Molasses/Urea Blocks

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Extract from FAO Tropical Feeds Database

Ruminant diets in most developing countries are based on fibrous feeds: mainly mature pastures (particularly at the end of the dry season) and crop residues (e.g. wheat and rice straw, maize and sorghum stovers). These feeds are imbalanced and particularly deficient in protein, minerals and vitamins; they are highly lignified their digestibility is low. These characteristics keep intake and productivity low.

The principles for improving the use of these poor quality roughages by ruminants include:

- satisfying the requirements of the rumen microorganisms to ensure efficient fermentation of fibre and increased production of microbial protein relative to volatile fatty acids;
- balancing the products of fermentative digestion with dietary nutrients (mainly through the use of bypass protein) to meet the needs of growth, milk, meat and wool production.

In practice this can be achieved by supplying, in order of priority:

1. A supplement of fermentable nitrogen and minerals.
2. A small amount (10 to 20 percent) of good quality forage, preferably a legume or grass cut at an early stage.
3. A small amount of a supplement containing materials that bypass the rumen: these include protein meal (e.g. toasted soya cake, solvent extracted groundnut cake) or starch based supplements (e.g. maize and sorghum).

This strategy is applicable in developing countries, e.g. in the Sahelian region of Africa, where ruminants are fed on pastures throughout the year with limited access to supplementary crop residues, or in Asia where they are fed mainly on rice straw and their diets are low in true protein for prolonged periods.

Mixtures of liquid molasses and urea, which provide fermentable nitrogen and are a good source of minerals, have been used for many years by ranchers in Australia and Southern Africa. Mineral licks (sometimes including urea) have also been extensively used in various parts of the world. However, small farmers have rarely benefitted from these supplements usually because of difficulties of handling these in small quantities. Molasses in the liquid form is difficult to transport (requiring expensive tanker trucks), to store (requiring tanks), to handle (it is highly viscous) and to distribute to animals (troughs or other receptacles being needed). Mineral licks which are usually imported are highly expensive and their cost/benefit ratio is often questionable.

By-pass nutrients, with the exception of legume leaves, come generally from rather expensive feeds which are either in demand for human nutrition (cereals) or exported for foreign exchange (oil cakes). However, because recent research has generally shown that their inclusion at a low rate in the diets is efficient, they should be economical to use in many situations.

Block Formulation

The blocks can be made from a variety of components depending on their availability locally, nutritive value, price, existing facilities for their use and their influence on the quality of blocks. They can also include specific components.

- Molasses provides fermentable substrate and various minerals and trace elements (but low amounts of phosphorous). Because of its pleasant taste and smell, it makes the block very attractive and palatable to animals. The degree Brix of the molasses should be as high as possible, and preferably higher than 85, to ensure solidification.

- Urea, which provides fermentable nitrogen, is the most important component of the block. Urea may increase the intake of straw by cattle by about 40 percent and its digestibility by 8 units (or 20 percent). The intake of urea must be limited to avoid toxicity problems but sufficient to maintain ammonia levels in the rumen consistently above 200 mg N/l for growth of microorganisms and high rates of degradation of fibre. Blocks are an excellent way of controlling intake and allow continual access.
- Wheat or rice bran has a multiple purpose in the blocks. It provides some key nutrients including fat, protein and phosphorus, it acts as an absorbent for the moisture contained in molasses and gives structure to the block. I may be replaced by other fibrous materials such as dry and fine bagasse or groundnut hulls which are finely ground but some loss of nutritive value occurs.
- Minerals may be added where appropriate. Common salt is generally added because this is often deficient in the diet and it is inexpensive. Calcium is supplied by molasses and by the gelling agent, calcium oxide or cement. Although phosphorus is deficient, there is no evidence that its addition is beneficial where animals are at below maintenance when grazing on dry mature pastures or fed low-quality forage. Mineral requirements are reduced at maintenance or survival levels. Deficiencies will generally become a problem only when production is increased, particularly when a bypass protein supplement is given and in these cases phosphorus should be included in that supplement.
- A gelling agent or binder is necessary in order to solidify the blocks. Although the mechanism of gelling is unknown, various products have been tried successfully: magnesium oxide, bentonite, calcium oxide, calcium hydroxide and cement.

