Production and Nutritional Evaluation of Multimineral Blocks for Small Ruminants in Adamawa State

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ABSTRACT

A study on the production of multimineral blocks using locally available feed resources was conducted at the Adamawa State University, Livestock Teaching and Research Farm Mubi. The cost of production, hardness and compactness were evaluated as feed supplement. multimineral block was developed using local ingredients. The values for phosphorus, pottasium, calcium, magnesium, sodium, iron, copper, manganese and zinc were determined, Maize had the highest amount of phosphorus, pottasium, calcium, magnesium, sodium, iron. Red clay had the highest value in copper, manganese and zinc. The hardness and compactnes at 15/30 days after moulding was good. The cost of production of a block of 5kg weight was N350. The practicability of the process has been demonstrated and can be easily adopted by the local farmers. The technology of making multimineral blocks for dry and wet season feeding is both simple and practicable and does not need sophisticated equipment.

Keywords: *Multimineral block, Local ingredients, Formulation, Ruminants*

INTRODUCTION

In most developing countries, particularly in tropical regions, the basal diet of ruminants, particularly large ruminants, consists of fibrous feeds, mainly from mature pastures (particularly at the end of the dry season) and crop residues (e.g. wheat and rice straw, maize and maize stover, sugar cane tops and trash). These roughages are unbalanced in terms of nitrogen (N), mineral and vitamin content, and they are also highly lignified. Consequently, their dry matter (DM) digestibility is reduced. These characteristics keep voluntary dry matter intake (DMI) and productivity low, and consequently the quantity of animal products (meat, milk, draught power, wool) is limited or nil. Animals may sometimes barely survive, or even die during, times of feed scarcity. To remedy this situation it is necessary to supply the rumen microbes with the elements that are deficient in the diet. One problem is that protein supplements (such as oil cakes) are in many cases not available in the country, are exported in order to get foreign exchange or are too expensive for the small-scale farmer to buy. The same occurs with mineral and vitamin supplements. The manufacturing process differs substantially from country to country, depending on the scale of operation. To mix the ingredients, various approaches have been used, ranging from use of a shovel or even bare hands, to mechanical mixing using a dough mixer or concrete mixer. Similarly, moulds made up from metal, wood, cardboard and plastic, with square, rectangular or cylindroid shape, have been used, and in some countries, car and truck tyres and buckets have been used to give shape to the blocks. Depending on the composition of the blocks, in particularly the concentration of the binder, blocks have been hardened without or with the use of pressure. If used, pressure is generally applied either by foot by standing on the moulds, or through mechanical devices such as a car jack, screw-driven press or lever. Electrical, steam or diesel motors have also been used in countries such as Viet Nam, Malaysia and Mongolia to compress the blocks. To avoid losses due to rats, birds, insects and fungal growth in high humidity areas, polyethylene packing has been the most used method when it is necessary to store blocks for a long period. In most countries, when the farmers have to buy the blocks, a smooth surface and good quality packing are preferred.

Use of blocks in emergency situations

In the recent past, a unique role for blocks as a supplement to the basal diet during the severe winter periods in Mongolia and upland regions of China has emerged. This has decreased the number of deaths in cattle. The blocks have also prevented deaths during the drought periods and after floods in countries that have included India, the Sudan and Zimbabwe. During drought periods, only crop residues and other highly lignified fibrous materials are available for feed. Through blocks, the supply of nitrogen, minerals and vitamins to rumen microbes enhances the availability of energy supply to the animal from fibrous materials. The simplicity of the method of block production and compact nature of the blocks, and hence their fast production and ease in transport from nonemergency to emergency situations, are some of the advantages of this technology in disaster situations.

MATERIALS AND METHODS

Location of the study area

The study was conducted in the Animal Nutrition Laboratory, Adamawa State University. The study area lie within Northern Guinea Savannah zone of Nigeria and located at latitude10°00 north, longitude 13°30 east and about 305m above sea level, with an area of 961.39 km^2. The dry season in this area commences early October and last up to April. The raining season begins from May and attains its peak between July and August and declines in September. The mean annual rainfall is 1050 mm, while the relative humidity is extremely low 20-30% between January and March and starts increasing as from April and reaches a peak of about 80% in August and September. Relative humidity starts to decline from October following the cessation of rains. The maximum temperature can reach 40°C particularly in April, while minimum temperature is about 18°C between December and January. A variety of livestock include cattle, sheep, goats and pigs (Adebayo, 2004).

Necessary Ingredients needed for Salt and the mineral block

- Red clay – 3 kg
- Salt – 0.5 kg
- Maize Flour – 1 kg
- Egg shell powder – 0.5 kg
- Water- as per need

Preparation method

Collection, drying and processing of locally available materials was done in the laboratory.

