

1 **The Effect of Replacing Molasses with Pineapple Pulp in Multi-Nutrient Feed Blocks**
2 **Containing Different Foliages**

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5 Running title: Replacing Molasses with Pineapple Pulp in Foliages

6

Abstract

This study was carried out to determine the effect of replacing Molasses with Pineapple pulp in 9 multi-nutrient feed blocks (MNFBs) containing *Chromolaena odorata*, *Tithonia diversifolia*, *Merremia aegyptia* on their mineral and anti-nutritional components. The nine MNFBs were formulated to contain (1) 10M20P0B (2) 10M20P10C (3) 10M20P10T (4) 10M20P10M (5) 0M30P0B (6) 0M30P10C (7) 0M30P10T, (8) 0M30P10M (9) 30M0P0B. The molded blocks were sundried for three days until it was completely dry and hard. The inclusion of browse plants had a significant influence ($p < 0.05$) on the mineral content of MNFBs. 10M20P10M had 18.48g/kg of Potassium. 10M20P10T had Copper content of 0.5 mg/kg while 10M20P10C had Calcium content with 240.55g/kg. However, 10M20P0B had Zinc (11.37 mg/kg). 30M0P0B contained tannin content (4.25 g/kg) while 10M20P10T had saponin at 1.43%. MNFBs containing *Chromolaena odorata* (10M20P10C and 0M30P10C) had Copper, Calcium and saponin contents. 30M0P0B had the highest tannin content of 4.25 g/kg. MNFBs with no molasses had moderate levels of tannin content while 10M20P10M had the lowest tannin level of 0.79g/Kg. It could be concluded that the browse plants and pineapple pulp used for this experiment can serve as good sources of Calcium, Potassium and Copper supplements in ruminant feed.

Keywords: Browse plant, *Chromolaena odorata*, *Merremia aegyptia*, *Tithonia diversifolia*

Word count : 197

Introduction

Ruminants (cattle, sheep and goats) are important livestock components in all ecological zones and every type of agricultural systems in tropical Africa (FAO ,2011). In Nigeria, grazing on communal lands is the dominant feeding system and the nutritive value is not a constraint when there is rain, but during the extended dry seasons, they are low in nutritive value (Sanusi *et al.*, 2017). The technique adopted to improve feed use and animal performance consists of mixing the required feed ingredients in a container and pouring the mixture into molds and leaving to solidify into blocks (Bheekhee , 2010) . Reports abound in the literature on the origin, development, formulation, manufacture and utilization of multinutrient feed blocks as supplements for ruminant animals have increased considerably in developing countries especially in Nigeria (Asaolu 2009; Aye and Adegun 2010) from various locally available materials. These multinutrient feed blocks (MNFB) contains urea, molasses, pineapple pulp, browse plants such as *Chromolaena odorata*, *Tithonia diversifolia* and *Mmeremia aegyptiary* and binding agents. Different ingredients used in MNFB have major roles in ruminant feed such as (1) Urea: it supplies small quantity of nitrogen required by the rumen microbes. Nitrogen must be sufficient to maintain the ammonia level in the rumen, at a optimum level for the development of the rumen microbes leading to better degradation of the fibre . (2) Molasses is a major by-product of the sugar industry and is considered a good source of energy for feeding ruminants as it contains high levels of sugars (48—56 percent). Molasses is low in protein (<3.5 percent), but it contains water soluble vitamin B, with iodine, sulphur, cobalt, lead, zinc and manganese.. (3) Browse plants/Minerals: they supplement minerals deficiency in animal diet (4) Cement or quick limes: it is a binding agent (Upreti *et al.*, 2010). The use of fodder trees as supplements has been suggested as an alternative to the use of concentrates (Yusuf *et al.*, 2023). The forages from these trees contain reasonable amounts of protein, both as soluble and insoluble components, and are also an important source of minerals such as Sulphur, Copper and Iron (Somasiri *et al.*, 2010a). The availability of fodder trees, with leaves rich in good quality protein, which could be a cheap and suitable solution, has however been observed by Lata and Mondal (2021). Therefore, replacement of molasses with pineapple pulp in multi-nutrient feed blocks containing different foliages to meet the nutritional requirement of ruminant animal throughout the year was the focus of this project work.

