the rice straw more than double from loose dry straw but decrease the NDF from 76 to 56% denoting the breakage of lignified bond and release of hemicellulose. On the other hand, cell wall components were also affected by urea treatment by reducing the NDF and hemicellulose contents of rice straw by 10.30% and 39.89% due to binding of ammonia with straw and solubilization of hemicellulose by the action of ammonia evolved from urea (Srinivasulu *et al.* 1999; Misra *et al.* 2006). The CP content in UMS with loose and with chopped were 12.24% and 10.15% respectively.

Table 2: Chemical Composition of Experimental Feeds (Dry matter basis)

Feed ingredients	Treatment	DM (g/100g)	Composition (g/100 g DM)							
			OM	CP	CF	EE	NFE	Ash	NDF	ADF
Loose rice straw	T_0	94.3	82.44	4.92	31.28	1.2	45.04	17.56	76	50
Chopped rice straw	T_1	94.52	82.76	5.09	30.64	2.06	44.97	17.24	68	50
UM Treated loose rice straw	T_2	94.47	84.97	10.15	26.64	4.71	43.47	15.03	66	42
UM Treated chopped straw	T_3	94.35	83.98	12.24	22.58	4.43	44.73	16.02	56	36
Grass	All	88.46	88.47	10.21	28.96	2.45	46.85	11.53	68	46
Wheat Bran		95.7	97.53	13.68	1.86	1.01	80.98	2.47	36	24
Khesari Bran		88.82	93.61	17.51	23.78	1.6	50.72	6.39	50	42
Pellet feed		89.92	89.59	20.14	3.75	3.5	62.2	10.41	18	10

T_0 (control): loose rice straw + green grass + concentrate; T_1: value addition to rice straw through chopping (physical) + green grass + concentrate; T_2: value addition to rice straw through urea and molasses without chopped (Chemical) + green grass + concentrate; and T_3: value addition to rice straw through urea molasses with chopping (Physical and chemical) + green grass + concentrate. DM: Dry matter; CP: Crude protein; CF: Crude fiber; EE: Ether extract; NFE: Nitrogen free extract; OM : Organic matter; ADF: Acid Detergent fiber; NDF: Neutral detergent fiber; UM: Urea molasses.

Intake of value added straw and nutritional improvement

The intake in terms of dry matter and nutrients of value-added straw is depicted in Table 3 which shows a significant ($p<0.05$) differences among the groups. In relation to DM intake, is observed that DM intake of T_2 was higher than that ofT_0, T_1, and T_3. This could be due to the softening of fibrous portion of straw by soaking with urea solution which makes it more palatable to the animals (Akbar, 1992). Another reason could be that because the treatment of straw increased the readily available nitrogen source for the microbes in the rumen resulting in higher microbial activity and rapid fermentation and rate of passage of digesta (Islam, 1989).

Crude protein (CP) intake was higher in animal receiving diet T_2 and diet T_3than diet T_0 and diet T_1 have been showed in Table 4.8. Total CP intake of experimental group T_0, T_1, T_2 and T_3 were 1.72, 1.61, 1.93 and 1.94 kg, respectively. There was highly significant ($p>.05$) differences among the groups on CP intake. The CP intake from rice straw of different experimental group was 0.28, 0.24, 0.64 and 0.65 kg respectively. CP intake from rice by the animals of T_2 groups was significantly higher ($p<0.01$) than that of the animals receiving diet T_0, T_1 and T_3.

The higher highest crude protein intake is observed for the T_2 which might be due to the fact that higher DM intake and it's associated with CP content. It may be due to addition urea molasses which may cause a higher rate of fermentation, increased rate of passage and therefore, resulted in higher intake and less gut fill. T_3 also added urea molasses but DM intake is decreased in T_2 because wastage was high due to chopped straw and secondly and the most importantly it is suspected that length of the straw is highly correlated with the feed intake and digestion. The lower the chop length than 2 inch might have reduced the rumination effect which ultimately cause less efficiency in protein digestion as well as the intake. Since in Bangladesh, it was found from during field study that there is virtually no straw chopper is available which can produce the chopped length more than 4 inches. However, it is also not clear the ideal chop length for increased efficiency in value added straw utilization. The voluntary intake of dry matter of urea treated paddy straw fed ad libitum was higher ($P<0.05$) than untreated paddy straw supplemented with urea or treated straw fed in restricted amount (Gupta *et al.* 2003).

