

DEVELOPMENT AND FIELD EVALUATION OF ANIMAL FEED SUPPLEMENTATION PACKAGES FOR IMPROVING MEAT AND MILK PRODUCTION IN RUMINANT LIVESTOCK USING LOCALLY AVAILABLE FEED RESOURCES

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Abstract

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Molasses is a major by-product of the sugar industry in Mauritius and is still under-utilized for livestock production because of legislation and handling problems. A combination of urea, molasses and other feed ingredients can be used to produce urea-molasses multinutrient blocks (UMMB) that can be fed to livestock as a supplement. The main objective of UMMB supplementation is to provide a constant source of degradable nitrogen throughout the day, to promote growth of rumen microbes in ruminants fed poor quality forage. In Mauritius, studies were undertaken to evaluate the effect of UMMB supplementation on milk production, reproduction parameters and live weight change. Sixty cows were initially involved, 30 receiving UMMB over and above their normal ration and 30 constituting the control group. These studies have shown that UMMB improved milk yield of cows although the animals were already fed a dairy concentrate. Cows that calved resumed ovarian activity slightly earlier in the treatment group (67 ± 32 days) than those in the control group (73 ± 36 days). Body condition was not affected by UMMB supplementation.

1. INTRODUCTION

Natural fodder and crop residues such as sugar cane tops and leaves are important forage feeds in the livestock production systems in Mauritius. However, they are often of poor quality, usually deficient in protein and minerals. To improve production, the farmer should optimise the efficiency of utilisation of the available feed resources. This is done by the use of supplements that provide the deficient nutrients, especially protein. Some of these supplements can sometimes be produced using locally available ingredients and agro-industrial by-products such as sugarcane molasses and bagasse.

Molasses is a major by-product of the sugar industry in Mauritius. It is a good, palatable and cheap source of energy for ruminants. Use of liquid molasses by small farmers, however, is very limited due to problems related to transport, storage and legislation. One strategy to get over this obstacle and increase the use of molasses in the animal industry is through the manufacture of urea-molasses multinutrient blocks (UMMB). The technique consists of mixing the required feed ingredients in a container and pouring the mixture into moulds and leaving to solidify into blocks. This strategy of producing UMMB has been proposed in many countries by the FAO and the International Atomic Energy Agency (IAEA) in order to develop affordable and sustainable supplementation packages for improving the productivity of smallholder farms. UMMB can be fed through out year but are more beneficially utilised during the dry season or when the animals are grazing low quality

pastures. Major advantages of using the blocks are their convenience in terms of packaging, storage, transport and ease of feeding.

This project comprised of two phases. Phase I consisted of formulating and testing a feed supplementation package using locally available feed resources. Phase II dealt with field evaluation of UMMB as a supplement for lactating cows.

2. MATERIALS AND METHODS

2.1. Phase I. Development of Urea Molasses Multinutrient Blocks (UMMB) as a feed supplement for livestock production

The objectives were to produce a supplementary feed, convenient and easy to use, for improving milk and meat production, and to maximise the use of locally available feed materials to reduce high cost of concentrate feeds.

2.1.1. Development of UMMB

The ingredients and their respective amounts required to prepare UMMB can vary depending on their availability and cost, and also according to the objectives for which the blocks are to be utilised, i.e. for maintenance or production. Ingredients available locally are sugarcane molasses, urea, common salt and wheat bran. Other ingredients such as minerals, vitamins and a source of good quality protein like cottonseed cake are imported and are readily available on the local market. Cement is used as a binding agent.

Studies conducted in Canada and USA on the utilisation of cement and its by-products as minerals for animals have not revealed any negative effects when fed up to a maximum of 3% of the total daily dry matter intake [1]. Studies conducted at AREU using manufacturing procedures as described by Aarts et al. [1] resulted in several formulations that produced blocks of appreciable hardness. These formulations were later reviewed to optimise the utilisation of sugarcane molasses and decrease the proportion of cement thereby reducing the cost of production of the blocks.

