



## Effects of Molasses at Different Levels in Concentrate Supplement on Milk Yield of Dairy Cows Grazing *Setaria* Grass (*Setaria Sphacelata*) Pasture in Fiji

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**ABSTRACT :** Effects of different levels of molasses in a concentrate supplement on milk yield of cows grazing *Setaria* grass pastures were investigated. Thirty Friesian cows, 6-7 years old with mean pre-experimental body weight of  $428 \pm 6.5$  kg, in early stage of lactation were randomly allotted to five dietary treatments in a completely randomized design experiment that lasted for 126 days. Experimental dietary treatments were forage alone and forage/concentrate mixtures with molasses included at 0, 5, 10 or 15% levels designated as T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>, respectively. The parameters studied were voluntary dry matter (DM) intake, average daily live weight change (LWC), milk yield, body condition score (BCS) and apparent nutrient digestibility coefficients. The DM and energy contents of *Setaria* grass were low compared to the concentrate diets. Fibre fractions-NDF, ADF, ADL, hemicellulose and cellulose; and gross energy were higher in concentrate mixtures than in the forage. Total DM intake (forage+concentrate mixtures) was significantly higher ( $p < 0.001$ ) in cows on the concentrate mixtures. LWC was not significantly different ( $p > 0.05$ ) between the cows. Average milk yields were significantly different ( $p < 0.05$ ) between cows. Fat corrected milk (FCM) was similar among cows in the treatments. BCS was better ( $p < 0.001$ ) in cows on concentrate mixtures. Digestibilities of DM, CP, NDF, ADF, ADL, OM, and energy were significantly higher ( $p < 0.001$ ) in cows on T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub> than in those on T<sub>1</sub>. There were no significant differences in the digestibility of DM, CP, NDF, ADF and ADL ( $p > 0.001$ ) in cows on concentrate mixtures. This study therefore demonstrated that lactating dairy cows in Fiji need a level of readily fermented energy source such as molasses in their diets; however, a level above 10% is not nutritionally suitable for lactating dairy cows. Based on data on production parameters-milk yield, fat corrected milk, body condition score and apparent nutrient digestibility coefficients- molasses levels that range between 5-10% are recommended, however, 10% is the best and therefore recommended for inclusion in the concentrate mixture of lactating dairy cows on a basal diet of *Setaria sphacelata* in Fiji. (**Key Words :** *Setaria sphacelata*, Molasses, Fed Intake, Milk Yield, Dairy Cow, Nutrient Utilization)

### INTRODUCTION

In the South Pacific region, Fiji is the only small island country that has a well established dairy industry with the presence of the Rewa Co-operative Dairy Company milk processing facilities and a number of registered farmers. In 1996 the dairy industry was 27.4% self-sufficient in total milk fat equivalents. In 1996 there were 215 registered dairy farms and 179 of them supplied 11,900,000 litres of fresh milk to Rewa Co-operative Dairy Company. The

competition amongst the producers for necessary resources and infrastructure is very critical for the survival of the dairy industry.

The deregulation of the dairy industry in Fiji has therefore put pressure on farmers to increase production efficiency through supplementation to improve the poor nutritive value of local pastures. The efficiency of milk production from existing lactating cows is not optimized due to many associated factors especially nutrition that is based largely on local pastures and pasture/legume mixtures that are of poor nutritive value. Inadequate use of protein and energy supplements during the dry season (May-November) affect the milk yield.