Table 3: Total daily nutrient intake of the experimental dairy cattle

Parameters	Diets (Mean ± SD)				SED	Level of Significance
	T_0	T_1	T_2	T_3		
TDMI (kg/day)	12.96^{ab} ±0.38	12.06^{b} ±0.31	13.44^{a} ±0.26	12.47^{b} ±0.16	0.08	*
TCPI (kg/day)	1.72^{c} ±0.0.03	1.61^{d} ±0.03	1.93^{a} ±0.05	1.84^{b} ±0.02	0.002	*
CPI from Rice straw (kg/day)	0.28^{b} ±0.042	0.24^{b} ±0.0	0.64^{a} ±0.02	0.65^{a} ±0.09	0.004	**
TNDFI (kg/day)	6.43^{a} ±0.19	5.79^{b} ±0.15	6.40^{a} ±0.13	5.69^{b} ±0.07	0.02	**
TADFI (kg/day)	4.46^{a} ±0.13	4.15^{b} ±0.11	4.41^{a} ±0.09	3.94^{c} ±0.05	0.01	*

^{abc}Different superscripts indicate significant ($P < 0.01$) differences between means in the same column; TDMI: Total Dry Matter Intake; TCPI: Total Crude Protein Intake; CPI: Crude Protein Intake; TOMI: Total Organic Matter Intake; TNDFI: Total Neutral Detergent Fiber Intake; TADFI: Total Acid Detergent Fiber Intake; T_0 (control): loose rice straw + green grass + concentrate; T_1: value addition to rice straw through chopping (physical) + green grass + concentrate; T_2: value addition to rice straw through urea and molasses without chopped (Chemical) + green grass + concentrate; and T_3: value addition to rice straw through urea molasses with chopping (Physical and chemical) + green grass + concentrate; NS: Non-significant;*: 5% level of significant; **: 1% level of significant.

This explanation has been supported by the higher intake of treated straw (UMS) than that of untreated straw (Table 3). Mathur *et al.* (1985) also reported that soaked straw resulted in higher intake than untreated straw. The higher CP content of the soaked straw diet might have caused higher microbial activity in the rumen resulting in higher feed intake than that of untreated straw (control) diet. The average intake, nutritive value and milk production performance of the diet was expected to be higher in treated group than that of control group. The present findings were well corresponding with the results of Ahmed et al. (2003) that crude protein intake was significantly higher ($p<0.05$) in urea-treated rice straw. Similarly, Narayan *et al.* (2004) also found a higher CP intake in urea treated straw. It is evident from the Table. 4.8 that CP intake of animals increased with the increased supply of urea molasses treated rice straw both loose and chopped contained more CP than loose rice straw. As a result, higher intake of CP was observed in diet T_2 and T_3 group.

Daily Milk Yield

Daily milk yield and milk yield gain by the different groups of cows have been presented in the table 4, where it shows that the initial milk yield of the experimental groups of animal were 7.17±0.29, 6.50±1.32, 5.33±0.76 and 6.67±0.58 in the fed diet T_0, T_1, T_2, and T_3 respectively. It can be seen that the daily milk yield gains were 0.31, 0.11, 1.44 and 1.46 kg in treatment groups T_0, T_1, T_2, and T_3 respectively and differences were highly significant ($p<0.01$) among the groups. But, total milk yield were 7.30, 6.61, 6.78 and 8.12 kg per day in the treatment groups T_0, T_1, T_2, and T_3 respectively were not significantly different ($P>0.05$). The result is consistent with Berger et al, 1994 who found similar results ($P>0.05$) among three dietary treatments (urea, urea + soybean meal, soybean). Miah *et al.* (2000); Alam *et al.* (2006) in indigenous and crossbred cows found better ($P<0.05$) milk yield in cows fed UMB than controls (without urea). Vu *et al.* (1999) found better ($P<0.05$) daily milk yield in crossbred Holstein-Friesian cattle fed urea-treated rice straw than in those without urea.

Milk composition of different experimental groups

Milk composition of different experimental groups are presented in Table 5, where it shows that the result of this study also indicated milk composition of fat (4.40, 3.97, 4.90 and 4.10%), Protein (3.88, 3.69, 3.98 and 3.72%), SNF (8.42, 8.69, 8.49 and 8.13) and TS (12.57, 12.34, 12.96 and 11.90) in groups T_0, T_1, T_2 and T_3, respectively. A significant difference (p0.01) was observed in terms of milk yield fed by value added rice straw and non-valueadded rice straw. However, Rehrahie *et al.* (2010) reported that only milk protein was significantly different while milk fat, total solid and lactose were not significantly different between treated and untreated wheat straw. In addition, Rehrahie and Ledin (2004) reported that the effect of hay-based diet, urea treated straw based diet on milk fat percent didn't differed significantly. According to O'Connor (1994), any ration that increases milk production usually reduces the fat percentage of milk. It is also believed that the fat content is influenced more by roughage (fiber) intake and the solid-not-fat content can fall if the cow is fed a low energy diet. In temperate type cows, the fat and SNF percentages tend to be higher in the early weeks of lactation, dropping by the third month then rising again as milk yield gradually declines (O' Manhony, 1988).