2.2. Phase II. The effect of supplementing dairy cattle with urea-molasses multinutrient blocks (UMMB) on reproductive performance and milk yield and quality

Phase II of the project consisted of on-farm testing of UMMB blocks, as a feed supplement for dairy cows. The study was implemented at Bon Accueil/Lallmatie area where fodder quality and availability is a major constraint to production. The project commenced on 5th March 1998 and ended in October 1999.

The studies undertaken aimed at determining the effects of feeding UMMB to 7-month pregnant cows up to 4 months post-partum, on milk yield, milk quality, resumption of ovarian activity and body condition score.

2.2.1. Experimental animals

From a total population of around 1400 cows, 60 cows were randomly selected and gradually introduced to the study as and when they reached 7-month stage of pregnancy. These animals were then randomly allocated to 2 groups of 30 head each. One group constituted the treatment group (with UMMB) while the other was the control (without UMMB). Cows kept as control received mixed forages and a dairy concentrate. Those in the treatment group received in addition, a regular supply of UMMB as a supplement.

2.2.2. Feeds and feeding

All animals were stall-fed. The average smallholder unit consisted of 2–5 cows; only 4 farmers had 6–12 cows. The selected animals were given the basal diet as per the farmer's routine practice, which consisted of cut and carry forage, plus a small amount of dairy concentrate varying from 2.0 to 5.0 kg/animal per day. The forages consisted of mixed species, grasses, vines and leaves, and sugarcane tops during the harvest period. This diet was the control. The treatment group received, in addition to mixed fodder and the concentrate, a regular supply of UMMB as a lick, during the whole period of study, without interruption. The UMMB was placed on racks, which were fixed in front of the cow at a height of 30 cm above the floor to prevent contamination with urine and faeces. Blocks weighing 10–15 kg were used for convenience and their consumption was monitored weekly. All the animals got used to licking the blocks within an adaptation period of 2 weeks.

2.2.3. Monitoring of milk yield

Field visits were carried out once a week to monitor the intake of UMMB and the daily milk production. Milk production was recorded by the farmers on pre-designed sheets. These were checked on each visit for accuracy and consistency.

2.2.4. Parameters observed

The following parameters were observed and records maintained.

- UMMB intake of individual cows
- Milk production
- Assessment of cows for body condition score
- Estimation of live weights.
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Samples of milk were collected monthly for the analysis of quality. Proximate analysis was carried out on feed and UMMB samples collected regularly.

3. RESULTS

3.1. Phase I

The composition of a few formulations of UMMB are presented in Table I. Costs of production (in November 1999) include transport and labour for each formulation.

Table II shows the chemical composition of the block selected for on-farm trial (RF2) as against the original formulation. The mean calculated metabolizable energy (ME) value varied between 10.9 and 11.0 MJ/kg dry matter (DM) respectively, for the two blocks.

3.2. Trials for UMMB intake

Initially, 8 kg blocks were manufactured according to formulation B1. Intake trials were conducted with 2 groups of 8 adult Friesian heifers. UMMB was given together with a basal diet consisting of about 25 kg of fresh fodder and 2 kg of a dairy concentrate/head per day. Intake of UMMB ranged from 400 to 1300 g per head/day. There was no incidence of urea toxicity. No other adverse symptoms were observed.

TABLE I. SUMMARY OF FORMULATIONS AND THEIR COSTS OF PRODUCTION

Ingredients	Original formulation	Revised formulations (RF)		
	Block B1%	RF1%	RF2%	RF3%
Molasses	40	40	45	50
Urea	10	9	8	8
Mineral mixture	5	4	3	2
Salt	3	3	2	1
Cottonseed cake	5	6	6	5
Cement	17	12	12	12
Wheat Bran	20	26	24	22
Cost of production (MR/tonne)	3630	3514	3175	2900

MR: Mauritian Rupee (US \$ 1.00 = MR 25.00)

TABLE II. CHEMICAL COMPOSITION OF UMMB (% \pm SD) ON FRESH WEIGHT BASIS

Component	Block B1	RF 2
Dry Matter (DM)	77.7 \pm 4.2	83.2 \pm 0.4
Crude protein (CP)	27.5 \pm 2.3	30.3 \pm 0.7
Crude fibre (CF)	2.2 \pm 0.5	2.1 \pm 1.3
Ether Extract (EE)	1.4 \pm 1.5	0.3 \pm 0.2
Calcium (as Ca)	5.5 \pm 0.5	4.8 \pm 0.5
Phosphorus (as P ₂ O ₅)	1.4 \pm 0.2	2.1 \pm 0.1
Ash (other than Ca and P ₂ O ₅)	17.6 \pm 1.8	16.9 \pm 1.8

3.3. Phase II

In this experiment, 60 cows were initially involved but some were dropped due to unreliability of milk production records, deaths and sale to other regions.