For a target level of milk production from forages, daily-ingested young forage leaf and stem dry matter must have specified levels of protein (nitrogen), metabolizable

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**Table 1.** Percentage composition of experimental diets (Diets-level of molasses\*)

Feedstuff/Ingredients	0	5	10	15
Mill mix	53.0	43.0	34.0	25.0
Molasses	-	5.0	10.0	15.0
Dried brewers grain	5.0	10.0	14.0	18.0
Coconut meal	40.0	40.0	40.0	40.0
Salt (NaCl)	0.5	0.5	0.5	0.5
Premix <sup>1</sup>	1.5	1.5	1.5	1.5
Total	100.0	100.0	100.0	100.0

<sup>1</sup> ALROC Livestock mineral supplement (ALROC Companies, Australia) contains: Phosphorus 3,252 mg/kg; Potassium 3,787 mg/kg; Sulphur 1.32%; Calcium 5.30%; Magnesium 2.6%; Iron 1.81 mg/kg; Manganese 344 mg/kg; Copper 20.4 mg/kg; Zinc 52.2 mg/kg; Sodium 3.19%.

energy (ME), phosphorus, calcium, potassium, magnesium, sulfur, sodium and trace elements (FAO, 1998). Lactating cows have higher requirements for protein, metabolizable energy (ME), phosphorus, calcium and sodium than growing animals, therefore to achieve high milk production in the Southwest Pacific region dairy cows require better quality pastures and good supplementary feeds. The need to match livestock production with available feed resources requires the supplementation of low quality pastures with cheap concentrate diets that can be formulated using locally available feedstuffs.

Large quantities of by-products that are usually available in the tropics can be used to supplement the lactating dairy cow during the dry season. However, the use of crop residues and agro-industrial by-products has not been fully explored rather they are only partially used or discarded resulting in lost of valuable potential feed sources. With proper treatment and storage by-products and crop residues could provide a satisfactory source of nutrients for livestock supplement during the dry season (O'Donovan et al., 1972) however, it is usually difficult to maintain a continuous supply for the entire year (Aregheore, 2000).

Molasses, one of the by-products of the sugar cane industry is a valuable source of energy, and is often either under utilized or exported at a low price. When used in livestock rations, frequently much less than its maximum value is obtained because it is fed with unsuitable feedstuffs and in unbalanced diets especially at the on-farm situation. Molasses is an energy feed, free of fat and fibre and contains little protein. It is mainly used to improve appetite of animals or add extra energy when prices of molasses are lower than that of other energy sources. Energy is the most limiting nutritional factor affecting reproduction and production of dairy cows in Fiji. The aims of this study therefore are to investigate the effect of inclusion of molasses at different levels in concentrate supplement on milk yield and also to determine the effects of supplementary feeding on voluntary dry matter intake, live weight gain, body condition score and apparent nutrient digestibility coefficients of cows grazing *Setaria* grass pasture in Fiji.

## MATERIALS AND METHODS

### Site

The experiment was carried out at the Koronivia Research Station-Livestock Research Unit, Nasouri (18°S, 178°30' E) situated 19 Km north of Suva at an altitude of about 15-m above sea level. The mean annual rainfall and temperature are 3,050 mm and 24.4°C, respectively.

### Animals, diets and experimental design

Thirty milking cows (Friesian), 6-7 years old, mean pre-experimental body weight of 428±6.48 kg and in their early stage of lactation were allotted randomly to five dietary treatments in completely randomized design with six replications. Each cow was ear tagged for individual identification purposes and represented an experimental unit.

The treatments were forage alone and forage/concentrate mixtures with molasses included at 0, 5, 10 or 15% levels and they were designated as T<sub>1</sub>-Forage alone (*Sateria sphacelata*); T<sub>2</sub>-Forage/concentrate without (0%) molasses; T<sub>3</sub>-Forage/concentrate with 5% molasses; T<sub>4</sub>-Forage/concentrate with 10% molasses; T<sub>5</sub>-Forage/concentrate with 15% molasses. The feedstuffs and ingredients used for the concentrate diets were dried brewer's grains, mill mix, copra meal, salt, micro-ingredients and molasses. The concentrate mixtures were formulated to contain 18% CP on DM basis, the level considered optimal for dairy cows raised under the tropical conditions of Fiji (Crest Feed, Suva, Fiji, 2002). Table 1 presents the percentage composition of the concentrates.

