EFFECT OF MOLASSES SUPPLEMENTATION OF A ROUGHAGE BASED DIET ON GROWTH PERFORMANCES OF CATTLE

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Summary

Two feeding trials were conducted to determine the effect of molasses feeding on the growth performances of bulls. In the first experiment, the straw of a control diet of straw and urea was replaced by molasses of 150 g (M_{150}) or 300 g $\cdot$ kg^{-1} (M_{300}). The three diets were fed *ad libitum* to three groups of bulls having five in each and the dietary responses were statistically analyzed in a simple design. The bulls were given fishmeal (30 g $\cdot$ $hd^{-1} \cdot d^{-1}$), wheat bran (0.5% of Liveweight, LW) and allowed grazing for 5 hrs $\cdot$ d^{-1}. Molasses supplementation significantly ($p < 0.001$) increased the dry matter intake (DMI) of the bulls of M_{150} (35.8 g) and of M_{300} (42.9 g) than the control (30.4 g $\cdot$ $kg^{-0.75}$). The daily LW gain of the bulls of the M_{150} (982 g) was significantly ($p < 0.05$) higher than the bulls of the control or of the M_{300} diet. In the second experiment, a control group of four bulls was fed a straw diet. Treatment two groups, having four bulls in each, were fed a mixed diet of *Leucaena leucocephala* and *Setaria splendida*(1:1, DM basis) with (LSM) and without (LS) molasses at 100 g $\cdot$ kg^{-1}. The dietary responses were statistically analyzed in a simple design. The bulls of the LSM diet had significantly ($p < 0.05$) higher DMI, DM digestibility and LW gain (128 g $\cdot$ $kg^{-0.75}$, 663 g $\cdot$ kg^{-1} and 419 g $\cdot$ d^{-1}, respectively) than the bulls of the LS diet (98.3 g $\cdot$ $kg^{-0.75}$, 583 g $\cdot$ kg^{-1} and 292 g $\cdot$ d^{-1}, respectively). But the differences between the LSM and the control were nonsignificant. It may be concluded that molasses may be utilized as supplement to straw at 150 g $\cdot$ kg^{-1} or forages at 100 g $\cdot$ kg^{-1} diet for the profitable beef production from young growing bulls.

(**Key Words** : Molasses, Supplementation, Growth, Cattle)

Introduction

The poor quality fibrous feed is deficient in readily fermentable carbohydrate (RFC), digestible protein and some minerals. Such fibrous feeds provide about 96, 91 and 84% of the dry matter (DM), metabolizable energy (ME) and crude protein (CP), respectively available for the ruminant animals of Bangladesh (Huque et al., 1992). Better utilization of the fibrous feeds through strategic supplementation with feeds of protein and RFC sources is one of the means of reducing the nutritional deficiencies of the animals. Supplementation with a protein feed may increase the intake (O'Donovan et al., 1983) and the digestibility (Perdok, 1987) of poor quality fibrous feeds. The utilization of supplementary proteins or their response to rumen microbial protein production may be limited by the absence of a RFC feed in diets (Maeng and Baldwin, 1976). Supplementation with a RFC feed at a low level in the presence of true protein sources increased the intake of poor quality roughage (Huque, 1992; Khalili, 1993).

Sugar cane molasses is one such non-conventional feed, which is rich in soluble carbohydrate (Shirely, 1986) and widely available in Bangladesh. Supplementation of poor quality roughage with molasses increased their intake (Khalili, 1993, Khalili et al., 1993) or growths of cattle (Barnah et al., 1992, Preston and Leng, 1987).

