Ensiled Banana Wastes with Molasses or Whey for Lactating Buffaloes during Early Lactation[a]

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ABSTRACT : Low-quality roughages [banana wastes (B), wheat straw (WS) and dried broiler litter (BL)] were ensiled using either sweet whey (W) or diluted molasses (M) as rehydration media to study their effects on milk yield, milk composition and some parameters of blood plasma. The feeding trial involved 25 lactating buffaloes in five groups (five animals each). Buffaloes as control animals received diets of concentrate feed mixture, rice straw and wastelages (70:30:00). In the other 4 treatments, the wastelages replaced 50% of rice straw in the control diets. The wastelages were BL:B:M (3:2:10) (T1), BL:WS:M (3:2:10) (T2), BL:B:W (3:2:10) (T3) and BL:WS:W (3:2:10) (T4) on a fresh matter basis, during the 1st 17 weeks of lactation period. Results indicated that feeding lactating buffaloes on wastelages resulted in slightly higher (p>0.05) milk yield, 4% fat-corrected-milk yield and feed efficiency, and slightly lowered (p>0.05) contents of milk total solids, fat and protein. Wastelages, especially BL-B-M, increased (p<0.05) milk non-protein-nitrogen and ash contents and plasma urea, GOT and GPT. The results demonstrate that banana plant wastes with some additives in silage form may be good untraditional roughage for lactating buffaloes without any adverse effect on milk production. *(Asian-Aus. J. Anim. Sci. 2000. Vol. 13, No. 5 : 619-624)*

Key Words : Banana Wastelages, Lactating Buffaloes, Feeding, Milk Composition, Blood Plasma

INTRODUCTION

The increasing demand for animal protein foods requires integrated strategies to develop the livestock sector. Feed supplies as a component of such strategies should consider the potentiality of using new feed resources for ruminants. Additionally, the overpopulation results in rising demands for animal protein, so strategies should be directed towards exploring the possibility and the limit of using non-conventional sources as animal feeds. Wheat and rice straws are the main roughages used in animal feeding. Because of their continuously increasing prices, attempts to use other, new, sources of roughages such as vegetable and fruit residues have been recently tried by several workers (El-Sayed, 1994; El Kady, 1997). Also, due to low nutritive value of the straws, broiler litter can be used as a good supplement or as a good replacement for roughage. Broiler litter is a good source of nitrogen which is derived from both true protein and non protein nitrogen (NPN) (Fontenot et al., 1983). Both banana wastes and broiler litter can be considered as feeds which have not been traditionally used in animal feeding due to some problems such as the presence of antinutritional compounds (tannin in banana wastes) or of pathogenic microorganisms (Shegella, proteus and Salmonella) in broiler litter. One of several efficient means to solve some problems is the ensiling process. To stimulate the fermentation process to produce silage, a source of soluble carbohydrates is available in another non-conventional feeds, which is liquid whey (agro-industrial waste and rich in soluble carbohydrates). We aimed to process a cheap, high quality and fresh feed in silage form. This feed was formulated from wheat straw and banana wastes with broiler litter, with whey or diluted molasses added as substrate for microorganisms responsible for the ensiling process. The present work used the chosen wastelages as feed for lactating buffaloes and studied effects on milk yield, milk composition and some parameters of blood plasma.

MATERIALS AND METHODS

Materials of study

Green banana wastes were obtained from banana farms at Om Dinar, Embaba, Giza province. The wastes were cut into lengths of about 15 cm and sun-dried. Rice straw (10-15 cm) and wheat straw (2-3 cm) were obtained from the store of crop residues at Elbhr-Elaazm street, Giza province. Dried broiler litter (wheat straw base) was obtained from Shalakan farm, El-Kanater El-Khiria, Kalubia Province. Sweet whey was obtained from Domitti Company at 6 October

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Table 1. Chemical composition, fiber fractions and calculated nutritive value of diet ingredients (% on dry matter basis)

Items	Roughages					Concentrate feed mixture
	Rice straw	Wastelages				
		BL-B-M (T1)	BL-WS-M (T2)	BL-B-W (T3)	BL-WS-W (T4)	
Dry matter	95.00	36.10	37.25	36.35	36.95	93.20
CP %	2.09	14.47	11.87	14.94	12.51	14.47
CF %	34.98	19.76	22.20	18.54	20.96	14.11
EE %	1.03	2.10	2.01	2.55	2.48	2.45
NFE %	48.71	46.24	48.70	48.52	50.87	58.17
Ash %	13.19	17.43	15.22	15.45	13.18	10.80
			Fiber fractions			
NDF %	74.87	45.67	48.24	45.00	48.40	38.50
ADF %	52.26	30.66	32.71	30.09	32.83	23.60
HC %	22.61	15.01	15.53	14.91	15.58	14.90
ADL %	6.33	3.61	3.86	3.64	3.98	5.95
C %	45.93	32.05	28.85	27.45	28.85	17.65
Starch value	0.26	0.42	0.38	0.36	0.35	0.55
Digestible CP	zero	9.21	7.66	9.71	8.13	10.5