- Red clay was Mince into dust, screen it before use.
- Minced egg shell
- Mixed dust of red clay, dust of egg shell, salt and white flour in a container. Add adequate water to shape it as cake/block, note that thinner mixture is difficult to prepare a cake/block.
- Shape of Cake/blocks was made rectangular
- After 4-5 days, the prepared mineral cakes/blocks was ready for use.

The hardness and compactness of the blocks was simply measured by three persons independently after manufacturing following the method of (Hunton, 2005). Hardness was assessed by pressing with the thumb in the middle of the block. Each block was characterized soft (S), medium (M) or good (G) when the thumb penetrated easily, very little or only with greater pressure, respectively. The compactness was assessed by trying to break the block by hand. A block was characterized as null (N), medium (M), fairly good or good (G) when it was broken easily, with difficulty or with great effort, respectively. Physical characteristics Appearance/ colour, texture, aroma and taste was determined independently by three persons according to Hadjipanayiotou (1996) methods. Mineral and proximate composition was carried out as described by (AOAC, 2000) and fibre fractions (Van Soest *et al.*, 1991).

STATISTICAL ANALYSIS

The results obtained was subjected to analysis of variance using SPSS, (2000). Cost of block production was calculated based on the current prices of locally available feed ingredients at the time of blocks formulation and preparation.

RESULT AND DISCUSSION

Production of mineral blocks

Till the 1970s, the blocks were produced mostly by feed manufacturing companies, thus expensive, and their use in developing countries was negligible. In the early 1980s, with the realization of the significance of the blocks for smallholders in developing countries, work on simplification of the block production technology gained momentum through the efforts of the Joint FAO/IAEA Division, Professor Leng from Armidale University, Australia, and the National Dairy Development Board, Gujarat, India. The Joint FAO/IAEA Division, FAO and UNDP promoted block technology in many Asian, African and Latin American countries. During the initial phase, up to the mid-1980s, the “hot process” of block production was promoted, despite the high cost of the heating process. In 1986, the FAO Feed Resources Group modified the process to one that did not require heating of the ingredients, and this became known as the “cold process”. The cold process used solidifying agents such as calcium and magnesium oxide, calcium hydroxide, di-ammonium phosphate, cement or bentonite Nadziakiewicza *et al.*, (2019). Although the cold process was available, the use of the hot process continued into the mid-1990s. However, use of the hot process could not be sustained because of increasing energy costs, and interest in block technology diminished. In the late 1990s, with the promotion of the cold process through FAO/IAEA Regional Technical Cooperation (TC) Projects RAF/5/041, RAS/5/030 and RAS/5/035, the use of the block technology picked up in many Asian and African countries. Countries like Nigeria, Pakistan and several other countries shifted to the cold process for block production (FAO, 2012). Manufacturing process and method of offering the blocks levels typically vary from 4 to 10 percent, and the binder vary from 30 to 45 percent and 6 to 15. The manufacturing process differs substantially from country to country, depending on the scale of operation. To mix the ingredients, various approaches have been used, ranging from use of a shovel or even bare hands, to mechanical mixing using a dough mixer or concrete mixer. Similarly, moulds made up from metal, wood, cardboard and plastic, with square, rectangular or cylindroid shape, have been used, and in some countries, car and truck tyres and buckets have been used to give shape to the blocks.

In Multi-Nutrient Blocks for example particularly the concentration of the binder, blocks have been hardened without or with the use of pressure. If used, pressure is generally applied either by foot by standing on the moulds, or through mechanical devices such as a car jack, screw-driven press or lever. Electrical, steam or diesel motors have also been used in countries such as Viet Nam, Malaysia and Mongolia to compress the blocks. To avoid losses due to rats, birds, insects and fungal growth in high humidity areas, polyethylene packing has been the most used method when it is necessary to store blocks for a long period. In most countries, when the farmers have to buy the blocks, a smooth surface and good quality packing are preferred. The blocks have been offered to animals in a wooden box or bucket of dimensions slightly larger than that of the block, which restricts biting of the block by animals. The hanging of blocks in front of the animal using a wire passing through the centre of the block has been another approach. In Venezuela, blocks weighing as large as 25 kg have been offered to animals in rangelands. These blocks are kept under shade and near the water source. The daily consumption per animal varies: 500 to 800 g for cattle and buffaloes, 60 to 125 g for sheep and goats, and 400 to 600 g for yak. The block should be hard enough to ensure that the animal gets a slow release of nutrients through the licking process (Liu, *et al*., 2015). This slow release of nutrients, particularly of nitrogen and carbohydrates, increases the efficiency of utilization of these nutrients. However, in Indonesia, a variation to produce soft blocks has also been found to be popular and effective in increasing milk production. The soft block, weighing about 500 g, is broken into two or three pieces and given to cattle at different times of the day. Soft blocks have also been used in China by some workers. In this the ingredients were sourced locally, a wooden mortar was used to mince the clay and albendazole tablet, the eggshell was grinded in a well cleaned grinding machine and all other preparation were made manually. Hand mixing was employed.