Preston and Leng (1987) stated that molasses feeding to cattle on green pastures can be highly beneficial and, provided that the pasture has a high nitrogen (N) content, additional fermentable nitrogen is not needed. Daily feeding of 3 to 4 kg molasses to cows grazed on irrigated and fertilized Pangola grass increased milk production by up to 2.5 liters $\cdot$ day^{-1} (Chopping et al., 1970). Rahman (1992, personal communication) stated that the mixed cropping of *Leucaena leucocephala* with *Setaria splendida* gave an annual biomass yield of 62.5 tons $\cdot$ h^{-1}. Feeding these forages in a 1:1 mixture would give a diet containing 150 to 160 g CP and 8.0 to 9.0 MJ

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ME· kg^{-1} DM. Supplementation of the mixed forages with molasses should increase ME concentration and the availability of RFC to the rumen microbes, and hence may have a positive effect on production performances. The feeding system of molasses with straws or green grasses is also important factor to take into consideration. Molasses ferments rapidly without a lag phase in the rumen but the latters follow the converse course. Doyle et al. (1986) stated that a RFC should be fed frequently i.e. two or more meals a day rather than once to avoid depression on cell wall digestibility and intake of straw. Feeding of a RFC as an intimate mix with straw avoided its nonadditive effects on the rumen fibre digestion (Huque, 1992) or at the same time when grass hay and protein meal were fed, increased hay intake (Khalili et al., 1993). However, the data on the effect of molasses supplementation to a roughage diet are scarce in Bangladesh.

Thus, the present study was undertaken to determine the effect of molasses feeding as an intimate mix with straws or green grasses on the growth of native bulls.

Materials and Methods

Two experiments were conducted at the Animal Research Station, Pachutia (ARSP), BLRI to test the value of molasses feeding to growing bulls.

Experiment 1

The experiment was conducted for a total period of 60 days on the growth of bulls. Their average initial liveweight (LW) was 279.5 ± 54.0 kg. Fifteen bulls were divided into three groups each of five based on their age and LW.

The control group was fed a diet of straw and urea at 970 g and 30 g · kg^{-1} (US), respectively (table 1). In the treatment diets the straw of US was replaced on DM basis by molasses at the rate of 150 g and 300 g · kg^{-1} (W/W) and termed as M_{150} and M_{300}, respectively. The diets were prepared twice a week. The required amounts of urea or molasses were weighed and dissolved in tap water to make solutions and then mixed intimately with dry straw. The diets were fed *ad libitum*. All the experimental bulls were daily given wheat bran at 0.5% of LW and fishmeal at 30 g $hd^{-1} \cdot d^{-1}$. The two feeds were mixed together and offered in the morning and the evening in two equal halves before feeding straw. Besides, they were kept on grazing for five (5) hours daily during the experimental period (March to May) when the most of the available pasture was affected by draught. The animals were taken out to grazing after the morning meal.

TABLE 1. COMPOSITION OF DIETS FED TO THE ANIMALS OF EXPERIMENT 1

Feed ingredients	Diets		
	Control	M_{150}	M_{300}
Straw	970	820	670
Urea	30	30	30
Molasses	–	150	300
Total	1,000	1,000	1,000

The intake of straw was calculated from the difference of feed offered and refused by the animals. The fortnightly LWs of the bulls were measured by a digital cattle weighing balance which was standardized against a scale controlled manually. Daily liveweight gains (LWG) of an individual bull was calculated by regressing its cumulative liveweights against days of the experiment.

The data on straw intake and daily LWG were analyzed in an ANOVA of a completely randomized design (CRD) and treatment means were compared by the least significant difference (LSD).

Experiment 2

This experiment determined the supplementary effect of molasses on the growth responses of growing bulls of initial LW of 122.5 ± 41.7 kg. Twelve bulls were divided into three groups each of four animals.

A diet of straw and a concentrate mixture containing wheat bran, rice bran and dried leucaena leaf meal (LLM) at 120, 130 and 750 g · kg^{-1} DM, respectively, and previously tested in growing animals by Rahman et al. (1990) was fed to one of the groups of bulls as a control treatment. The daily allowance of the concentrate mixture, at 1.50% of LW, was divided into two equal halves and fed in the morning and the evening. The other two groups were fed *ad libitum* either with a 1:1 mixture (DM basis) of *Leucaena leucocephala* and *Setaria splendida* (LS) or the same mixed roughage mixed with molasses at 100 g · kg^{-1} DM (LSM). The composition of the diets are shown in table 2. The straw or branch tops of fresh Leucaena and Setaria were also fed twice a day. At each meal, the weighed amount of molasses was thoroughly mixed with the green forages offered in the manger. The feeding trial was conducted for 60 days and at the end of trial, feed offered, refused and faeces voided were determined for seven days to determine the daily dry matter intake and dry matter digestibility. The formightly weights of the experimental bulls were measured by a calf weighing platform balance. Daily LWGs were calculated from the slope of a regression line of cumulative liveweights of each animal against total days of experimentation.