BL=Broiler litter, B=Banana wastes, M=Molasses, WS=Wheat straw, W=Sweet whey, CP=Crude protein, NFE=Nitrogen-free-extract, NDF=Neutral detergent fiber, ADF=Acid detergent fiber, HC=Hemicellulose, ADL=Acid detergent lignin, C=Cellulose.

city, Giza province. Molasses was obtained from the sugar factory at El-Hwamdia city, Giza province.

The chemical composition and fiber fractions of the raw materials are shown in table 1.

Silage preparation

Dried banana wastes (B) or wheat straw (WS) and dried broiler litter (BL) were ensiled using two rehydration media (RM). The RM were molasses (1 part, 25% moisture) diluted with water (9 parts w/w), and whey (W, 93% moisture). The chosen silage formulae were applied in large bunkers (silos) lined with a layer of rice straw. The combinations were BL-B-M (bunker-1), BL-WS-M (bunker-2), BL-B-W (bunker-3) and BL-WS-W (bunker-4).

Mixtures of 500 kg dried material (200 kg of banana wastes or wheat straw mixed with 300 kg of dried broiler litter) and 1 ton of rehydration medium (diluted molasses, or whey) were mixed together on a 6×6 m plastic sheet, and stored layer by layer with pressing in 2×2×1 m cement silos. The silos were then sealed perfectly with plastic covers and left to ferment. After the fermentation period (8 wk), the bunker was opened. The quantities of silage offered to lactating buffaloes each day were removed from the silo, after removing spoiled silage, and the silo was then recovered.

Feeding trial

Twenty-five lactating buffaloes in the first week of lactation were used. The animals were randomly assigned among five experimental treatments of five animals each. The overall mean animal weight was 560-569 kg for the 5 groups. The experimental period extended to 17 weeks.

The intended ratio of concentrate to roughage was 70:30 on DM basis. Concentrate feed mixture (CFM) consisted of undecorticated cotton seed meal 25%, wheat bran 35%, yellow corn 30%, rice bran 4%, molasses 3%. limestone 2% and sodium chloride 1%. Control ration (C) was 70% CFM and 30% rice straw. Treated rations were 70% CFM, 15% rice straw and 15% (DM basis) wastelages: BL-B-M (52% BL, 35% B and 13% M on DM basis of wastelage) for treatment 1; 15% wastelages BL-WS-M (52% BL, 35% WS and 13% M for treatment 2; 15% wastelage BL-B-W (52% BL, 35% B and 13% W for treatment 3; and 15% wastelages BL-WS-W (52% BL, 35% WS and 13% W for treatment 4. Dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and ash for air dried ground samples were determined according to AOAC (1990) and NFE was determined by subtraction. Fiber fractions were determined according to Goering and Van Soest (1970).

The roughage portion the diets was given at 7 am and 2 pm after the animals were given access to fresh drinking water, and the concentrate portion was offered in two equal rations at milking times (8 am and 3 pm). Both roughage and concentrate allowances were adjusted according to any change in milk yield and live body weight. Animals were weighed monthly before morning feeding. The daily ration was offered

Table 2. Effect of the different experimental treatments on daily feed intake

Ingredients (kg/head/day)	Experimental treatments											
	Control		BL-B-M (T1)		BL-WS-M (T2)		BL-B-W (T3)		BL-WS-W (T4)		SE	
	Fresh	DM	Fresh	DM	Fresh	DM	Fresh	DM	Fresh	DM	Fresh	DM
CFM	10.84	10.08	10.70	9.95	10.67	9.93	10.66	9.91	10.74	9.99	-	-
Rice straw	4.55	4.32	2.29	2.18	2.28	2.17	2.27	2.16	2.31	2.19	-	-
Wastelage	-	-	5.33	1.92	5.41	1.95	5.37	1.93	5.42	1.96	-	-
Total intake	15.39[b]	14.40	18.32[a]	14.05	18.36[a]	14.05	18.30[a]	14.02	18.47[a]	14.13	0.63	1.80

[a,b] Means with different superscripts in the same raw were different ($p<0.05$). BL=Broiler litter, B=Banana wastes, M=Molasses, WS=Wheat straw, W=Sweet whey, DM=Dry matter, SE=Standard error.

individually according to each animal's requirement which was calculated according to Ghoneim (1964).