3.4. Intake of UMMB

Intake of UMMB ranged from 200 to 2200g and the average intake observed was 706 \pm 495 g/head/day (n = 28). No adverse symptoms were recorded.

3.5. Milk Yield

The peak milk yields were attained as early as 2 weeks in some instances. However, all cows in both groups reached their peak milk production at 4 weeks post-calving. The mean peak milk yield at 4 weeks was 12.0 \pm 4.0 and 13.2 \pm 3.4 litres per head per day for UMMB-supplemented and non-supplemented groups, respectively. The average daily milk yield per head computed over 120 days of lactation was 10.9 \pm 3.0 (n = 20) and 11.7 \pm 2.7 (n = 23) litres respectively (P < 0.05), for the two groups.

3.6. Milk quality

Milk samples were collected on a monthly basis and analysed for solids, fat, protein and lactose. Figures were compared with standards as quoted by Schmidt [4] and the Ministry of Agriculture, Mauritius.

3.7. Resumption of ovarian activity

The interval from calving to resumption of ovarian activity was found to be 67 ± 32 days ($n = 22$) for animals in the treatment group and 73 ± 36 days ($n = 27$) for those in the control group. These differences were not significant. The longest interval was in the treatment group with 150 days while for the control it was 132 days.

3.8. Body condition score (BCS) and liveweight of animals under study

The condition scoring system was based on handling two areas of the cow to assess the level of fat cover, namely, the loin area and around the tail head. A condition score of 1.0 to 5.0 was adopted with a BCS of 1.0 indicating absence of fatty tissue in the pelvic and loin areas and a BCS of 5.0 indicating excessive fat.

Most cows in the study had fairly good body condition scores ranging from 2.5 to 3.5. During the first two months in milk the cows lost more than 0.5 points in the BCS, stabilising at a score >2.5 by 120 days. At around 200 days in milk, the BCS was close to 3.0 in both the treatment and the control groups of animals, indicating that body reserves that were lost in early lactation were being replenished.

Since it was not practical to use any form of weighing scale to weigh the stall-fed animals body weight was estimated visually.

3.9. Nutritive value of feeds

Feeds that were utilised were sampled regularly once a month for the analysis of dry matter (DM), crude protein (CP), crude fibre (CF), crude fat (EE), ash and nitrogen-free extract (NFE) by standard methods (Table III).

TABLE III. THE CHEMICAL COMPOSITION (% DM \pm SD) OF SOME FEEDS USED IN THE FEEDING TRIALS (ON DRY MATTER BASIS)

Feed	DM (%)	(% IN DM)				
		CP	CF	EE	Ash	NFE
UMMB	77.7 ± 4.2	35.4 ± 2.3	2.8 ± 0.5	1.8 ± 1.5	31.5 ± 4.1	28.5
Cowfeed concentrate	83.7 ± 2.7	16.2 ± 1.1	6.2 ± 0.8	2.2 ± 1.4	9.7 ± 0.5	65.7
Cottonseed cake	88.5 ± 4.9	44.9 ± 2.7	13.0 ± 1.7	9.6 ± 1.0	6.0 ± 0.3	26.5
Sugarcane tops	28.0 ± 5.3	6.4 ± 1.3	30.4 ± 2.9	3.2 ± 0.4	5.4 ± 0.9	54.6
Mixed fodder	29.0 ± 7.1	7.6 ± 3.1	34.1 ± 5.3	2.1 ± 0.7	6.6 ± 1.8	49.6

4. ECONOMIC ANALYSIS

Only the cost of UMMB supplementation has been considered since all other variable costs are the same for both groups. Following assumptions were made in the calculation of cost of production.