### Feeding and management

**Grazing :** The experiment started in August 19, 2002 and ended in December 22, 2002 (126 days). An adaptation period of 15 days was allowed the cows to get used to the treatments before data collection. The cows were grazed in 16 night paddocks composed of *Setaria (Setaria sphacelata)* as the main grass. The paddocks were stripped depending on their size and the cows grazed the paddocks on rotational basis for 25-28 days. During the day, the cows were grazed on three stripped paddocks located near the milking shed on a 15-18 days rotation. The cows had access to fresh clean drinking water and mineral lick blocks.

Representative herbage samples of what the cows ate were collected at the beginning, middle and end of the experiment. The samples were dried, processed and stored until required for chemical analysis. Voluntary herbage intake of cows in the paddocks was estimated as:

$$\text{Faecal output (kg/d)} = \frac{\text{Faecal output (kg/d)}}{1 - \text{herbage digestibility}}$$

**Concentrate feeding and management :** The diets were prepared on a weekly basis from the same batch of feedstuffs and ingredients. During each milking time at 0600 and 1500 h, 300 g of the concentrate was given to avoid spillage. The rest of the concentrate portion (7.4 kg) for each cow was given after the morning and evening milking in individual feeding stalls before they were returned to the paddocks for grazing. The amounts of concentrate offered in the feeding stalls were estimated at the ratio of 2 litres of milk to 1 kg of concentrate (Samson, 1993). Concentrate mixtures offered to the cows were reduced or increased depending on intake and refusals recorded on a daily basis to determine actual intake. Total feed intake for each cow was the sum of voluntary forage intake and concentrate mixture offered.

**Milk yield and composition :** Milk yield was recorded daily during the morning (0600 h) and evening (1500 h) milking sessions to determine actual daily milk yield using the Waikato Milk Meters, (Waikato, NZ) to determine actual daily milk production. Milk samples were collected into 200 mls cylindrical sampling bottles (Becton Dickson, NZ) from cows in each treatment and fat corrected milk (FCM) was calculated as:  $FCM = (15 \times FAT/100 + 0.4) \times MILK$ . Where:

FAT = milk fat percentage (%)

MILK = milk yield (kg)

**Live-weight gain and body condition score :** Cows were weighed at the beginning of the experiment and biweekly immediately after the morning milking. Live-weight gain was calculated as live-weight at 126 days-live-weight on day 0. Body condition score (BCS) was assessed visually at the start and end of the experiment using 1-5 condition scoring system (Selk, undated). BCS of cows was evaluated according to treatment.

**Digestibility studies :** The procedure of Parker et al. (1990) was used for the digestibility study. In brief: intra-ruminal chromium controlled release capsule (CRC, Captec (NZ) Ltd., Auckland) was administered orally to the cows using a dosing gun to stabilize the chromium release rate in the rumen. Towards the end of the trial (days 122-126) faeces were collected by grab sampling twice a day. Faecal samples were dried in a forced -air oven at 70°C for 48 h before chromium level was determined. Apparent nutrient digestibility coefficients of cows in concentrate mixtures with molasses at 0, 5, 10 and 15% levels was calculated from the method used for mixed diets outlined by Crampton (1956) as follows:

$$S = \frac{100(T-B)}{s} + B$$

Where, S = digestibility of the concentrate supplement

B = digestibility of the basal diet (forage from grazing)

T = digestibility of the mixed diets i.e. concentrate supplement and basal diet (forage from grazing)

s = proportion of concentrate supplement in the mixed diet.

Feed refusals were collected each day, weighed and dried in a forced-air oven at 70°C for 48 h. The processed samples of herbage, concentrate diets and feces were bulked separately and milled with a laboratory mill (Chris and Norris Ltd; Process Engineers, Chelmsford, UK) to pass through 1.77 mm sieve and stored in air tight plastic bottles until required for analysis.

