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Low-Cost Multi-nutrient Blocks Produced from Locally Sourced Ingredients for Small Agro-Pastoral Farmers in the Sahel Zone of West Africa

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Abstract
This study was carried out at the University of Maiduguri Teaching and Research farm Nigeria to formulate and produce low-cost multi-nutrient blocks from locally sourced ingredients for small agro-pastoral farmers. The experimental design was set in a factorial arrangement consisting of different locally sourced ingredients at five formulations (F1 - F5). The analysis of the manufactured multi-nutrient blocks after 3 weeks of drying revealed that the moisture in the blocks was almost completely removed (94.6 – 97.9 %DM). The %CP, %CF, %EE and %Ash ranged from 13.56 – 26.43 %, 19.50 – 26.50%, 2.50 – 3.00% and 10.00 – 14.50 % respectively with the cost of production per block ranging from ₦74 – ₦94 equivalent to $0.45 – $0.58 USD. Of all the formulations, F2, in addition to its least cost of production (₦74/block), had the better compactness and hardness that can ensure the slow release of nutrients to animals as they lick the blocks. Taken together, using locally available resources would not only produce affordable multi-nutrients blocks for small farmers but could equally contribute to waste management through the recycling of waste into feed for animals thereby abating pollution in the environment.
Keywords*:* Developing countries, Multi-nutrients block, Ruminant animals, Semi-arid regions, Small local farmers.

1. Introduction

One major factor limiting the growth of the livestock industry in the developing countries especially the semi-arid regions is low-quality feed. In the Sahel zone of West Africa, fodder and crop residues are major sources of ration fed to ruminants (Mubi *et al.,* 2013; Dzidiya *et al,* 2015). Low-quality feed has been responsible for the low voluntary feed intake and digestibility in the animals (Sharma *et al.,* 2004) with consequences seen in vulnerability of animals to diseases, reduced performance, weight loss, low birthrate and birth weight (Mshelizah, *et al.,* 2015; Abbator *et al.,* 2016). Studies have shown that fodder and crop residues are deficient in nitrogen, minerals, and vitamins, but high in fiber (Makkar, 2007). Minerals such as phosphorus and nitrogen and energy of grasses during the dry season drop low drastically with crude protein below 4% (Norman, 1963; Crowder and Chleda, 1982). Cattle feeding just on natural grasses lose about 200- 600g of their body weight per head per day (Dzidiya *et al,* 2015).

For many years, supplementation of animal feed with multi-nutrient blocks has proved promising. Over 60 countries of the world have embraced the multi-nutrient blocks technology with records of astonishing increase in milk yield, body weight, meat production, reproductive performance, and a decrease in inter-calving days and animal death during severe winter and drought (Makkar, 2007). Up to 25 - 30% increase in feed intake and 20% increases in the digestibility of fibrous feeds was reported in ruminant animals fed with multi-nutrient blocks (Muhammed *et al.,* 2016). The supply of nitrogen, minerals, and vitamins to animals using multi-nutrient blocks enhances intake, availability of nutrient and digestibility through optimizing rumen fermentation (Long et al., 2005; Makkar, 2007; Rafiq et al., 2007). Although the protein supplements for livestock such as groundnut and soybeans have been valuable in animal feed production, it cost has remained a challenge for the small local farmers. The high price of the protein supplement led to the use of non-protein-nitrogen sources like urea in a way to remedy the nitrogen deficiency in the fibrous feeds and enhance intake, availability of nutrient and digestibility by optimizing rumen fermentation (Makkar, 2007).

A lot of studies have been carried out to formulate and produce low-cost multi-nutrient blocks, however, those studies been based on resources available in the areas where they were carried out. The aim of this study was to formulate and produce low-cost multi-nutrient block supplement from locally available resources that can be purchased by small agro-pastoral farmers in the Borno state Nigeria, an area within the Sahel (semi-arid) zone of West Africa.

2. Materials and Method

2.1. Site of study

The study was conducted at the University of Maiduguri Teaching and Research Farm, Borno State Nigeria. It is an area within the Sahel (semi-arid) zone of West Africa characterized by short duration (about 3 – 4 months) of rainfall 645.9mm per annum with 45% relative humidity in August which gets to about 5% in April and May (Malgwi and Mohammed, 2015).