- ◆ Basal diet consisting of cut and carry forage at no cost to the farmer.
- ◆ The daily concentrate allocation to lactating cows is 3.0 kg/head although the recommended practice is to feed 0.5 kg concentrate per litre of milk produced. This item has not been computed as it is common to both groups.
- ◆ Labour cost is not included since it is predominantly family labour.
- ◆ Selling price of milk is Rs 9.00/litre.

4.1. Data used in analysis

Total milk production was estimated for the complete lactation period of 305 days (43 weeks) and was found to be 2892 and 2739 litres for UMMB-supplemented and non-supplemented cows, respectively. Assuming the total milk consumed by a calf to be 375 litres, amount of saleable milk for the two groups of animals were 2517 and 2364 litres, respectively. The mean daily intake of UMMB was 700 g/cow fed during a period of 365 days and the cost of production of UMMB (Block B1-Table 1) was Rs 3.63/kg.

Results show that the profitability per cow increased by Rs. 45000 with UMMB supplementation in the regions selected for the experiment (Table IV).

TABLE IV. ADDITIONAL REVENUE THROUGH SALE OF MILK IN A WHOLE LACTATION

	UMMB-supplemented cows Cost (Rs/cow)	Non-supplemented cows Cost (Rs/cow)
Purchases (UMMB)	927	-
Returns (Sale of milk)	22653	21276
Net Revenue/cow (Rs)	21726	21276
Additional revenue/cow (Rs)	450	-

5. DISCUSSION

The cows under study were of mixed breeds, mostly Friesian and Creole crosses. Most of the cows were in good condition as reflected by their body condition scores. The productivity of these animals is usually greatly constrained by the lack of good quality fodder, especially during the dry season. To improve production, most smallholder dairy farmers have adopted the practice of supplementing their animals with a dairy concentrate, locally referred to as "cowfeed". The major components of this dairy concentrate are sugarcane molasses, cotton seed cake, maize and wheat bran. Its high crude protein content (16.2% DM) and energy value (10.0 MJ ME/kg DM) make it an excellent supplement for dairy cattle. Over and above this supplement some farmers also feed cottonseed cake

In relation to milking, the farmers involved in the study adopted one of the following three systems:

- Partial milking: milking 3 teats and leaving 1 teat for the calf
- Partial milking: milking partially all 4 teats
- Complete milking and bucket-feeding the calf

As a consequence of these different practices, a correction factor was applied to the recorded daily milk production of each individual cow. An average quantity of 3 litres was added to the daily production of partially milked cows, disregarding any residual milk. Unlike temperate breeds of cattle which attain peak milk yields at about 6 weeks after calving, dairy cattle in the tropics tend to attain this peak as early as 2 to 4 weeks as found in the study. Moreover, this peak was not highly pronounced, and was close to the average daily milk yield per head as computed over 120 days of lactation. Although the weekly milk production during the first week of lactation was higher in the control group (82 litres) as compared to the treatment group (72 litres), the production was the same in the thirteenth week (Figure 1).

Using regression analysis of the weekly milk yields, a linear relationship was generated for each group of animals. The rate of decline in milk production over time was different for the two groups of animals. The treatment group showed a lower rate of decline (-0.695 litres/week) as compared to the control group (-1.5386 litres/week), an effect which could be attributed to the beneficial contribution of the UMMB supplement (Jayasuriya, Personal communication).

Treatment Group $Y = -0.695 X + 82.18$ ($R = 0.4$)

Control Group $Y = -1.5386 X + 96.78$ ($R = 0.7$)

Where,

Y = weekly milk yield (litres)

X = lactation period (week)

Milk yield (litres)