Table 4: Mean of daily milk yield of different experimental groups

Parameters	Diets (Mean ± SD)				SED	Level of Significance
	T_0	T_1	T_2	T_3		
Initial Milk yield (kg/day)	7.17±0.29	6.50±1.32	5.33±0.76	6.67±0.58	0.69	NS
Total Milk yield (kg/day)	7.30±0.23	6.61±1.35	6.78±0.77	8.12±0.30	0.64	NS
Milk yield gain (kg/day)	0.13^{b}±0.51	0.11^{b}±0.24	1.44^{a}±0.07	1.46^{a}±0.30	0.10	**

^{abc}Different superscripts indicate significant ($P < 0.01$) differences between means in the same column; T_0 (control): loose rice straw + green grass + concentrate; T_1: value addition to rice straw through chopping (physical) + green grass + concentrate; T_2: value addition to rice straw through urea and molasses without chopped (Chemical) + green grass + concentrate; and T_3: value addition to rice straw through urea molasses with chopping (Physical and chemical) + green grass + concentrate; NS: Non-significant;*: 5% level of significant; **: 1% level of significant.

Table 5: Milk composition of different experimental groups

Parameters	Diets (Mean ± SD)				SED	Level of Significance
	T_0	T_1	T_2	T_3		
Fat (%)	4.4±0.44	3.97±1.16	4.90±0.35	4.10±0.20	0.42	NS
Protein (%)	3.88±0.29	3.69±0.24	3.98±0.37	3.72±0.16	0.09	NS
Solids not fat (%)	8.42^b±0.14	8.69^a±0.08	8.49^a±0.24	8.13±0.13	0.03	*
Total solids (%)	12.57±0.52	12.34±0.86	12.96±0.22	11.90±0.21	0.42	NS

[ab]Different superscripts indicate significant ($P < 0.01$) differences between means in the same column; T_0 (control): loose rice straw + green grass + concentrate; T_1: value addition to rice straw through chopping (physical) + green grass + concentrate; T_2: value addition to rice straw through urea and molasses without chopped (Chemical) + green grass + concentrate; and T_3: value addition to rice straw through urea molasses with chopping (Physical and chemical) + green grass + concentrate; NS: Non-significant;*: 5% level of significant.

Milk selling is the major source of income for the dairy farmers (Uddin *et al.,* 2010) which imply that dairy farmers invest strong feeding and managerial skill to increase the milk production. However, since the milk fat and SNF is linked with formal sector, farmers also take care their animals toward a feeding system which lead to higher fat content. The milk price of famers paid by the formal sector is based on the fat content which signifies the need for adopting strategy particularly roughage feeding to increase the fat.

At the same pace, the processors must comply with the SNF 8% for marketing their milk as set by the Bangladesh Standard and Testing Institute (BSTI). In contrast, for the informal sector, milk price is solely depending on the volume, which once again leads to the adoption of the feeding practices that increase the volume of milk. Since the value-added straw has influence on the milk yield gain as it is seen from the table 4, it is of paramount important to extend the valued added straw feeding technology to the wider range of the dairy farmers. It is noteworthy to mention that the value addition by adding urea and molasses is well evident long before, but the key interesting point is that this technology is not adopted at all at farm level. This implies that factors that affect the farmers decision on to adopt the urea treated technology need to be explored.

Conclusion

The value addition of poor-quality rice straw is obvious in the context of dairy farming in Bangladesh. As most of the dairy farmers compel to use rice straw, any intervention that help to increase the nutritional quality and enhance milk yield is of highly prioritized. However, the degree and magnitude of the value addition plays key role in increasing nutritional quality. From this study, it is clearly evident that value addition through urea and molasses without chopping is better (T_2) than value addition with chopping (T_3). The chopping length of less than 2 inch has negative impact on the feed intake and milk yield. This study, finally, concludes that value addition to rice straw with urea and molasses without chopping can be used for increasing the nutritional quality and milk yield and Solids-Not-Fat (SNF). The further study might be needed to identify the optimum chopping length on the value addition and milk productivity increase and why the farmers does not adopt this technology at farm.

Acknowledgement

The authors highly acknowledge the Krishi Gobeshona Foundation (KFG) project (Reference: TF 49-L/17) for financial support for materializing this study. The authors also acknowledge the Bangladesh Milk Producers Cooperatives Union Ltd (Milk Vita) for providing access to data and their affiliated farms for conducting experiments.

Conflict of interest

There is no conflict of interest neither on the results nor any part of this study.

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