TABLE 2. COMPOSITION OF DIETS FED TO THE ANIMALS OF EXPERIMENT 2

Feed ingredients	Composition ($g \cdot kg^{-1}$) of diets		
	Control	LS	LSM
Straw	*Ad libitum*	–	–
Green leucaena	–	500	450
Green setaria	–	500	450
Molasses	–	–	100
Concentrate mixture	1.50% LW	–	–

The three diets were also fed to three (3) rumen cannulated animals in a 3 × 3 latin square design to determine the rumen cellulolytic activity. Each period consisted of ten days adjustment followed by a seven days collection phase. During the collection phase, 2 g of milled (4 mm) straw sample was incubated in the rumens using the dacron bag technique (Orskov et al., 1980). Straw samples were incubated for 0, 8, 16, 24, 48 and 72 hours. After removal from the rumen, the bags were washed, dried to constant weight and weighed. Weight loss of straw was calculated to determine its digestibility during different incubation periods. The data were mathematically evaluated by a computer program (NAWAY) using an exponential equation developed by McDonald (1981) to calculate the rate and extent of rumen digestion of the test straw sample. The differences in the rumen cellulolytic activity in response to three diets were determined by the differences in the rate and extent of digestion *in sacco* of the same straw sample incubated in three rumens in three periods. Chemical analysis of feed samples was done according to the method described by AOAC (1984).

Data on feed intake and digestibility and daily LWGs were analyzed in an ANOVA of a completely randomized design (CRD) for determining significant differences among the treatments. The differences in the rumen cellulolytic activity among the treatments were analyzed in an ANOVA of a 3 × 3 latin square design. Treatment means were compared by the least significant differences (LSD).

Results and Discussion

Daily straw intakes expressed either in $g \cdot hd^{-1}$ or $g \cdot kg^{-0.75}$ and initial LW of the bulls and daily LWG are shown in table 3. As the animals were kept on grazing for five hours a day and fed with wheat bran at 0.5% LW; their intakes of straw were comparatively low. The table shows that the daily DM intake of straw and urea (US) was 1960 $g \cdot hd^{-1}$ or 30.4 $g \cdot kg^{-0.75}$. Supplementation of US with molasses increased DM intake significantly ($p < 0.001$) to 2700 $g \cdot hd^{-1}$ or 35.8 $g \cdot kg^{-0.75}$ by the bulls of M_{150}, and to 2780 $g \cdot hd^{-1}$ or 42.9 $g \cdot kg^{-0.75}$ by the bulls of M_{300}. Molasses supplementation did not change straw intake significantly ($p > 0.05$) up to 300 $g \cdot kg^{-1}$ diet (table 3), except a significant ($p < 0.01$) increase in the total straw intake in M_{150} (2214 g vs 1900 $g \cdot hd^{-1}d^{-1}$ in the control). However, this difference disappeared when the straw intake of M_{150} were expressed on metabolic body size because the bulls in the M_{150} group had the highest average initial LWs. A similar trend of increased total dry matter intake was found in response to supplementation of oaten hulls with molasses and urea at 150 g and 30 $g \cdot kg^{-1}$ diet, respectively (Hemsley, 1964) or of straw with pure maize starch up to 300 $g \cdot kg^{-1}$ diet (Huque, 1992 and Mulholland et al., 1976) or of straw with concentrate up to half of the total diet (Fahmy et al., 1984 and Poore et al., 1990).