**Analytical methods :** The AOAC (1990) procedure was used for proximate chemical analyses of available nutrients in the forage, concentrate diets and fecal samples. DM was determined by drying at constant weight at 70°C for 24 h in a forced-air oven, ash by incineration at 600°C for 2 h, protein by the micro-Kjeldahl procedure (N $\times$ 6.25) (Procedure ID Number 954.02). Fibre fractions, neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin, cellulose and hemicellulose were determined by the procedures of Van Soest et al. (1991). The NDF was assayed with sodium sulfite, without alpha amylase and was expressed with residual ash. The gross energy (MJ/kg) values were determined using a bomb calorimeter (Adiabatic bomb, Parr Instrument Co. Molin, IL, USA), with thermochemical benzoic acid as standard. All analyses were completed in triplicate.

**Statistical analysis :** The experiment was a completely randomized design with five dietary treatments and data on voluntary dry matter intake (DMI), growth rate, milk yield, body condition score and nutrient digestibility were analyzed using standard analysis of variance (ANOVA) using MINITAB (2000) statistical software. The LSD procedure was used to separate means in the presence of a significant difference ( $p < 0.05$ ;  $p < 0.001$ ), F-test for treatment.

## RESULTS

### Proximate analysis of diets

Chemical composition of the forage (*S. sphacelata*) and experimental concentrate mixtures is presented in Table 2. Dry matter (DM) content of the forage (T<sub>1</sub>) (15.8%) was significantly ( $p < 0.05$ ) lower than those of the concentrate mixtures (T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>). Crude protein (CP) content of the concentrate mixtures was in the range of 18.0-18.2% compared to 11.1% for forage. Fibre fractions (NDF, ADF, ADL, hemicellulose and cellulose) were higher in T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub> than in T<sub>1</sub>. However, among the concentrate diets T<sub>2</sub> (0% molasses concentrate diet) had higher NDF than T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>. Gross energy (MJ/kg DM) content of the forage

**Table 2.** Chemical composition of forage and experimental concentrates

Components	Concentrates <sup>a</sup>				
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>
Dry matter-DM (%)	15.8	89.5	88.9	88.7	88.6
On dry matter basis					
Crude protein	11.1	18.1	18.0	18.0	18.2
Ether extract	2.7	5.3	6.3	6.3	6.4
Ash	12.2	6.4	6.6	6.8	7.1
Neutral detergent fibre	27.1	38.2	36.5	34.6	33.9
Acid detergent fibre	12.5	20.2	20.4	20.5	20.8
Acid detergent lignin	6.8	10.7	10.8	10.8	10.9
Hemicellulose	14.6	18.0	16.1	14.1	13.1
Cellulose	5.7	9.5	9.6	9.7	9.9
Organic matter	87.8	93.6	93.4	93.2	92.9
Gross energy (MJ/kg DM)	15.9	16.3	16.7	16.7	16.2
Metabolizable energy	13.0	13.4	13.7	13.7	13.3

<sup>a</sup> T<sub>1</sub>: Forage alone (*Setaria sphacelata*); T<sub>2</sub>: Forage/concentrate without (0%) molasses.

T<sub>3</sub>: Forage/concentrate with 5% molasses; T<sub>4</sub>: Forage/concentrate with 10% molasses; T<sub>5</sub>: Forage/concentrate with 15% molasses.

**Table 3.** Performance characteristics of lactating dairy cows fed forage alone or forage/concentrates with different levels of molasses

Parameters	Concentrates <sup>a</sup>					SEM	LSD	Sign.
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>			
No of cows	6	6	6	6	6	-	-	-
Initial live-weight (kg)	430	430	433	426	426	6.5	-	-
Final live-weight (kg)	447	455	457	451	449	6.7	-	-
Weight gain	17	25	24	25	24	2.1	16.24	NS
Average daily gain (ADG, g/d)	134	194	193	196	193	0.02	0.13	NS
Forage intake (kg/d)	10.5	9.2	8.7	8.6	8.1	0.43	3.31	NS
Concentrate (kg/d)	-	5.9	5.9	6.1	6.5	0.43	0.78	NS
Total dry matter intake (kg/d) (Forage+concentrate)	10.5	14.9	14.6	14.6	14.6	0.49	3.16	*
Percentage of forage intake	100	60.9	59.6	58.2	55.8	-	-	-
Percentage of concentrate intake	0	39.1	40.4	41.8	44.2	-	-	-
Average milk yield (litres)	914.8	924.5	1,221.4	1,418.4	1,017.9	56.2	371.6	*
Average daily milk yield (litres)	7.3	7.3	9.7	11.3	8.1	0.45	2.95	*
Fat corrected milk (kg) FCM	6.3	6.3	8.4	9.2	6.8	0.37	2.47	*
Body condition score (BCS)	2.5	3.3	4.0	4.1	3.5	0.11	0.46	***

