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Development of Mineral Blocks for Sheep in Semi-Arid Area of Borno State, Nigeria

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Abstract: *This study was carried out to utilize local ingredients in production of multi mineral blocks, asses the nutritional composition of the ingredients and formulated mineral blocks in semi-arid environment. The production cost of the multi-mineral blocks was also evaluated. Four (4) Multi-mineral blocks were developed designated, as F2 – F5. F1 served as control. Each of the four formulations contained different proportion of bone meal, egg shell, potash, wood ash, salt, Adansonia digitata (bobab) leaf meal and parkia yellow pulp as the ingredients. The blocks were assessed based on hardness and compactness, F2 recorded Good hardness (GH), Good compactness (GC) and recorded 8.00 kg/cm^2 as measured using instrument. Cost of producing a block ranged from ₦55.50 – ₦ 103.59. for F2 – F5, respectively. It is therefore, possible to use local ingredients to produce multi mineral blocks with good harness and compactness, with improved shelf life and easy storage ability and at affordable cost for ruminant farmers.*

Keywords: *Multi Mineral Blocks, Hardness and compactness, Sheep, Semi Arid*

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INTRODUCTION

Dry season feeding is a major constrain to ruminant livestock production in the Semi - arid area of West Africa (Abbator *et al*., 2002).The long dry season results in deterioration in both quality and quantity of grasses, which are the major feed resources for ruminant livestock. The crude protein content of the grasses drops below 4% during the dry season, and are equally very low in phosphorus and energy (Abdulwaheed and Daniel, 2014).Reduced growth of animals and reproductive problems are widespread even when forage distribution is sufficient. These problems may be directly associated with the low concentrations of minerals in soil and the related forages (McDowell, 1997).

Forage and grasses alone cannot meet all the mineral needs of grazing livestock (McDowell, 1992). Analysis of soil and forage mineral constitution is important to evaluate the level of minerals supplied to livestock (Ahmad *et al*., 2012).

For the proper functioning of the animal's body, in addition to protein, fats and carbohydrate, minerals and vitamins are also required in small amounts to prevent deficiency, and diseases in the animals (McDowell, 2003). Macro minerals required by ruminants include calcium (Ca), magnesium (Mg), phosphorus (P), potassium (K), sodium (Na), chlorine (Cl) and sulphur (S) (Ranjihan, 1980). For grazing livestock to which concentrate feeds cannot be fed economically, it is necessary to rely on both direct and indirect methods of providing minerals. Self-feeding of free-choice mineral supplements are widely used for grazing livestock (McDowell, 2003).

Other valuable sources of minerals include direct administration of minerals to livestock in water, mixtures and drenches, ruminal preparations, injections and mineral licks (McDowell, 1996; 1997; 2003).

Multi-mineral salt blocks are hard, rock-like manufactured blocks that contain a range of trace elements. They can be scattered around a farm for animals to lick. The blocks are usually mainly common salt (sodium chloride), but can also contain calcium, iodine, copper, cobalt, iron, selenium and zinc (Gary *et al.,* 2012).

METHODOLOGY

Experimental Site/Location

The study was conducted at the Teaching and Research Farm, Department of Animal Production Technology, Ramat Polytechnic Maiduguri, Maiduguri, Borno State. The State is located between the latitudes of 10^0 N and 14^0 N and the longitudes of $11^0$30'E and $14^0$45'E. Borno State has an area of 61,435sq. km and is the largest state in the federation of Nigeria in terms of land mass with an altitude of 354m above sea level (Encarta, 2007).

Formulation of Mineral Blocks

Bone meal, Egg shell, Potash, Wood Ash and Salt were the ingredients used for the formulation of four (4) different mineral blocks, while *Adansonia digitata* and Parkia Yellow Pulp was used as binders. The four mineral blocks are shown in Table 1were designated as F2to F5

Method of Production

The cold process was the method used for the production of the mineral blocks for this study.

Mixing of Ingredients

The raw materials were mixed manually but thoroughly in a 200 L drum cut to a height of 50 cm. A batch of 20 kg (ingredients) were mixed in order to get a homogenous mixture as recommended by Mohammed *et al*. (2007). The mixing was done as described by Aarts *et al*. (1990).

Molding of the Blocks

After preparation of a homogenous mixture, the content is placed in a wooden container mold lined with a polythene sheet and pressed manually using hand in compartment measuring 15 x 15 x 10 cm (Mohammed *et al.*, 2007). The polythene sheet lining the inner surface of the wooden mold is to facilitate and remove smoothly the multi-mineral bocks when formed. Removal of the blocks was done by knocking the sides of the moulds gently after the block materials have settled and partly dried.