TABLE 3. INTAKE OF STRAW AND UREA (US) AND UREA-MOLASSES IMPREGNANT STRAW (UMS) AND LIVEWEIGHT GAINS OF BULLS IN EXPERIMENT 1

Items	Diets			Significance	
	Control	M_{150}	M_{300}	SED	Levels
Initial Av. liveweight (kg)	258.8	319.2	260.4	32.7	$p > 0.05$
US/UMS intake ($g \cdot head^{-1} \cdot day^{-1}$)	1,960	2,700	2,780	32.0	$p < 0.001$
US/UMS intake ($g \cdot kg^{-0.75} \cdot day^{-1}$)	30.4	35.8	42.9	1.95	$p < 0.001$
Straw intake ($g \cdot head^{-1} \cdot day^{-1}$)	1,900	2,214	1,860	53.0	$p < 0.01$
Straw intake ($g \cdot kg^{-0.75} \cdot day^{-1}$)	29.4	29.3	28.7	1.85	$p > 0.05$
Liveweight gain ($g \cdot hd^{-1} \cdot d^{-1}$)	682	982	682	66.0	$p < 0.001$

Table 3 also shows that the average daily LWG of bulls in the M_{150} group was significantly ($p < 0.01$) higher (982 g) than the bulls in the control group (682 g). Increasing molasses to 300 $g \cdot kg^{-1}$ DM failed to increase liveweight gain (682 $g \cdot d^{-1}$ in M_{300}) although its effect on dry matter intake was significantly ($p < 0.001$) higher. The higher average initial LWs of the bulls of the M_{150} group may be a factor giving greater response. However, supplementation with molasses in the presence of fishmeal (30 $g \cdot d^{-1} hd^{-1}$) might give a greater yield of microbial cells in the rumen.

In a similar work from the same Institute, Huque and Chowdhury (1994, personal communication) found that the yield of rumen microbial protein increased from 8.0 $g \cdot hd^{-1} d^{-1}$ in a dry straw diet to 24.0 $g \cdot hd^{-1} d^{-1}$ in a similar diet to that of the M_{150}. Maeng and Baldwin (1976) also stated that the addition of fishmeal to a RFC supplemented diet gave a greater yield of microbial cells than the control. Moreover, molasses supplementation decreases the rumen retention time of digesta (Hemsley and Moir, 1963) and might result in a large flow of undegradable protein to the small intestine. Cullision and Lowery (1987) stated that 100 to 150 g molasses per kilo diet is an optimum level for supplementation, and further increase may disrupt rumen microbial activity and decrease the feeding value of the base ration. Thus, a significant increase in LWGs was found in the M_{150} group.

Increasing molasses in the M_{300}, increased its intake without any change in straw intake, and thus may have modified rumen fermentation with a negative associative effect on the rumen microorganisms. Similar statements were made by Doyle et al., 1986; Huque, 1992, Mulholland et al., 1976; Wedekind et al., 1986). Moreover, at a high level of sugar, protozoal concentration might be increased with the destruction of bacteria and thus the net yield of microbial biomass could have been decreased (Leng, 1990).

Experiment 2

Table 4 shows the chemical composition of feed ingredients used in Experiment 2. The level of CP in wheat bran was comparatively high (191 $g \cdot kg^{-1}$ DM) The CP levels in Leucaena and Setaria were 241 and 108 $g \cdot kg^{-1}$ DM. A 1:1 mixture (LS) of the forage gave a CP level of 175 $g \cdot kg^{-1}$ DM.