Materials and Methods

Experimental site

The mineral analysis was carried out at the Central Laboratory, Federal University of Agriculture, Abeokuta (FUNAAB) Ogun State, Nigeria. This location lies along the South-West geo-political zone of Nigeria with an annual rainfall of 2400mm and annual temperature range of 25⁰C to 32⁰C (Latitude 7⁰93' N and Longitude 3 ⁰20^t E). (Google Earth, 2014) The anti-nutritional factors' determination was carried out at Precision Analytical and Research Laboratory, Ibadan, Oyo State.

Sourcing and Preparation of Feed Ingredients

All the available feed ingredients and agro-industrial by-products were sourced-from a reputable commercial feed miller in Abeokuta, Ogun State. The browse plants (*Merremia aegyptia*, *Tithonia diversifolia*, *Chromolaena odorata*) were sourced around the school premises. Pineapple pulp, which was used in fresh form immediately after collection, was sourced from Fruit juice manufacturing company at Ibadan, Oyo State, Nigeria. After gathering the browse leaves, they were sundried while still retaining its greenish colour.

Multinutrient blocks

Multinutrient blocks were made by heating molasses at 40°C for 10 minutes. The ingredients for the multinutrient block were mixed in a bucket with the order of feedstuffs having the lowest volume to those with the highest volume. Then, all ingredients were mixed until homogeneous. Mixing of the ingredients was done by hand. The feed block were formed using a plastic mold. The molded blocks were sundried for three days until it was completely dry and hard.

Statistical Analysis

All data collected from parameters investigated were based on completely randomized design and subjected to one way analysis of variance using the procedure of statistical analysis

software SAS 9.1 (SAS, 2003) and treatment means were compared using Duncan's procedure of the same software (Duncan, 1955). The statistical model focused primarily on inclusion level effect as the main treatment. The following model was thus used: $Y_{ij} = \mu + M_j + e_{ij}$; where Y_{ij} is the dependent, continuous variable; μ is the overall mean; M_j is the fixed effect of the j th inclusion of ruzi and or *Panicum maximum* and e_{ij} is the residual error.

Conflict of interest

There were no conflict of interest whatsoever.

Results

The mineral composition of the browse plants and pineapple pulp is shown in Table 2. Potassium content was observed to be 21.30g/kg in *Mmeremia aegyptia* , 16.82g/kg in *Tithonia diversifolia*, 20.52g/kg in *Chromolena odorata* and 20.60 g/kg in pineapple pulp respectively. The value of Zinc observed in the browse plants and pineapple pulp was in the range of 11.14 mg/kg and 11.40 mg/kg The Copper content observed, showed that *Tithonia* had the highest Copper content was found to be 0.6 mg/kg while *Chromolena odorata* had the lowest copper content of 0.20 mg/kg. *Mmeremia aegyptia* and pineapple pulp had values of 0.26 mg/kg and 0.29 mg/kg respectively. The Calcium content of the browse plants and pineapple pulp were observed to be in the range of 78.70g/kg and .25g/kg in *Tithonia diversifolia* and *chromolena odorata* respectively.

Table 3 shows the mineral composition of the multnutrient feed blocks with different inclusion levels of pineapple wastes and molasses. The Potassium content varied from 17.13 g/kg to 18.48 g/kg. 0M30P0B had the lowest Potassium level (17.13 g/kg) and 10M20P10M contained the highest amount(18.48 g/kg) respectively. The highest Zinc value was observed in 10M20P0B as 11.37 mg/l and the least value was observed in 0M30P10M as 11.03 mg/kg respectively. It was also observed that the highest value of Copper was found in 0M30P10T at 0.55 mg/kg and the lowest value was discovered in 0M30P10M at 0.22 mg/kg. Calcium content was in the range from 193.83 g/kg to 240.55 g/kg.

Table 4 shows the anti-nutritional factors (tannin and saponin) present in the following browse plants and pineapple pulp. *Chromolaena odorata* had the highest value of tannin (10.5 g/kg) and pineapple pulp had the lowest of 2.63 g/kg while *Tithonia diversifolia* and

119 *Merremia diversifolia* had 8.45 g/kg and 8.5g/kg respectively. Chromolena showed the
120 highest level of saponin content at 3.66%, *Tithonia diversifolia* at 3.32%, *Merremia aegyptia*
121 at 1.58% respectively. The lowest value of saponin was recorded in pineapple pulp as I
122 .32%.