2.2. Samples Collection and Preparation

The Samples were collected and grouped into four: the energy group, the protein and nitrogen group, the mineral group and the binders group as shown in Table 1. The poultry litters were obtained from the University of Maiduguri poultry farm. It was sun-dried for four days, ground and sieved to remove all wood shavings and feathers. The bone meal and blood meal were purchased at the Borno State abattoir; they were ground, sieved and packaged appropriately. Powdered dry okra was obtained from the market and soaked overnight, then sieved to form the juice. The molasses was purchased from Adamawa State Savanna Sugar Company Numan Nigeria. The brans, salt, urea, and cement were purchased in already processed form from accredited dealers in the market.

2.3. Feed Formulation and Mixing

Five Rations were formulated (Table 1). The feed ingredients were manually mixed in batches of 20kg per batch to obtain a good mixture using a cold process method as earlier described by Mohammed *et al.,* (2007).

Table 1: Multi-Nutrients Block Formulation

Ingredients	**F1**	**F2**	**F3**	**F4**	**F5**
Energy Group					
Maize Bran	15	30	20	10	10
Millet Bran	10	0	20	25	15
Sorghum	20	14	10	20	20
Protein and Nitrogen Group					
Poultry Litre	10	10	15	0	12.5
Blood Meal	18	15	13.5	24	15
Urea	2	3	1.5	1	2.5
Mineral Group					
Salt	2	1	3	2	1
Bone Meal	3	5	2	3	2.5
Binders Group					
Molasses	5	0	4	2	4
Cement	0	10	1	10	10
Okra Juice	15	12	10	3	7.5
TOTAL (Kg)	100	100	100	100	100
Water (L)	115	105	102.5	105	110

F1 - F5 = Formulations

2.4. Chemical Analysis

All the individual ingredients and the formulated rations were analyzed for Dry Matter (DM), Crude Protein (CP), Ether Extract (EE), Crude Fibre (CF), Nitrogen Free Extract (NFE), Ash, and minerals based on the methods of analysis of the Association of Official Analytical Chemists (AOAC, 2000).

2.5. Molding and Drying Of the Multi-Nutrient Blocks

The molding of the multi-nutrient blocks was done using a wooden mold with 15x15x15 cm dimension. The mold surface was covered with a nylon sheet for easy removal of the blocks from the mold frame. The blocks were cast on a flat surfaced floor. The process was manually done and took a total of 36.5 minutes to mold and cast a total of 70 blocks from 20kg/batch formulation. After casting, the blocks were allowed to dry for 3 weeks. In the interval of two days, the blocks were turned to avoid maggot incursion due to the wet poultry litter, blood meal, and brans. After drying, the blocks were wrapped in dry air-tight polythene bags and kept in the ventilated moisture-free area.

2.6. Block Assessment

All blocks were assessed for Hardness and compactness post-drying period. The hardness of the blocks was evaluated using the thumb method characterized as soft (S), medium (M) or good (G), and the compactness, characterized as null (N), medium (M) or good (G) as described by Muhammed *et al.,* (2016).

2.7. Cost Analysis of Formulated Rations

The cost implication of producing all the five formulated rations was based on the market prices of the ingredients as at the time of this study when $1 US Dollar = ₦ 163.

3. Results and Discussion

The Multi-nutrients blocks are an important innovation that provides animals with basic nutritional need as they lick the blocks placed around in their house (Dzidiya *et al,* 2015). One of the advantages of multi-nutrient block technology is that it does not require sophistication, both in term of equipment and technical know-how. This, therefore, makes it applicable to small local farmers. In addition, producing the multi-nutrient blocks using local ingredients makes transportation of the block easy to farm from the nearby processing unit thus cutting down transportation cost and operating costs especially labor (Makkar, 2007; Sunarso *et al*., 2011; Karimizadeh *et al.,* 2017).