The components of the multimineral block

The components of multi-nutrient blocks are red clay, salt, eggshell, maize flour, and water as required. Red clay was used as a binder and maize flour as source of energy and binder (Hadjipanayiotou, *et al.*, 1993). The use of red clay and maize flour as binders ensures the slow release of the mineral and chemical components of the block as opined by (Onwuka, 1997; Nadziakiewicza, *et al.*, 2019). Multimineral block is an excellent way of providing readily available minerals to ruminant animals and can increase digestibility and feed intake of fibrous feeds by up to 20% and 25 - 30%, respectively.

Table 1. Proximate composition of the ingredients

Constituents (%)	Maize	Eggshell
Moistures	12.0±0.010	1.9±0.03
Ash	1.1±0.001	32.8±0.02
Crude protein	9.0±0.240	1.8±0.20
Crude fat	3.4±0.200	1.1±0.01
Crude Fibre	1.0±0.001	3.4±0.20
Total carbohydrates	74.5±0.220	49.8±0.03

The chemical composition of a multi nutrient block depends on the quantity and the kind of ingredients used in the fabrication. Analyses made on the feed ingredients showed that the composition of the finished blocks may be related to that of the individual ingredients even though no proximate analysis was made on the blocks due to some constraints. The chemical composition of a block determines its feeding value as a supplement. The proximate composition of the feed ingredients is presented in Table 3. The lower moisture observed means higher DM values which indicate that when fed to animals, they will eat less to obtain their requirement as earlier posited by (Sansoucy *et al.*, 1995).

Benefits of block supplementation: The use of the blocks as a supplement has resulted in economic benefits to the farmers. Block supplementation with crop-residue-based diets has resulted in increased milk production, with a favourable cost– benefit ratio, varying from 1:2 to 1:5, depending on the purchase price of ingredients and selling price of milk. Invariably, an increase in milk fat content by 0.2 to 0.8 percentage units on feeding the blocks also brought

a higher price for the milk. Increase in lactation length has also been observed. Decreases in inter-calving days and in the age at first calving are additional beneficial effects of feeding the blocks. Feeding of crop residues with Multimineral blocks (MBs) can sustain a milk yield of up to 4 or 5 litres per day in cattle. For high production animals, blocks containing 'rumen undegradable protein' sources ("by-pass" protein sources), such as fishmeal, cottonseed meal, etc., have been developed and used in India, Venezuela and Pakistan.
In some situations, supplementation of the blocks has allowed a reduction of up to 50 percent in green fodder or a substantial reduction in concentrate mixture (as up to 30 percent of total crude protein requirement can come from the blocks) without sacrificing milk yield or live weight gain, giving additional benefit to farmers through reduced input costs. Uptake of the block technology has been easier and faster for dairy cattle compared with beef cattle because of an immediate increase in milk yield from the third or fourth day of feeding the blocks, giving additional profit to the farmers. An increase in milk yield of the order of 1 to 1.5 litre per day on giving about 500 g of block has been recorded. Factors such as animal species and basal diet influence the beneficial effects of feeding the blocks. In general, the effects are most pronounced in cattle, then buffalo, sheep (in that order), and least in goats. The greater ability of goats to browse different trees and browses containing leaves with high protein content could be responsible for the apparent lower efficiency of nitrogen utilization from blocks in this species. Similarly, supplementation of the blocks with diets of good composition has also resulted in poor response in cattle, buffalo and sheep. In such a situation, an attractive option is to decrease the costs of inputs by replacing concentrate mixture or green fodder with the block, and getting the same milk yield. This approach has been used in practical situations in countries such as Bangladesh, India, Indonesia and Sri Lanka for animals of medium milk yield. Maximum gains from supplementing with multimineral blocks are achieved during the dry period in tropical countries, when the farmers have nothing except crop residues and poor quality grasses and weeds. Substantial enhancement of reproductive performance has been obtained in buffaloes following pre- and postpartum block supplementation. In most countries, the extension of the block technology to farmers has been through demonstration of increased milk yield, or better body weight gain and hence greater meat production. However, the adoption of the block technology may be through demonstration of the impact on reproductive performance, with a spillover effect being enhanced milk yield. Widespread reproductive problems in ruminants, which is attributed to poor nutrition, can be overcomed through an appropriate, low cost and simple technology like multimineral blocks (Brar and Nanda, 1996).