<sup>a</sup> T<sub>1</sub>: Forage alone (*Setaria sphacelata*); T<sub>2</sub>: Forage/concentrate without (0%) molasses.

T<sub>3</sub>: Forage/concentrate with 5% molasses; T<sub>4</sub>: Forage/concentrate with 10% molasses; T<sub>5</sub>: Forage/concentrate with 15% molasses.

SEM: Standard error of mean; LSD: Least significance difference.

NS: Not significant, \* \*\* \*\* p<0.05 and p<0.001 respectively.

(15.9 MJ/kg DM) was close to those of the concentrates that were in the range of 16.2-16.7 GE MJ/kg DM.

#### Dry matter intake, average daily gain, milk yield and body condition score

Performance characteristics of cows in the different treatments are presented in Table 3. Forage dry matter intake (DMI) of cows in T<sub>1</sub> (forage alone) was higher than cows on T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>, however the differences observed were not statistically significant (p>0.05). Concentrate dry matter intake increased with increase in the level of molasses, but intakes were not statistically significant also (p>0.05).

Total DMI (forage+concentrate) was significantly higher (p<0.001) for cows on concentrate mixtures than those on forage only. However, differences among

concentrate mixtures were not significantly (p>0.001) different from each other. The percentage of forage DM intake was higher than concentrate DM intake for cows on forage/concentrate with or without molasses.

Average daily live-weight gains (ADG) of cows were 134, 194, 193, 196 and 193 g/d for T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>, respectively, but were not statistically different (p>0.050) from those of cows on forage alone. Average milk yield of cows was 914.8, 924.5, 1,221.4, 1,418.4 and 1,017.9 l for cows on dietary treatments T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>, respectively. Cows on T<sub>1</sub> (forage alone) had the lowest milk yield.

Milk yield was highest in cows that received dietary treatment T<sub>4</sub>. This was followed by those in T<sub>3</sub>, T<sub>5</sub> then T<sub>2</sub> respectively. Average milk yield among the dietary treatments were significantly different (p<0.05) from each other and the milk yield of cows in T<sub>4</sub> was 503.6, 493.9,

**Table 4.** Apparent nutrients digestibility of cows fed forage alone or forage supplemented with concentrate with varying levels of molasses

Nutrients (%)	Concentrates <sup>a</sup>					SEM	LSD	Sign
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>			
Dry matter	0.566	0.595	0.612	0.706	0.689	0.105	2.21	***
Crude protein	0.578	0.665	0.672	0.677	0.658	0.11	0.86	***
NDF	0.518	0.635	0.642	0.646	0.629	0.09	0.52	***
ADF	0.513	0.627	0.630	0.660	0.623	0.09	0.82	***
ADL	0.506	0.617	0.626	0.627	0.617	0.08	0.78	***
Organic matter	0.524	0.616	0.622	0.697	0.633	0.10	0.74	***
Energy	0.521	0.607	0.616	0.659	0.619	0.08	0.73	***

<sup>a</sup> T<sub>1</sub>: Forage alone (*Setaria sphacelata*); T<sub>2</sub>: Forage/concentrate without (0%) molasses; T<sub>3</sub>: Forage/concentrate with 5% molasses;

T<sub>4</sub>: Forage/concentrate with 10% molasses; T<sub>5</sub>: Forage/concentrate with 15% molasses.

NDF: Neutral detergent fibre; ADF: Acid detergent fibre; ADL: Acid detergent lignin.

SEM: - standard error of mean; lsd- least significance difference.