In this study, the poultry litter was obtained free of charge. It is worthy of note that using poultry litter can serve as way of waste management through recycling of the waste into animal feed. The quantity of salt used in this study (lower than 4%) is in agreement with what other researchers reported (Mohammed *et al.,* 2007). The Salt adds palatability to the multi-nutrient blocks (Makkar, 2007). The quantity of salt in feed supplementation has to be kept low especially in the semi-arid regions where there is a poor supply of water to avoid dehydration of animals (Dzidiya *et al.,* 2015). The molasses' sugary taste and aroma, together with the salt flavor, serve to provide an appetite for the animals to lick the blocks. The volume of water used for the formulation and production of 100kg multi-mineral block ranged from 102.5 – 115 liters/100kg (or 20.5-23 liters/20kg). This volume was more than twice the volumes reported by other researchers (Dzidiya *et al.,* 2015). The variation is thought to be due to the kinds of ingredients used. Some of the ingredients used in this study, for example, the brans, absorbed much water. Mohammed *et al.,* (2007) reported 24 liters/20kg mixture using wheat offal, a volume which is in correlation with the volume of water used in this study.

Table 2: Proximate Analysis of Feed Ingredients Used

Parameter	Maize Bran	Millet Bran	Sorghum Bran	Poultry Litter	Blood Meal	Urea	Salt	Bone	Molasses	Cement	Okra
% DM	97.57	97.57	93.80	95.50	96.2	97.00	-	99.30	70.00	-	93.10
% MC	2.43	2.43	6.20	4.50	3.80	3.00	-	0.70	30.00	-	6.90
% CP	4.30	4.30	1.36	14.00	4.29	3.00	-	0.80	2.90	-	5.00
% EE	1.20	1.20	1.50	5.00	0.50	0.08	-	1.00	1.01	-	0.80
% CF	15.70	6.20	13.50	20.00	6.90	0.02	-	2.00	0.28	-	19.00
% NFE	70.50	79.20	79.14	50.50	38.81	45.00	-	85.10	23.10	-	-
% ASH	8.30	9.10	4.50	6.00	49.50	0.01	-	11.00	03.10	-	48.10
Ca (ppm)	-	0.02	0.03	2.50	1.44	-	-	13.60	0.82	25.00	2.10
Na (ppm)	-	-	-	-	0.21	-	39.34	0.06	23.10	-	-
Cl (ppm)	-	-	-	-	-	-	60.66	0.13	-	-	-
Fe (ppm)	-	3.90	-	-	11.00	-	-	42.00	-	21.45	-
Mg (ppm)	-	-	-	-	6.00	-	-	1.56	-	130.00	-
N (ppm)	-	-	-	-	0.69	49.00	-	0.13	0.48	-	-
Mn (ppm)	-	-	-	-	0.06	-	-	21.0	-	179.00	-
P (ppm)	-	-	2.30	-	0.04	-	-	15.6	-	-	0.80

DM = Dry matter; MC = Moisture content; CP = Crude Protein; EE = Ether Extract; NFE = Nitrogen Free Extract; CF = Crude Fibre. Ppm = Part per million

The proximate analysis of the locally sourced ingredients for the formulation and production of the multi-nutrient blocks are shown in Table 2. From the result of the composition of the brans, millet was found to contain abundant iron (3.90ppm) while sorghum showed a good amount of phosphorus (2.30ppm). The poultry litter has a protein content of 14 %, more than any the ingredient analyzed in this study. The advantage of the poultry litter is that it is a source of protein which is not in demand by humans. Unlike other protein sources such as groundnut and soybeans which are expensive because of their demand by man, poultry litter is cheap and available in the study area. The urea contained abundant nitrogen (49.00ppm) which is needed for the utilization of the dry matter in the rumen by microbes as shown by Makkar (2007). The salt, bone meal, blood meal, and cement contain essential minerals such as Ca, Na, Cl, Fe, Mg, N, Mn, and P required for the well-being and proper functioning of animals as established by McDowell (1996). In addition to its energy, the molasses also contain some essential minerals; and together with okra and cement, they serve as binders in the block.