The simplicity of the method of block production and compact nature of the blocks, and hence their fast production and ease in transport from nonemergency to emergency situations, are some of the advantages of this technology in disaster situations. The mineral composition of the ingredients used in the production of multimineral block is presented in table 2.

Table 2. Mineral composition of the samples

Minerals (mg/100g)	Maize	Eggshell	Red clay	Salt
P	299.6 ± 57.8	6.3575 ± 0.013	0.37±0.040	
K	324.8 ± 33.9	7.25 ± 1.0	4.20±0.210	-
Ca	48.3 ± 12.3	1.074 ± 0.2	8.06±0.230	0.71±0.011
Mg	107.9 ± 9.4	0.0575 ± 0.1	1.26±0.010	0.28±0.013
Na	59.2 ± 4.1	6.000 ± 0.2	1.69±0222	98.55±1.22
Fe	4.8 ± 1.9	5.10	2.85±0.120	-
Cu	1.3 ± 0.2	0.45	48.26±0.023	-

Mn	1.0 ± 0.2	-	217.85±0.012	-
Zn	4.6 ± 1.2	3.30	93.74	

Determine Physical characteristics of the mineral blocks

Hardness and compactness of blocks were measured by three persons independently. Most of the blocks were fairly good (G) compactness and hardness. The result obtained from this research revealed that the blocks are of fairly good compactness. This is similar to what was reported by Hadjipanayiotou *et al.*, (1993). Santhiralingam and Sinniah, (2018) suggested that if they are too soft, there may be risks of toxicity resulting from the high intake of elements. If they are too hard, the intake is too low to have any effect on the animals. This shows that good compression is needed to obtain multi nutrient blocks of good strength despite the role binder's play. The combinations of binders (clay and maize flour) gave the blocks medium strength. This has the advantage of ensuring gradual release of nutrients to animals when fed such feed blocks, otherwise, toxicity will occur, and also becomes more convenient for packaging, storage, transport and ease of feeding as noted by (Sansoucy *et al*., 1986 Santhiralingam and Sinniah, J. (2018).). However, Nadziakiewicza *et al.*, (2019) indicates that clay can replace cement as it is more expensive and most animal welfare advocates are against the usage of cement in animal feed preparation. The drying was done under open ventilation to avoid direct sunlight as this might result in a loss of nutrient elements like vitamin C, the blocks did not grow mouldy. This may be attributed to the minimum amount of water used for fabrication. This emphasizes on the fact that provided minimum amount of water used for multi nutrient block fabrication, blocks can be stored for months (Kunju, 1986). This implies that when fabricated towards the end of the rainy season, they could be used up to the beginning of the next rainy season, where more feed will be available for ruminants (Mohammed, *et al.*, 2007). According to Garad, (2019) the blocks were of good strength. The consistency observed in the final blocks mixtures was due to the premixing of the clay in water before adding to mixture. This also tends to ensure an even spread of the clay in the feed mixture which facilitates and improves uniform hardening of blocks, this also ensured that the ingredients were held together reasonably (Sansoucy *et al*., 1995).

Production cost

A unit of 5kg block on average costs about N350. The average cost of each block was estimated seems to be highly affordable among the smallholder farmer in the semi-arid environment.

Table 3. Cost effectiveness of producing 5kg mixture (1block)

Ingredients	Cost in Naira (₦)
Red clay (3kg)	50
Salt (0.5kg)	50
Maize Flour (1kg)	150
Eggshell powder (0.5kg)	100
Total	350

Cocncluusion and Recomendation

The findings of this experiment revealed that the rumen requirement of ruminants could be met at a very convenient and affordable way in terms of cost and availability of required minerals in rations fed to animals. Multi-mineral blocks obtained from local feed ingredients have the tendency to enhance the activities of microorganisms by increasing the number of the resident microbes in the rumen for better utilization of low quality roughages especially during dry season, when livestock are often dependent on crop residues which are low in crude protein and high in fiber and as such, peasant agro-pastoralists should augment the basic mineral requirement of their ruminant animals using locally produced multi-mineral blocks from locally available ingredients.

Recommendations

Based on the findings of this experiment, the use of formulated multimineral block as supplement can provide rumen microorganism requirement for ruminants and could reduce the cost of supplementary feeding of concentrates which are generally more expensive. Thus, use of multi-mineral blocks is strongly recommended in feeding regimen of ruminant animals in regions with poor quality roughages and crop residues.

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