Level of significance \*\*\* p<0.001.

197 and 400.5 higher than those of cows in T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, and T<sub>5</sub>, respectively. Fat corrected milk (FCM) among the treatments was not significantly different (p>0.05) from each other.

Body condition score (BCS) of cows in T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub> were 2.5, 3.3, 4.0, 4.1 and 3.5, respectively and was significantly different (p<0.001). Dietary treatments had significant influence on BCS of the cows. Comparatively cows on T<sub>3</sub> and T<sub>4</sub> were better in BCS than those in the other three dietary treatments.

#### Apparent nutrient digestibility coefficients

Table 4 present data on apparent nutrient digestibility coefficients of cows in T<sub>1</sub> (forage alone-*S. sphacelata*) and T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub> (forage/concentrates with molasses at 0, 5, 10 and 15% levels), respectively. The digestibilities of DM, CP, NDF, ADF, ADL, OM, and energy were significantly higher (p<0.001) for cows in T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub> than those on T<sub>1</sub>. Among cows that received the concentrate mixtures there were no statistically significant differences in the digestibility of DM, CP, NDF, ADF and ADL (p>0.001). Except for the digestibility of organic matter (OM) and energy that were significantly higher (p<0.001) for cows in T<sub>4</sub>, the digestibility of other nutrients were observed to decrease with increase in levels of molasses inclusion in the concentrate mixtures.

## DISCUSSION

Information on many tropical feeds and pasture species are not readily available and this has hindered efforts to design appropriate livestock feeding standards in the tropics using locally available feed resources (Harris and Kearn, 1978; Aregheore, 2000).

Dry matter (DM) and CP contents of the *S. sphacelata* used in this trial are in agreement with values reported by Gohl (1981). CP content of 11.1% suggested that the herbage was of medium quality. Compared to most tropical

grass species the fibre fractions were low, however its energy value was consistent with estimates for forages fed to ruminant livestock in other tropical countries (Butterworth, 1964). Compared to other grass species in Fiji, *S. sphacelata* has high dry matter yield, nutritive value, palatable, productive and persistence and these qualities have over the years attracted dairy farmers in Fiji to its usage (Ranacou, 1985).

All the concentrate mixtures had similar DM content, CP and GE contents; and the 18.0% CP content for the concentrate mixtures is the same as the level recommended (Crest Chicken Dairy Feed, Fiji 2002) to meet milk production requirements of lactating dairy cows in the tropical environment of Fiji. The CP content of the forage and concentrate mixtures are within levels suggested by NRC (2001) as adequate to meet the requirements of the live-weight of cows used in this experiment.

NDF indicates an index of bulk and it decreased with increasing levels of molasses in the concentrates due to the diluting effects of molasses. NDF content of the concentrate mixtures at 35.8% is below concentrations of 55-60% DM above which may affect efficiency of rumen environment and limit feed intake (Meissner et al., 1991). ADF content ranged from 20.2 to 20.8% and this was similar in value to minimum range of 19 to 21% recommendation as ideal in ruminant diets (NRC, 1989). However, all the concentrates had similar contents of organic matter and energy.

Estimation of voluntary DMI is important in nutritional studies because it establishes the amount of nutrients available to an animal for health and production (NRC, 2001) and this is influenced primarily by dietary and animal factors. DMI of the concentrate portions increased with subsequent level of molasses. Molasses is a concentrated plant juice, and as such contains a wide range of trace minerals, vitamins, sugars (sucrose, glucose and fructose, usually about 2:1:1) and is particularly rich in potassium and sulphur (Sudan and Leng, 1986). In this experiment molasses might have acted mainly to increase efficiency of

utilization of the diets. Improved DMI of cows in forage/concentrate mixtures is in agreement with Gill et al. (1981), and Yan et al. (1997), who reported higher total feed intake in diets of dairy cows supplemented with molasses. The level of molasses used in the concentrates was within the range reported by Hatch and Beeson (1972).