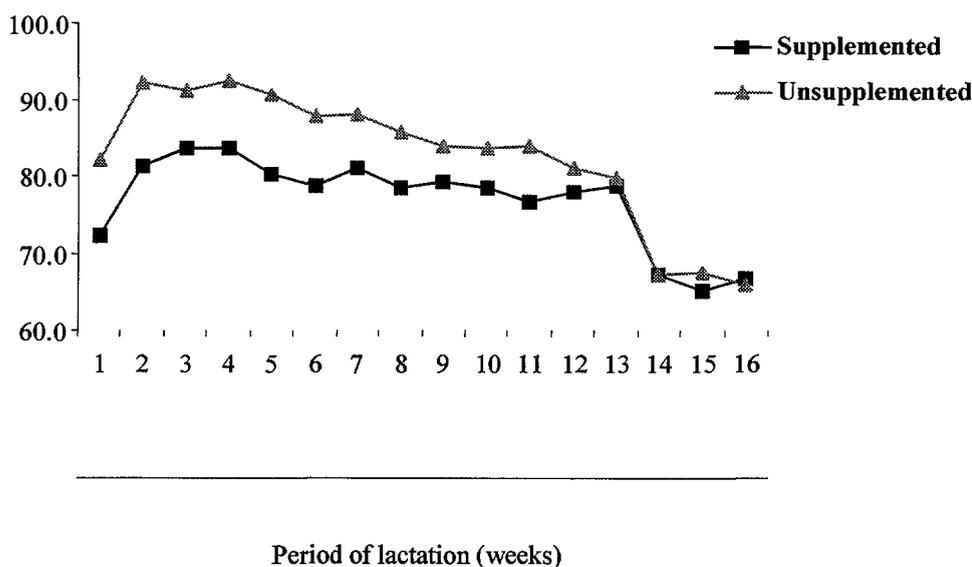


Figure 1: Milk yield of supplemented and un-supplemented group of cows.

The linear relationships generated by the regression analysis indicate a better fit in the control group as opposed to the treatment group. However, these relationships were useful in estimating the total milk produced by each group of animals over a whole lactation of 43 weeks. Accordingly, the average milk yield of UMMB-supplemented animals was estimated at 2892 litres and it exceeded that of non-supplemented ones (2739 litres) by 153 litres, ensuring a net financial benefit of Rs. 450.00 per cow, after taking into consideration additional expenses incurred for feeding UMMB.

Moreover, regarding basal feeds supplied to animals, forages and cane tops were of medium quality (6.0–7.6% CP and 30–35% CF on DM basis). Most animals were in good

body condition at calving. They had enough energy available for the synthesis of milk in early lactation, a time when the animal has a difficult time consuming enough forage to meet her maintenance and milk production requirements. Results obtained in Indonesia with UMMB supplementation showed that responses depend on the quality of the basal diet. Quick response to UMMB supplements is obtained when animals are fed rice straw. In a ration with high by-pass nutrients, the responses are negligible or even negative [2].

The fat content of milk in the treatment group during the first month (2.7%) and that of milk in control group in the first two months of lactation (3.2%) were quite low. Otherwise, all figures were comparable or higher than data quoted by Schmidt [4].

The UMMB supplementation appears to have a positive effect on the resumption of ovarian activity. Cows that calved resumed ovarian activity slightly earlier in the treatment group (67 ± 32 days) than those in the control group (73 ± 36 days). This compared favourably with findings by Hendratno [2] in Indonesia where UMMB supplemented cows showed resumption of ovarian activity at 85.3 ± 52 days against 88.5 ± 21 days for control animals. In Mauritius dairy cows resumed ovarian activity much earlier with or without UMMB supplementation compared to animals in West Java where animals were raised on straw-based diets.

6. CONCLUSION

Livestock is an important source of cash income at the smallholder level. The productivity of dairy cows is greatly constrained by the lack of good quality feed, especially during the dry season. Supplementation with the locally manufactured dairy concentrate is a common practice among smallholder farmers, with some even feeding cottonseed cake as an additional supplement to cows in lactation. Supplementation of cows already receiving some concentrates with UMMB marginally improved milk yield with a much slower rate of decline in the milk production than in the non-supplemented group. Also, there appeared to be an improvement in the reproductive performance of the animals, as observed from the resumption of ovarian activity. Feeding of UMMB to animals raised on low quality fodder may be an alternative to other forms of supplementation especially when these become unavailable or too expensive. UMMB may perhaps constitute an innovative feeding strategy for other species of livestock as well where concentrates feeding is not a common feature, namely in goat rearing and deer ranching.

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