The use of cement has raised some questions, from various nutritionists and extension workers, about possible negative effects on animals. In fact, research on the use of cement or its by-product, cement kiln dust, as a mineral supplement have not shown such adverse effects at levels of 1 to 3 percent of the total diet dry matter. (Nevertheless, the USDA has restricted the use of cement kiln dust since it could cause a deposit of heavy metals in animal tissue.)

- Various chemicals or drugs for the control of parasites or for manipulation of rumen fermentation (e.g. anti-protozoal agents, ionophores) can be added to the molasses blocks which can be an excellent carrier for these products.

Recent work has shown that the addition of small amount of rumen- insoluble calcium salts of long chain fatty acids could further increase the efficiency of the use of fibrous residues.

Finally, the formulae may vary according to the process adopted in manufacturing the block (Table 1).

Table 1. Examples of formulae according to manufacturing process

Process	Hot	Warm	Cold	Cold
Molasses	60	55	50	50
Urea	10	7.5	10	10
Common salt	-	5	5	5
Mg0	5	-	-	-
$C0_3Ca$	4	-	-	-
Bentonite	1	-	-	-
Ca0	-	10	5	-
Cement	-	-	5	10
Cottonseed meal or bran	20	22.5	25	25

The Manufacture of Molasses-urea Blocks

Different processes have been tried and can be grouped in three categories:

The "hot" process

This is the process which was first recommended in Australia. The molasses (60 percent) and urea (10 percent) were cooked with magnesium oxide (5 percent), calcium carbonate (4 percent) and bentonite (1 percent) at a temperature of 100-120 deg C for about 10 minutes. The content was brought to a temperature of about 70 deg C and mixture was left to cool slowly which enhanced solidification. It settled after some hours. The cooking was done in a double-jacketed rotating boiler with circulating water and steam.

The "warm" process

The molasses (55 percent) was heated to bring the temperature to about 40-50 deg C and the urea without water (7.5 percent) is dissolved in the molasses (Choo, 1985). The gelling agent was calcium oxide (10 percent). The rest was made up of common salt (5 percent) and bran (22.5 percent).

The inconvenience of these processes, particularly the "hot" one, is the necessity for providing energy for heating. However, if it is possible to use the hot molasses as it leaves the sugar factory or if an excess of steam is available, the cost of energy may be acceptable. The advantages are the reduction of time for setting and the finals product is not hygroscopic.

The "cold" process

It has been noted that, in tropical conditions, it was not necessary to heat the molasses in order to obtain a good block when 10 percent of calcium oxide was used as a gelling agent. This observation is of primary importance when blocks are manufactured in a unit separate from the sugar factory as was the case in Senegal.

The "cold" process involves a horizontal paddle mixer, with double axes, which is used to mix, in the following order of introduction, molasses (50 percent), urea (10 percent), salt (5 percent), calcium oxide (10 percent) and bran (25 percent). The mixture is then poured into moulds (plastic mason's pails or a frame made of four boards 2.5 m x 0.2 m). After about 15 hours, blocks may be removed from the mould and they may be transported by truck after 2 days.

Calcium oxide may be replaced by cement, but when cement is used it is important to mix it previously with about 40 percent of its weight in water, and common salt to be included in the block. This ensures its binding action, as the water in molasses does not seem to be available for the cement. The quality of the cement is of primary importance. Mixing the salt with cement accelerates hardening.

The disadvantage of the "cold" process is that it needs some time to set and the final product is somewhat hygroscopic. The advantages are the saving in energy, and the simplicity and ease of manufacture.

Independent of the process, the hardness of the block is affected by the nature and proportion of the various ingredients. High levels of molasses and urea tend to decrease solidification. The concentration of gelling agents and bran is highly important in the hardness of the final product. For example if the urea percentage is as high as 20 percent, molasses should be reduced to 40-45 percent and the gelling agent needs to be increased. Quick lime produces harder blocks than cement.