The values for total dry matter intake (DMI) and digestibility (DMD), straw digestion *in sacco* and daily LWG of bulls are presented in table 5. The DMI of bulls

TABLE 4. CHEMICAL COMPOSITION OF FEED INGREDIENTS USED FOR FORMULATION OF DIETS OF EXPERIMENT 2

Feed items	Dry matter ($g \cdot kg^{-1} \cdot$ fresh sample)	Dry matter ($g \cdot kg^{-1}$ dry sample)	Chemical composition ($g \cdot kg^{-1}$ dry matter)		
			Ash	Crude protein	Crude fibre
Straw (*Oryza sativa*)	855	930	177	27	334
Leucaena leucocephala	314	931	50	241	237
Setaria splendida	137	887	102	108	390
Wheat bran	–	872	51	191	114
Rice bran	–	897	100	104	182

TABLE 5. DRY MATTER INTAKE AND DIGESTIBILITY OF DIETS, STRAW DIGESTION *IN SACCO* AND DIETARY RESPONSES TO GROWTH PERFORMANCES OF GROWING BULLS

Items	Diets			Significance	
	Control	LS	LSM	SED	Level
Dry matter intake ($g \cdot kg^{-0.75} \cdot day^{-1}$)	126	98.3	128	9.87	$p < 0.05$
Dry matter digestibility ($g \cdot kg^{-1}$)	618	583	663	103	NS
Straw digestion *In sacca*					
Rate constant (C)	0.0340	0.0399	0.0417	0.00528	NS
Total digest (a + b)	636	594	596	34.9	NS
Digestibility at 48 h	529	518	544	28.5	NS
Growth rate ($g \cdot day^{-1}$)	473	292	419	37.8	$p < 0.05$

NS = Nonsignificant.

in the LS diet was 98.3 $g \cdot kg^{-0.75}$ and was significantly ($p < 0.05$) lower than the DMI of the bulls of the control (126 $g \cdot kg^{-0.75}$) or the bulls in the LSM diet (128 $g \cdot kg^{-0.75}$). Bulls offered the control diet ate 47.4 g $DM \cdot kg^{-0.75} d^{-1}$ from the concentrate mixture and the rest as chopped straw.

Supplementation of LS with molasses increased total DMI significantly ($p < 0.05$), in agreement with the results of Experiment 1. Similarly, the total DMD of the LS in the whole gut increased nonsignificantly ($p > 0.05$) from 583 to 663 $g \cdot kg^{-1}$ in the LSM diet. The total DMD of the control diet was 618 $g \cdot kg^{-1}$ and did not differ significantly ($p > 0.05$) from that of the LS or the LSM diet.

Dietary responses to rumen cellulolytic activities, as measured by the rate (C) and extent (a + b) of digestion, did not differ significantly ($p > 0.05$) among the three diets. Thus, supplementation of LS with molasses at 100 $g \cdot kg^{-1}$ DM increased total DMI without any negative associative effect on the rumen cellulolytic activities. The positive effect of molasses supplementation on the rumen out flow rate as shown by Hemsley and Moir (1963) and Reyes (1974) might have resulted in a significantly higher DMI in the LSM diet of the present experiment.

The rate of liveweight gain for bulls consuming the control diet was 473 $g \cdot d^{-1}$. This value was higher than the value found by Rahman et al. 1990 in growing bulls fed a similar diet. The concentrate portion of our control diet contained about 210 g CP per kilo and provided about 37.6% of total DMI thus possibly resulting in a better growth rate. Feeding the LS diet *ad libitum* produced significantly ($p < 0.05$) lower growth rate (292 $g \cdot d^{-1}$) than the control diet, but supplementation with molasses (LSM) increased significantly ($p < 0.05$) daily LWGs further to 419 $g \cdot d^{-1}$. The LS diet had CP of 175 $g \cdot kg^{-1}$ DM containing both non-protein and true protein sources. Similar to the effect of molasses supplementation to straw, the availability of a RFC source as molasses in the presence of both the types of protein in the rumen of the LSM diet might have increased the synthesis of microbial protein or the yield of undegradable protein in the lower gut. Thus, a higher DMI and positive effect on microbial protein yield may explain the significant increase in daily LWGs which was found in response to supplementation of the green forages with molasses.

It may be concluded that molasses as a readily fermentable carbohydrate rich by product of the sugar industry may be utilized as a supplement to straw at 150 $g \cdot kg^{-1}$ and to green forages at 100 $g \cdot kg^{-1}$ dry matter for a profitable production of beef from young growing bulls.

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