Sampling and analysis of milk

The animals were machine milked twice daily at 8.0 am and 3 pm. Milk yield was recorded daily during the experimental period. Immediately after each milking (morning and evening), milk samples were taken for acidity and pH determination. The sample for each animal was a mixed constant percentage of the evening and the next morning yield. Titratable acidity, pH, total solids (TS), fat, total protein (TP), ash and NPN contents were determined according to Ling (1963). Lactose content was determined by the method of Barnett and Abd- El-Tawab (1957). Solids-not-fat (SNF) content was calculated by the difference between total solids and fat content.

Sampling and analysis of blood

Three animals of each group were blood sampled monthly at about 4-5 hours after morning feeding from the jugular vein and collected directly in glass tubes containing EDTA to serve as anticoagulant. The plasma was then separated by centrifugation at 4000 rpm for 20 minutes and stored frozen at -18℃ until chemical analysis. Plasma total proteins were determined according to Henry (1964), urea (Patton and Crouch, 1977), glutamic-oxaloacetic transaminase (GOT) and glutamic-pyruvic transaminase (GPT) (Reitman and Frankel, 1957).

Statistical analysis

The Statistical Analysis System (SAS) (1989) was used for least square of variance for repeated measures of milk yield, milk composition, milk acidity, pH of milk, feed efficiency, plasma nitrogen metabolites, GOT and GPT.

The following model was applied.

$$Y_{iJK}=U+T_i+e_{ik}+W_j+(TW)_{ij}+E_{ijk}$$

Where, Y_{ijk}=observation on the k^{th} animal in the j^{th} week given the i^{th} treatment, U=population mean, T_i= an effect due to treatments, e_{ik}=Error I (animal within treatment), W_j=an effect due to weeks of lactation, $(TW)_{iJ}$=interaction (treatment × weeks of lactation), E_{ijk}= is a randomized error. The Tukey procedure (HSD test) was used to test the significance between means.

RESULTS AND DISCUSSION

Feed analysis and intake

Chemical composition, fiber fractions and calculated nutritive value [starch value (SV) and digestible crude protein (DCP)] of rice straw (RS), wastelages and concentrate feed mixture (CFM) are shown in table 1. Wastelages contained higher CP contents, SV and DCP and lower fiber and fiber fractions than those of rice straw. Obviously, all wastelage containing diets had approximately similar SV and DCP values whereas the control diet had the lowest SV (47%) and DCP (7.4%) as calculated from table 1.

Table 2 shows the increase ($p<0.05$) in total fresh matter intake in animals received wastelages compared to the control. This may be explained on the basis that wastelages had a higher content of moisture and smaller particle size than rice straw. However, no differences were detected between the experimental groups regarding total DM intake (DMI). This demonstrates that ensiled banana wastes (up to 5% of DMI) could be accepted as a new source of roughage for lactating buffaloes without any adverse effect on daily feed intake. The present results are in accordance with those obtained by Viswanathan et al. (1989). They concluded that banana stalk may be fed to sheep as a roughage without any apparent ill effect on DMI. The daily refusal amounts of wastelages (DM basis) ranged between 0.21 and 0.26 kg which may reflect that whey possibly act better as a mask of an undesirable taste of banana plant wastes. A similar effect of whey on palatability was noticed by Casper and Schingoethe (1986).

Feed efficiency

Feeding lactating buffaloes on wastelages as replacement for one-half of their roughage (on DM basis) did not affect feed efficiency (table 3) expressed as FCM/kg DMI. Feed efficiency of the whey-group

Table 3. Effect of the different experimental treatments on milk yield, milk composition and feed efficiency