Feeding Molasses-urea Blocks to Ruminants

Factors affecting the intake of blocks

The hardness of the block will affect its rate of intake. If it is soft, it may be rapidly consumed with the risk of toxicity. On the other hand if it is too hard its intake may be highly limited.

High levels of urea may reduce intake of the block as well as of straw, urea being unpalatable (Table 2).

Table 2. Effect of urea content on intake of block and straw by lambs

Urea content of block, %	10	15	20
Block intake g/lamb/day	136	112	18*
Straw intake g/lamb/day	441	550	326

*4 out of lambs did not lick any of their block

Source: 621

The level of inanition or imbalance in minerals which lead to pica may result in excessive consumption in a short time also leading to urea poisoning. This has been noticed in at least one case in Senegal. Precautions should be taken to avoid this problem of over-consumption in drought prone countries particularly towards the end of the dry season when feed is scarce. The block should be introduced progressively, and it should be clear that the block, as it is presently formulated, cannot constitute the only feed and a minimum of roughage is necessary.

Where there is a bulk of dry feed the risk of toxicity from overconsumption is not apparent. In India, several thousand buffaloes in village herds have been fed blocks containing 15 percent urea without problems (625) and there is some indication that buffaloes learn to regulate their intake.

Finally, the intake of block obviously varies with the type of animals (Table 3).

Table 3. Intake of blocks for different types of animals fed a basal diet of straw

Type of animal	Animals weight	Block intake per 100 kg LW	Ref.
Lambs	22	400	622
Calves	66	250	623
Young buffaloes	100	380	624
Jersey bulls	300	185	625
Jersey bulls	350	150	"
Zebu heifers	280	110	626

Effects of blocks on intake of basal diet

Feeding blocks usually results in a stimulation of intake of the basal diet. With a basal diet of straw without any supplementary concentrate, the increase of straw consumption due to molasses urea blocks is between 25 and 30 percent. When some high protein concentrate is also given with the basal diet, the increase of straw consumption is less and varies between 5 and 10 percent (Table 4).

Effects of intake of blocks on digestibility of straw and some parameters of digestion

The digestibility of straw dry matter in dacron bags measured after 24 hours in the rumen of lambs increased from 42.7 to 44.2 percent when 100 g of molasses urea block was consumed, and to 48.8 percent by an additional supply of 150 g cottonseed meal.

Ammonia concentration in the rumen of lambs receiving molasses urea blocks increases to levels which are much higher than those generally recommended for optimal microbial development (60 to 100 mg NH_3/1 of rumen fluid). This concentration increases with the urea content of the block (Table 5) and when a by-pass protein is added (Table 6). The digestibility of straw in sheep increased even up to 250 mg NH_3 - N/1.

Table 4. Effect of block on intake of straw

Type of animals	Animal weight kg	Increase in straw intake %	Ref
STRAW WITHOUT CONCENTRATE			
Lambs	22	26	622
Jersey bulls	300	29.5	625
Dairy buffaloes	-	24	"
Young buffaloes	100	23	624
STRAW WITH HIGH PROTEIN MEAL SUPPLEMENTS			
Lambs	22(1)	8	622
Jersey bulls	350(2)	6	625
Crossbred cows	- (3)	10	"
	- (4)	5	"

Preston, Leng and Nuwanyapka, unpublished data, quoted in 576

(1) with 150g cottonseed meal (2) with 1kg concentrates (3) with 1kg noug cake (*Guizotia abyssinica*) (4) with 2kg noug cake

The total volatile fatty acids in rumen fluid is increased when lambs consume the blocks with or without additional by-pass protein. There is a small but significant shift toward a higher propionate and butyrate production, and a lower acetate production.