All the cows grazed the same paddocks on rotational basis therefore the differences in average milk yield cannot be attributed to differences in pasture quality. The cows supplemented with concentrate mixtures ate slightly less forage and this observation is in conformity with Spiekens et al. (1991) who reported that higher intake of concentrate lowered the intake of forage.

The cows on forage/concentrate mixtures were higher in average milk yield and this demonstrates that supplementary feeding of milking cows is one way to obtain higher milk yield of the existing dairy cows in Fiji. Fiji has an unlimited supply of molasses and every cow in milk can get two or three kilogram of molasses/day. Samson, (1993) in Fiji reported that a mixture of molasses and urea was an ideal supplementary feed and can contribute immensely to higher milk production

The milk yield of cows on forage/concentrates compared to cows on forage alone is in agreement with Sawal and Kurar (1998) and Kumar et al. (2005) who reported higher milk yield with higher input of concentrate with straws and hays as roughage. Yan et al. (1997) reported improvement in milk production with dietary molasses inclusion of up to 250 g/kg DM. In this trial cows on forage/concentrate with 15% molasses had lower milk yield than those on forage/concentrates with 5 and 10% molasses respectively. This seems to indicate that lower levels of molasses would improve milk yield than a higher level. Lofgreen and Otagaki (1960) reported that diets that constitute more than 10% molasses reduces milk yield. However, this contradicts the reports of Murphy, (1999) and Yan et al. (1997) that the inclusion of molasses at 26% and 31%, respectively in total DM in a complete diet of grass silage/concentrate significantly increased milk yield and protein concentration.

Data on average daily milk yield of cows is higher than the national average daily milk production of cows in Fiji (Singh et al., 1985; FAO, 1991; Rokomatu, 2001). This demonstrates that the inclusion of molasses at 5 to 10% levels in concentrate mixtures was ideal as supplement for improved milk yield to grazing cows on *Setaria sphacelata* in the tropical environment of Fiji. However, FCM among the treatments are lower than values reported by Wang et al. (2004) and Kumar et al. (2005) for dairy cows. Diets and environmental conditions might be responsible for the differences observed in FCM.

The amount of fat deposited on an animal's body contributes to what is referred to as body condition.

Visually and meaningfully, the best indicators of body condition are the amount of fat on the backbone, hips and ribs and around the base of the tail (i.e., at the junction of the tail with body) and the prominence of the pin bone (Domeoq et al., 1997).

BCS followed the pattern of ADG of the cows. The differences obtained between cows in the different dietary treatments suggested variation in the efficiency of utilization of energy released during digestion. The low BCS of cows on forage alone and forage/concentrate without (0%) molasses indicated that the cows utilized all absorbed nutrients from the forage for maintenance and milk production; and therefore had little to store as fat. The above observation also suggested a repartitioning of nutrients from body fat to other tissue compared to cows on forage/concentrate mixtures with molasses at 5 and 10% levels.

The cows that received forage/concentrates with 10 and 5% molasses had higher OMD compared to other dietary treatments. This might be the reason for the corresponding low milk yield and live-weight gain obtained for cows on the other treatments. Comparatively there was decrease in OMD for cows in concentrate mixture with 15% molasses.

Among the cows on the forage/concentrate mixtures with molasses, the digestibility of the fibre fractions (NDF, ADF, ADL) were lowest with cows on forage/concentrate mixture with 15% molasses. The feeding of molasses at higher levels has been reported to decrease ruminal fibre digestion (Khalili and Huhtanen, 1991; Osuji et al., 1995; Hall, 2003) and cellulose digestion, (Sutton, 1981; Sutton 1979). The low digestibility of NDF and ADF in cows on forage/concentrate mixture with 15% molasses could not be due to the level of protein because all the concentrates had close CP values, but could rather be related to the level of molasses. The depression in fibre digestion may therefore be attributed to low ruminal pH. However, the digestibility of NDF, ADF and ADL of the concentrates was above 60% level, indicating that the level of protein in the concentrates was nutritionally adequate to facilitate the effective digestion of the fibre fractions by rumen microbes.