Items	Experimental groups					SE
	Control	BL-B-M (T1)	BL-WS-M (T2)	BL-B-W (T3)	BL-WS-W (T4)	
Milk yield (kg/d)	8.2	8.13	8.26	8.35	8.58	0.91
4% FCM (kg/d)	11.71	11.73	11.92	11.94	12.09	1.01
Fat %	7.07	6.95	6.95	6.87	6.73	0.36
Fat yield (g/d)	560.6	558.4	568.3	567.2	571.2	43.6
Protein %	4.06	4.05	4.01	3.98	3.91	0.11
Protein yield (g/d)	323.8	326.7	326.4	331.4	333.7	33.6
NPN %	0.026^{b}	0.028^{b}	0.027^{b}	0.031^{a}	0.028^{b}	0.005
NPN yield (g/d)	2.09^{bc}	2.23^{b}	2.23^{b}	2.59^{a}	2.38^{ab}	0.77
Lactose %	4.80	4.82	4.82	4.85	4.89	0.25
Lactose yield (g/d)	387.0	393.4	399.5	406.5	422.5	56.2
Ash %	0.74^{c}	0.79^{a}	0.78^{ab}	0.77^{b}	0.78^{ab}	0.01
Ash yield (g/d)	58.9	63.6	64.2	63.7	66.7	7.60
SNF %	9.59	9.64	9.60	9.58	9.53	0.30
SNF yield (g/d)	767.2	781.9	795.5	800.2	818.2	123.3
TS %	16.66	16.60	16.55	16.45	16.26	0.33
TS yield (g/d)	1327.5	1343.0	1362.8	1368.8	1392.5	134.9
pH value	6.51b	6.56^{a}	6.56^{a}	6.58^{a}	6.60^{a}	0.03
Acidity %	0.171^{a}	0.166^{ab}	0.167^{ab}	0.163^{b}	0.156^{c}	0.013
Feed efficiency (FCM/Kg DMI)	0.81	0.83	0.84	0.85	0.85	0.05

BL=Broiler litter, B=Banana wastes, M=Molasses, WS=Wheat straw, W=Sweet whey, FCM=4% fat corrected milk, NPN=Non protein nitrogen, SNF=Solids-not-fat, TS=Total solids, DMI=Dry matter intake, SE=Standard error of means (40 samples from 5 animals each treatment). Means with different superscripts in the same raw were different (p<0.05).

was not significantly higher (p>0.05) than that of the molasses group. These results are in accordance with those noted by Khattab (1976).

Milk yield and composition

Averages of milk yield and its composition for the experimental groups are shown in table 3. The daily milk yields and 4% fat-corrected-milk (FCM) tended to be greater in the experimental group compared with control, but differences were not significant (p>0.05). This may reflect the decreased NDF intakes when wastelages were included in the diets. Beauchemin et al. (1994) suggested that milk yield decreased as dietary NDF increased.

Milk yield and FCM did not differ between groups that received wastelages rehydrated with whey and those that received wastelages rehydrated with molasses (table 3). Similar results were obtained by Casper and Schingoethe (1986).

Table 3 indicates that feeding lactating buffaloes on wastelages decreased milk fat content. The absence of differences between the four experimental groups might be explained by the observation that the ratios of acetic : propionic acids did not widely vary among the experimental groups; milk fat is affected by the molar proportions of the VFAs produced in the rumen (Davis, 1967; Kholif and Abo El-Nor, 1998). Fat content was slightly higher (p>0.05) in molasses groups than whey-groups. This result is negatively correlated with milk yield (table 3); this is in line with Khattab (1976). However, Casper and Schingoethe (1986) found that cows which received rations containing corn had lower (p<0.05) percentages of fat than those that received rations containing dried whey. The authors suggested that starch of corn proliferated the propionate producing microorganisms, while lactose of whey proliferated the butyrate-producing microorganisms. They added that butyrate can be used as a precursor of milk fat synthesis.

Means of experimental groups showed that feeding lactating buffaloes on wastelages insignificantly decreased milk protein content (table 3) and increased (p>0.05) milk protein yield. These findings are paralleled with protein intake of the experimental groups (table 2). Buffaloes which received wastelages containing molasses had insignificantly higher protein contents and lower (p>0.05) protein yield than those received wastelages containing whey. Protein contents (table 3) for molasses-groups (T1 and T2) and those for whey groups (T3 and T4), are in line with those obtained by Casper and Schingoethe (1986).

The NPN content of wastelages groups were similar for T1, T2 , T4 and control and significantly higher (p<0.01) for T3 than other groups. The highest significant values of both NPN content and NPN yield were recorded for T3. This result may be because

Table 4. Effect of the different experimental treatments on plasma parameters of lactating buffaloes

Items	Experimental treatments					SE
	Control	BL-B-M (T1)	BL-WS-M (T2)	BL-B-W (T3)	BL-WS-W (T4)	
Total proteins (g /dl)	7.41^{b}	7.43^{ab}	7.43^{ab}	7.45^{a}	7.43^{ab}	0.02
Urea (mg /dl)	32^{b}	35^{ab}	35^{ab}	41^{a}	37^{ab}	3.00
GOT (Unit/ml)	48.7^{d}	50.7^{c}	49.1^{d}	56.4^{a}	54.3^{b}	0.34
GPT (Unit/ml)	19.23^{d}	21.92^{b}	20.51^{c}	22.31^{b}	23.85^{a}	0.39