Table 3: Physical Characteristics of Blocks (at 3 weeks after production)

Characteristics	F1	F2	F3	F4	F5
Compactness	M	G	M	M	M
Hardness	S	G	M	M	S
Weight (Kg)	0.77	1.13	1.08	1.01	1.26

G = Good, M= Medium, S= Soft; F1 …… F5 = Formulations

The physical characteristics, compactness, and hardness, of the multi-nutrients blocks after 3 weeks of production and drying are shown in Table 3. Because mold growth is imminent on the moist nutrient matter, complete drying of blocks was necessary. The time taken for blocks to dry completely differs in several reported studies. For example, Mubi *et al.,* (2013) reported 30 days of drying, Muhammad *et al.,* (2016) observed 28 days of drying, and Dzidiya *et al,* (2015) reported 24 days of drying. This variation is thought to be due to the type of ingredients and amount of water used during molding. Of all the formulation, F2 showed better compactness and hardness which was possibly a consequence of the cement inclusion. The good compactness and hardness of F2 is an advantage because hard and compact blocks ensure a slow release of nutrients as animals lick them (Makkar, 2007) thus reducing the risk of urea toxicity from over-consumption of blocks.

Table 4. Proximate Constituents of the Multi-Nutrient Blocks

Parameter	F1	F2	F3	F4	F5
% Dry Matter	97.90	97.60	96.50	98.10	94.60
Crude Protein	26.43	24.77	19.08	13.56	17.42
Crude Fibre	21.56	26.50	22.00	19.50	25.00
Ether Extract	2.50	3.00	2.50	2.50	2.50
Nitrogen Free Extract	39.57	31.23	43.42	53.93	43.58
Ash	10.00	14.50	13.00	10.50	11.50

The result of the proximate composition of the multi-mineral blocks is shown in Table 4. The result of the dry matter assessment indicates that the moisture in the blocks was almost completely removed (94.6 -97.9%) after 3 weeks of drying. This is comparable to the results reported earlier by other researchers 93.80 - 95.60 % DM (Dzidiya *et al,* 2015), and 92 – 95 % DM (Mohammed *et al.,* 2007). The %CP, %CF, %EE and %Ash in this study ranged from 13.56 - 26.43 %, 19.50 – 26.50%, 2.50 – 3.00% and 10.00 – 14.50 % respectively. Dzidiya and colleagues reported 1.31-1.48 %CP, 7.00-14.00%CF, 1.0%EE, and 4.00-13.10 %Ash (Dzidiya *et al,* 2015). The difference in the results is thought to arise from the type of ingredients used in the feed formulations. It is worthy of note that the %CP in this study (13.56 - 26.43) using poultry litter as the principal protein source is comparable to the %CP (17.2-17.6) using soybeans as a principal protein source (Muhammad *et al.,* 2016). This indicates that cheap protein sources like poultry litter can replace the expensive human protein sources such as soybean.

Table 5: Cost of Ingredients and Multi-nutrient blocks

Ingredients	F1	F2	F3	F4	F5
Maize Bran	882	1,764	1,176	588	588
Millet Bran	714	-	1,428	1,785	1, 071
Sorghum	1,190	583	595	1190	1,190
Poultry Litre	-	-	-	-	-
Blood Meal	842	701	631	1,122	701
Urea	266	400	200	133	133
Salt	166	83	250	166	83
Bone Meal	322	537	215	322	268
Molasses	833	-	666	333	666
Cement	-	880	88	880	880
Okra Juice	315	252	210	63	157
Total Cost (₦)	5,530	5,200	5,459	6582	5737
Cost per block (₦)	79	74	78	94	82
Cost per Block (USD $)	0.48	0.45	0.48	0.58	0.50

$1 US Dollar = ₦ 163.

The cost of producing a multi-nutrient block was estimated based on the price of the feed ingredients in the market when the exchange rate of $1 USD was equivalent to ₦163 (Table 5). For a 20kg formulation, a total of 70 blocks were produced costing about ₦ 5,200 – ₦ 6582. The highest cost of production recorded was in F4 (6582₦) which was a consequence of the inclusion level of blood meal. In general, the cost of producing one multi-mineral block ranged from ₦ 74 - ₦94. This production cost is somewhat affordable for small local farmers in the study area.

4. Conclusion

Of all the formulations, F2, in addition to its least cost of production (₦74/block), had the better compactness and hardness that can ensure the slow release of nutrients to animals as they lick the blocks. This finding indicates that affordable multi-nutrients blocks for small farmers can be produced with protein sources like poultry litter that does not compete with the expensive human protein sources such as soybean and groundnut. The inclusion of cement in the production of the blocks provides good compactness and hardness required. The results further indicate that using locally available resources in feed formulation may contribute to waste management through the recycling of waste into feed for animals thereby abating pollution in the environment.