Drying of Blocks

After Molding, the blocks were air-dried; the blocks were arranged and allowed to dry in an open space under shade. A dry environment was maintained for proper and quick drying of the blocks

Table 1: Gross composition of ingredients used in the formulation of the mineral blocks

Ingredients (%)	F1	F2	F3	F4	F5
Bone Meal		10.00	15.00	20.00	25.00
Egg Shell		20.00	15.00	10.00	5.00
Potash		10.00	15.00	20.00	25.00
Wood Ash		20.00	15.00	10.00	5.00
Salt (NaCl)		2.00	2.00	2.00	2.00
[a]*Adansonia digitata* leaf meal		14.00	19.00	24.00	29.00
[a]Parkia Yellow pulp		24.00	19.00	14.00	9.00
Total		**100.00**	**100.00**	**100.00**	**100.00**

[a] = Binders

Block Assessment

Manual block assessment

Block hardness (H) and compactness (C) were tested four (4) days after de-moulding. Second test was done after 12 days of de-moulding and lastly after 20 days. The block's hardness was determined manually by pressing with the thumb in the middle and compactness by breaking the block using hand. The final test was done after 25 days.

Laboratory assessment of blocks The blocks were taken to Civil Engineering Laboratory for Hardness and Compactness tests using Concrete crusher manufactured by Seidner © Riedlingen, West Germany.

Table 2: Mineral composition (%) of the ingredients used in the formulation of the mineral blocks

Minerals*	Bone meal	Egg shell	Potash	Wood ash	Salt (NaCl)	Baobab leaves	Parkia pulp
Calcium (Ca)	31.70	26.50	-	2.50	-	2.65	1.05
Phosphorus (P)	13.00	0.14	-	10.60	-	0.25	0.08
Sodium (Na)	2.50	0.17	27.20	0.62	39.34	-	0.18
Magnesium (Mg)	0.40	0.34	21.00	0.61	-	4.95	0.71
Potassium (K)	0.30	0.08	46.10	4.50	-	19.60	0.41

* = Means of three determinations.

A calcium content of 0.2%-0.4% is considered adequate as long as the calcium and phosphorus ratio is maintained between 1:1 and 2:1 (David, 2014). Salt (sodium chloride) being the major source of sodium, recorded the highest value (39.34%), followed by potash, which contained aconsiderable content of sodium (27.20%) while egg shell recorded the lowest value (0.17%). David (2014) reported that sheep need sodium (salt) to remain thrifty, make economic gains, lactate and reproduce. Its deficiencies may result in abnormal appetite, licking of soil, depressed appetite, loss of weight and decreased milk production (Masters and White, 1996). However, the sodium content of salt (39.34%) is in agreement with the findings of Dzidiya *et al*. (2015); Masters & White (1996). The highest value (21.00%)for magnesium was recorded in potash while lowest (0.34%) was observed in egg shell. High intake of potassium decreases the absorption of magnesium and increases the incidence of grass tetany induced by magnesium deficiency (Masters and White, 1996).

Minerals participate in a wide range of biochemical reactions as components of enzymes and fulfil a structural and osmotic role in a number of animal tissues as reported by Masters and White (1996).

Mineral Composition of the Formulated Mineral Blocks

The mineral composition of the formulated multi-mineral blocks are shown in Table 3. The calcium and potassium content showed variation and increased from F2 - F5, (9.50 - 11.57%). The lowest value was recorded in F2.

Table 3: Mineral composition (%) of the basal diet and formulated mineral blocks

Minerals*	F1	F2	F3	F4	F5
Calcium (%)		9.50	9.94	10.23	11.57
Phosphorus (%)		3.23	3.72	3.88	4.05
Sodium (%)		5.39	6.83	5.27	9.96
Magnesium (%)		3.47	4.92	2.74	2.43
Potassium (%)		9.01	11.93	14.85	17.77

* = Means of three determinations

The higher values recorded for the F2 - F5 that increased across the formulation, might be attributed to inclusion of bone meal which contained calcium and phosphorus in higher quantities. Bone meal increased from 10.00% in F2 to 25% in F5. The values obtained for this study can provide enough calcium and phosphorus to meet the requirement of 0.20 to 0.82% and 0.16 - 0.38%, respectively recommended by NRC (2007).It also reflected the standard calcium and phosphorus ratio of 1.5 to 1, 1:1 or 2:1 (David, 2014).

The values of magnesium obtained in this study ranged from 1.5 to 2.43%. The magnesium content of the blocks (F2 – F5) are higher than the recommended values of 0.12 – 0.18% by NRC (2007) for sheep.

Potassium content followed the same pattern with calcium and phosphorus, with values of 4.1 to 17%. The values increased as the level of potash (0 - 25%) increased in the formulated blocks (F2 – F5). The values of the minerals in the formulated blocks are adequate to meet the needs of the sheep based on NRC (2007) recommendations.

The values of sodium in this study showed variations(5.39, 6.83, 5.27 and 9.96%)inF2, F3, F4 and F5, respectively. However, salt, which is the main source of sodium, was kept at a constant level of 2% throughout the formulations; other ingredients also contained some quantities of sodium. The highest value was in F5 (9.96%) which might be due to quantity of potash in the formulation. Potash is second to common salt (NaCl) in sodium content.