^{a,b,c,d} Treatments overall means with different superscripts in the same raw were different ($p<0.05$).
BL=Broiler litter, B=Banana wastes, M=Molasses, WS=Wheat straw, W=Sweet whey, GOT=Glutamic-oxaloacetic-transaminase, GPT=Glutamic-pyruvic-transaminase. SE=Standard error of means of 12 samples from 3 animals each treatment.

wastelages contained BL of high NPN content (Abo El-Nor and Kholif, 1993). Also, banana wastes had a higher content of NPN than other roughage sources (wheat straw and rice straw) (El-Shewy, 1998). The present results of milk NPN content are in line with those obtained by Khattab (1976).

The overall means of lactose content and lactose yield through the experimental groups were similar. This may be due to the similar level of energy intake for all groups.

Means of the experimental groups indicated that feeding lactating buffaloes on wastelages (up to 15% of DMI) tended to decrease milk TS content and increase TS yield though neigher effect was significant ($p>0.05$).

The inclusion of wastelages in the rations of milking buffaloes to replace half of their roughage did not affect significantly the SNF either as content or yield (table 3). This finding may show that feeding low NDF in wastelages was of no importance for SNF, and may be related to the similarity of energy intake by all animals. The results are in agreement with those reported by Khattab (1976) and Casper and Schingoethe (1986).

The lowest ($p<0.05$) milk ash content was recorded from the control group, while the highest was that for banana molasses group (T1). Generally, feeding lactating buffaloes on wastelages increased both milk ash content ($p<0.05$) and yield ($p>0.05$). Buffaloes of molasses groups had rather higher ash content but lower ash yield in their milks than those of whey groups, which may reflect the higher content of ash in molasses.

Feeding lactating buffaloes on wastelages up to 15% of DMI, increased ($p<0.05$) the pH values of milk (table 3). This may be paralleled with fat contents for all groups. Buffaloes receiving wastelages had significantly lower milk acidity (%) than those on control roughage. Also, buffaloes receiving wastelages rehydrated with whey had higher pH value and lower acidity of milk than those received wastelages rehydrated with diluted molasses. It should be born in mind that all values of pH and all percentages of milk acidity were within the normal range reported by El-Ashry et al. (1996) and Maark (1997) for healthy lactating buffaloes fed on common diets.

Plasma proteins, urea and transaminases

The differences among all experimental groups in total proteins were not significant; a difference ($p<0.05$) was only observed between control and T3 groups (table 4). These values could reflect that buffaloes in all groups had been fed on adequate levels of CP. The highest value of plasma proteins which was demonstrated for T3, paralleled with CP content in the ration of this group (table 1). Minute increase in plasma proteins was demonstrated for buffaloes receiving ensiled whey comparing with those receiving ensiled molasses (2% of DMI). This result is in line with that obtained by Khattab (1976).

Very small increases in plasma urea were demonstrated for buffaloes receiving wastelages. A significantly higher value was only observed for T3 versus control (table 4). Level of plasma urea in T3 is in line with level of milk NPN for this group (table 3). The present results of urea values may be explained on the basis that blood urea concentrations were unaffected by dietary urea but increased significantly with increasing the dietary CP (Knott et al., 1972).

Buffaloes of ensiled banana group had insignificantly higher plasma urea than those of ensiled wheat straw-group. This finding could be because rations containing ensiled banana wastes had higher CP content than those containing ensiled wheat straw (table 1). Feeding lactating buffaloes on ensiled whey resulted in minute increases in plasma urea, comparing with those fed on ensiled molasses. The present results are in an agreement with those reported by Khattab (1976).

Feeding lactating buffaloes on wastelages increased ($p<0.05$) the GOT concentration; the lowest percentage increase was observed in T2 while the highest increase was for T3 (table 4). These observations may be related to CP level in rations. Feeding wastelages increased ($p<0.05$) the activity of GPT. The lowest percentage increase was for T2 while the highest was for T4, not for T3 as it might be expected; no explanation is available. Buffaloes of whey groups had higher concentrations of both enzymes (GOT and GPT) than those of molasses groups. In all instances, however, concentrations of both enzymes in the present study were around those reported by others who fed lactating buffaloes on common diets at the same ratio of roughage to concentrate (Kholif, 1990; Maark, 1997). This finding may reflect normal function of liver.

The results demonstrate that banana plant wastes with some additives in silage form may be good untraditional roughage for lactating buffaloes without any adverse effect on milk production.

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