As an interim measure, the feeding of molasses and coconut meal in addition to other agro-industrial by-products in Fiji may prove to be economical at improving local dairy production, thus saving foreign exchange. Inclusion of a small percentage of molasses improves the palatability of the diet and was particularly valuable when incorporated with coarse unpalatable roughages. The addition of molasses to forage and urea treated whole crop wheat increased total DMI in lactating cows, however this was not the case with concentrate (Sutton et al., 2001).

While molasses have been used successfully in developed countries for feeding livestock, the recommendation has been that it should not form more than

10% of the ration. Lofgreen and Otagaki (1960a, b) found that diets containing more than 10-15 percent molasses had less net energy although this may vary with total feed ration composition. Morrison (1967) suggested that the maximum limit of molasses in the diet should be 10 percent, since at higher levels of 30-40 percent its feeding value could decline by almost 50 percent.

Contrary to the reports of Lofgreen and Otagaki (1960a, b) and Morrison (1967), Hatch and Beeson (1972) reported that replacing 10 and 15 percent molasses increased nitrogen retention, energy and DM digestibility; and the level of butyric acid in the rumen was significantly increased by higher percentages. Large quantities of cane molasses are produced in tropical areas therefore it is important to explore the possibility of using higher than conventional levels.

In the present study the inclusion of molasses did not reduce energy and CP digestibility an indication that available energy and CP in the concentrates were efficiently utilized for production purposes. The concentrate mixtures were similar in CP and energy and these may be responsible for the similarities in nutrients digestibility compared to forage alone. However, the digestibility of fibre fractions (NDF, ADF and ADL) was high and within the same range for cows on the forage/concentrate mixtures Overall, apparent nutrients digestibility of cows on the forage alone (*Setaria sphacelata*) were above 50% and this demonstrated that the *Setaria sphacelata* used was of medium nutritive quality and therefore could be used as a basal diet for lactating dairy cows. The cows effectively utilized the concentrate mixtures with molasses for maximum ADG and milk production.

The cows were healthy throughout the experiment and there was no incidence of reduced milk yield, scouring in some cows and incidence of ketosis (Losada and Preston, 1974) indicating that the levels of molasses used were not detrimental. The inclusion of molasses at high levels has been noted to decrease milk production (Wood, 1990), cause health problems including sub-clinical ketosis (Losada and Preston, 1974) molasses toxicity and loose feces that is often associated with diarrhoea.

## CONCLUSION

Compared to what operates at the specialized dairying units in Fiji, the overall milk production and body condition scores of cows offered the molasses concentrate diets were higher than the national standard. In most dairy farms in Fiji, there are no laid down feeding standard with respect to the quantity of molasses, mill mix and copra meal that could be mixed as supplements to lactating dairy cows grazing *Setaria* or other grass species. The effective inclusion of brewers' dry grains in the concentrate diets used in this trial

also contributes to the list of feed resources for dairy animals however this is not presently used in large quantities in Fiji. Data obtained in this trial indicates that milk yield from cows consuming concentrate diets was higher than those on forage alone.

A comparison of the concentrates indicated that concentrates with molasses were better in average daily milk yield, fat corrected milk and body condition score and this demonstrate that the incorporation of molasses with concentrates can improve daily milk yield, fat corrected milk and body condition score of lactating dairy cows. However, among the concentrates, cows on concentrates with 10% molasses were best in average daily milk yield, fat corrected milk and body condition score, followed closely by those with 5% and the lowest with 15% molasses.

This study therefore demonstrated that lactating dairy cows in Fiji needs a level of readily fermented energy source such as molasses in their concentrate mixtures, however a level above 10% would not be nutritionally suitable for lactating dairy cows. Based on data on production parameters; milk yield, fat corrected milk, body condition score and apparent nutrient digestibility coefficients, molasses levels in the ranges of between 5-10% are recommended, however 10% is the best and therefore recommended for inclusion in the concentrates of lactating dairy cows on a basal diet of *Setaria sphacelata* in Fiji.

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