Physical Examination of Produced Multi Mineral Blocks

The results of the physical assessment of the multi mineral blocks are presented in Table 4. For the manual assessment, F2 recorded good hardness (GH) and good compactness (GC). Other formulations, F3, F4 and F5 had medium hardness (MH) and medium compactness (MC). For the machine assessment, F2 recorded 8.00kg/ cm^2 showing superior hardness,F3 had a value of 5.33 kg/cm^2 while F4 and F5 recorded same value of 3.33kg/cm^2. However, the value recorded for F2 was higher than the values (3.6- 4.0kg/cm^2) reported by Mubi *et al*. (2013) but F3, F4 and F5 value (3.33kg/cm^2) was close to 3.6-4.0kg/cm^2 obtained by the authors. The difference in ranges might be attributed to differences in ingredients used. For instance, Mubi *et al.*(2013)included molasses, which softens the blocks; quantity of water used, or type of binders used also affects the hardness and compactness of formulated blocks. The values recorded for hardness and compactness for F2- F5 decreased along the formulations, which was as a result of the quantity of parkia yellow pulp used. The hardness decreased as the quantity of parkia yellow pulp decreased in the formulations. Parkia yellow pulp has a high binding capacity. Hassoun (1989) reported that Hardness and compactness are very good indices for assessing the physical qualities of mineral blocks. A block with good hardness and good compactness could be stored for a longer time without deterioration in quality. Moreover, such blocks are easier to handle and transport without breakage or damage.

Table 4: Assessment of hardness and compactness of mineral blocks

	Treatments			
Parameters measured	F2	F3	F4	F5
Machine assessment (kg/cm^2) (Hardness)	8.00	5.33	3.33	3.33
Manual assessment				
Hardness	GH	MH	MH	MH
Compactness	GC	MC	MC	MC

GH = Good Hardness

GC = Good Compactness

MH = Medium Hardness

MC = Medium Compactness

Cost of Production of the Mineral Blocks

The cost of producing the multi-mineral blocks is presented in Table 5. The cost of production of the mineral blocks ranged from ₦ 55.48 to ₦ 103.59 (F2 - F5).

The cost of the formulated mineral blocks increased as the level *Adansonia digitata* leaf meal increased in the blocks. The total cost of production of 20 kg of the blocks ranged from ₦ 552.00 to ₦ 1057.00. Compared to commercial mineral block (₦ 110.00/kg), the cost per kg of the formulation blocks is within the reach of an average livestock farmer.

Table5: Cost of formulation (₦) of the mineral blocks.

	Formulations			
Ingredient	**F_2**	**F_3**	**F_4**	**F_5**
Bone meal	4.00	8.00	12.00	16.00
Egg shell	1.75	1.40	1.05	0.70
Potash	1.75	3.50	5.25	7.00
Wood ash	0.90	0.70	0.55	0.35
Salt	0.25	0.25	0.25	0.25
Adansonia digitata	8.95	13.85	18.80	23.75
Yellow pulp	10.00	8.25	6.55	4.80
Total (₦)/kg	27.60	35.95	44.45	52.85
Average kg/ block	2.01	2.07	2.02	1.96
Cost/block(₦)/block	55.48	74.42	89.80	103.59

This value is lower than ₦ 159.19, ₦ 167.74, ₦ 184.36 and ₦ 192.92 for F2, F4, F5 and F1, respectively. These values are similar to the findings of Mubi (2010) who reported ₦ 136.29 and ₦ 157.84 for the group that was supplemented with the multi-nutrient blocks.

CONCLUSION AND RECOMMENDATION

Conclusion

The study showed that, it is possible to formulate Multi Mineral Block (MMB) of good nutritional composition, hardness and compactness using locally available feed ingredients. Blocks produced can meet the requirements and therefore could be used to ameliorate mineral deficiencies of sheep, most especially during the dry season when pasture grasses are of poor quality. Multi mineral block can be produced using other ingredients as source of the minerals; the choice of the ingredient depends on the availability, nutritive values, ease of handling and their overall effect on the quality of the blocks.

It is therefore concluded that formulation three (F3) that contained Bone meal (15.00%) + Egg shell (15.00%) + Potash (15.00%) + Wood Ash (15.00%) + Salt (2.00%) + *Adansonia digitata* leaf meal (19.00%) and Parkia Yellow Pulp (19.00%) proves to be better. However, it should be considered for production and adoption by farmers.

Recommendation

Based on the findings of this study, the use of formulated multi–mineral blocks may be used as supplement to improved feed utilization and could reduce the cost of supplementary feeding of concentrates, which are generally unaffordable by most agro-pastoral farmers in semi – arid region of Nigeria. Thus, use of multi-mineral blocks is strongly recommended in feeding regimen of ruminant animals in semi-arid regions with poor quality roughages and crop residues. On the basis of quality of finishing, least cost of production. F3can be utilized most preferably, although, more research need to be done in exploiting other ingredients that might provide minerals adequately and testing of the blocks on on animals may also be necessary.

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