Effects of blocks on ruminant growth

Dry mature pasture or straw given alone are unbalanced in nutrients to provide for an active and efficient rumen and to ensure an efficient utilization of the nutrient absorbed. Feed intake and the nutrient absorbed from such diets are insufficient to ensure even maintenance requirements and animals lose weight if they do not receive any nitrogen and mineral supplement. Molasses-urea blocks added to such an unbalanced diet allow for maintenance requirements because they ensure an efficient fermentative digestion. When some by-pass protein is added (e.g. cottonseed meal, noug cake) there is a synergistic effect which further improves considerably the average daily gain of ruminants and they become much more efficient in using the available nutrients. In addition total nutrients are often increased because feed intake is increased.

Compared to urea supplied by spraying on straw, urea from blocks give superior results. It is assumed that part of the response may be due to the small amount of supplementary energy supplied by the molasses but also by a stimulatory effect of other ingredients in the blocks on the rumen ecosystem (576).

Effects of blocks on milk production

The use of multinutrient blocks has allowed for a substantial reduction in concentrate in the diet of buffalo cows fed on rice straw. The fat corrected milk yield was not diminished by replacing part of the concentrate with block. But the amount of straw in the diet and thus the profit per animal per day were greatly increased.

Considerable commercial experience has now been acquired in the use of blocks for supplementing dairy buffaloes fed rice straw under village conditions in India. Reducing the amount of concentrate give to buffalo cows from 5 to 3.5 or 4 to 2.5 kg/day, and distributing blocks, did not reduce milk production but increased fat percentage by about 10 percent and reduced the cost of feeding. In other observations the addition of blocks to the diet increased milk production by about 10 to 25 percent and fat content of milk by 13 to 40 percent. In one village where the initial production level was lower the increase was even grater.

Subsequent trials were conducted in Ethiopia with crossbred cows given meadow hay of low quality with two levels of noug cake. They showed that milk yield was increased by 28 percent when feeding 2 rather than 1 kg of noug cake in the absence of blocks. However, there was no difference between the two levels of noug cake when the cows had access to blocks (containing 10 percent urea). It was then possible to save 1 kg nough cake by providing blocks without lowering milk production.

References

576. PRESTON, T.R. AND LENG, R.A. 1987. Matching ruminant production systems with available resources in the tropics and sub-tropics. Perambul Books, Armidale, Australia.

620. SANSOUCY, R., AARTS, G. AND LENG, R.A. 1988. Molasses-urea blocks as a multinutrient supplement for ruminants. In: Sugarcane as feed. Sansoucy, R., Aarts, G. and Preston, T.R. (eds.) FAO Animal Health and Production Paper No.72, 263-279.

621. EL FOULY, H.A. AND LENG, R.A. 1986. Manipulation of rumen fermentaion to enhance microbial protein synthesis from NPN supplements. In: Extended synopsis of international symposium on the use of nuclear techniques in studies of animal production and health in different environments. IAEA, Vienna, Austria, pp. 170-171.

622. SUDANA, I.B. AND LENG, R.A. 1986. Effects of supplementing a whea straw diet with urea or urea-molasses blocks and/or cottonseed meal on intake and liveweight change of lambs. Anim. Fd. Sci. Tech. 16: 25-35.

623. VAN WAGENINGEN AND PREMASIRI. 1986. Personal Communication to R. Sansoucy et al. (620).

624. LENG, R.A. 1983. The potential of solidified molasses-based block for the correction of multi-nutritional deficiencies in buffaloes and other ruminants fed low-quality agro-industrial by-products. In: The use of nuclear techniques to improve domestic buffalo production in Asia. IAEA, Vienna. pp. 125-150

625. GEORGE KUNJU, P.J. 1986. Urea molasses block lick, a feed supplement for ruminants. Paper presented at the international workshop on rice straw and related feeds in ruminant rations. Kany, Sri lanka. pp. 27.

626. DIALLO, I. AND NGOMA, A. 1985. Mesures de comsomm-ation de blocs d melasse et d'uree utilises comme complement chez des genisses Gobra recevant une ration d'entretien. Dahra, Senegal, ISRA/CRZ. Document No. 012, May 1985.