REFERENCES

Abbator, F.I., Kolo, U.M., Taimako, R.M.A. & Kwaghe, A.L. (2016). Performance of goats fed bovine rumen content and wheat offal as supplement to groundnut haulms. *Global Journal of Agricultural Research.* 4, 9-16.

Crowder, L.V., Chleda, H.R. 1982. Tropical Grassland Husbandary. 14th ed. Harlow, Essex, Britain: Longman Group: In Mshelizah, M.S., Malgwi, I.H., Mohammed, I.D. (2015). Dry Seasons Feeding Regimes for Ruminants and Their Rumen Degradation Characteristics in a Semi-Arid Environment of Nigeria. *Global Journal of Animal Scientific Research.* 3, 497-502.

Dzidiya, M. B., Malgwi, I.H., Nyako. H.D., Mohammed, I.D., Yahya, M.M. & Abbaya, H.Y. (2015). Multi–Mineral Block Formulation and Production Using Locally Available Feed Ingredients in Semi – Arid Region of Nigeria. *IOSR Journal of Agriculture and Veterinary Science.* 8, 41-47.

Karimizadeh, E., Chaji, M. & Mohammadabadi, T. (2017) Effects of physical form of diet on nutrient digestibility, rumen fermentation, rumination, growth performance and protozoa population of finishing lambs. *Animal Nutrition.* 3, 139-144.

Long, R.J., Dong, S.K., Wei, X.H. & Pu, X.P. (2005). The effect of supplementary feeds on the bodyweight of yaks in cold season. *Livestock Production Science.* 93, 197–204.

Makkar, H.P.S (2007). Feed Supplementation Blocks, Urea-molasses multi nutrient blocks: simple and effective feed supplement technology for ruminant agriculture. *FAO Animal Production and Health.* 164, 1-12.

Malgwi, I.H. & Mohammed, I.D. (2015). Development of Dry Season Supplements for Ruminants and Their Degradation Characteristics in the Semi Arid of Nigeria. *Global Journal of Animal Scientific Research.* 3, 403-411.

McDowell, L.R. (1996). Feeding mineral to cattle on pasture. *Animal Feed Science Technology*. 60: 247-271.

Mohammed, I. D., Baulube, M. & Adenyinka, I. A. (2007). Multi-nutrient Blocks 1: Formulation and Production under a semi-arid environment of North Eastern Nigeria. *Journal of Biological Sciences.* 7, 389-392.

Mshelizah, M.S., Malgwi, I.H. & Mohammed, I.D. (2015). Dry Seasons Feeding Regimes for Ruminants and Their Rumen Degradation Characteristics in a Semi-Arid Environment of Nigeria. *Global Journal of Animal Scientific Research.* 3, 497-502.

Mubi, A.A., Kibon, A. & Mohammed, I.D. (2013). Formulation and production of multinutrient blocks for ruminants in the guinea savanna region of Nigeria. *Agriculture and Biology Journal of North America.* 4, 205-215.

Muhammed, U.R., Bala, A.G., Bello, A.D., Al-Habib, I.K. & Shuaibu, A.S. (2016). Production of Multinutrient Blocks for Ruminant Animals Using Different Types and Levels of Binders in the Sudan Guinea Savanna of Nigeria. *New York Science Journal.* 9, 1-4.

Norman, M.J.T. (1963). The pattern of dry matter and nutrient content changes in nature pasture and Kotherine. *Australian journal* of experimental *agriculture* and *animal* husbandry. 3, 119-124.

Rafiq, M., Mumtaz, S., Akhtar, N. & Khan, M.F. (2007). Effect of strategic supplementation with multi-nutrient urea molasses blocks on body weight and body condition score of Lohi sheep owned by tenants of Pakistan. *Small Ruminant Research.*70, 200–208.

Sharma, K., Dutta, N. and Naulia, U. (2004). An on farm appraisal of feeding urea treated straw to buffaloes during late pregnancy and lactation in mixed farming system. *Livestock Research for Rural Development.* 16, 1-5.

Sunarso, B., Haryanto, E., Kurnianto, K.A., Setiadi, L.K., Dan, N. & Christiyanto, M. (2011) Technology of local feed utilization towards ruminant production improvement. *Pengemb Inov Pertan.* 4, 189-204.