123 Table 5 shows anti-nutritional factors (tannin and saponin) in multinutrient blocks with
124 different inclusions of pineapple waste and molasses. The study showed that 30M0P0B had
125 the highest value (4.25 g/kg), while 0M30P10M had the least value of 0.79 g/kg for tannin .
126 The contents of tannin in 10M20P10T and 10M20P10 were similar as 2.06 mg/kg.
127 10M20P10M was observed to have the highest value (1.43%) of saponin and the least value
128 was observed in 10M20P0B with a value of I .06%. There was a very close similarity
129 between 0M30P10T, 30M0P0B and 10M20P10M with 1.43%, 1.42% and 1.43%
130 respectively

131 Discussion

132 The high value of Potassium in 10M20P10M could be due to the inclusion of *Merremia*
133 *aegyptia* and molasses because *Merremia aegyptia* had higher Potassium value than other
134 browse plants and pineapple pulp with a value of 21.30g/kg and it was observed that the
135 multinutrient blocks with molasses had relatively higher values of potassium than those with
136 no molasses. This shows the importance of these browse plants as sources of Potassium which
137 is involved in acid-base regulation, osmotic pressure maintenance, ruminal digestion, nerve
138 impulse transmission, muscle contraction, and carbon iv oxide and oxygen transport (Goff,
139 2018). The amount of copper in the multinutrient feed blocks which was in the range from
140 0.22 mg/kg to 0.55mg/kg. was lower than the critical levels for ruminants is in line with the
141 report given by Asaolu, V. O. (2012). The inclusion of *Tithonia diversifolia* had an effect on
142 the high value of 0.55mg/kg which was reported in 0M30P10T. *Chromolena odorata* had an
143 effect on the calcium content of the multinutrient blocks in which it was included
144 (10M20P10C and 0M30P10C) with similar values of 231.17g/kg and 240.55g/kg
145 respectively. The reason is not farfetched, as *Chromolena odorata* had the highest value of
146 calcium (132.53g/kg), surpassing other browse plants and pineapple pulp. However, the
147 highest content of Calcium was observed in 0M30P10C at a value of 240.55g/kg. it has been
148 reported that Calcium (Ca) is essential for muscle contraction, blood clotting, skeletal tissue
149 and transmission of nervous impulses. Inadequate supply of Calcium during early lactation
150 results in milk fever and loss of milk that can not be regained. If dietary Ca is inadequate or
151 unavailable, depletion of Ca occurs from the bone reserves. Calcium interacts well with
152 Vitamin D, helps in bone formation, blood clotting, control of the heartbeat, membrane
153 permeability and as a co-factor in many enzymatic reactions. Its deficiencies include
154 decreased growth, decreased milk growth, poor conception, e.t.c. Zinc, on its own part, has a
155 profound effect on males — much more than females, since it is involved in sperm production
156 and the development of the sex organs. Its deficiency symptoms include. high bacteria in the
157 mouth with excess saliva, stiffness of the joints and low male sex drive. Zinc in milk is
158 proportional to feed intake and since goats' milk is usually too low in zinc to be ideal for
159 human consumption, so, supplementing zinc is a real benefit, especially when the milk is
160 required for feeding babies. Large quantities of Potassium is also needed in the feed. Grass
161 contains high level of potassium and deficiencies are therefore rare in grazed stock. They are
162 not toxic and its deficiencies which include emaciation, retarded growth, low feed intake, e.t.c

are detrimental to the goats and the farmers' yield. Copper, on its own part, participates in the keratinization and pigmentation of hair, serves as a structural component of certain proteins and is also essential for the proper development and function of rumen micro-organisms. Some of its deficiencies are diarrhea, anemia, abnormal appetite, osteomalacia, e.t.c. However, nutrient requirements in animals vary, e.g. lactating animals. In cases where there is need for more nutrient utilization or the nutrients are not enough or a specific animal or a group of animals, the feed offered to the animals or the affected animal should be supplemented with the nutrient/mineral. This can be done via offering free choice (cafeteria system), mixing minerals in concentrates, offering them multivitamin feed blocks, giving minerals to animals as a lick, to mention a few. Therefore, the quantity of dietary Ca is important, not only for maximum milk production and avoidance of hypoglacaemia, but also for maintenance of bone and teeth integrity (Gaingon *et al.*, 2019). The tannin contents in *Chromolena odorata*, *Tithonia diversifolia*, *Merremia aegyptia* ranged from 0.26 — 1.05%, lower than 0.84-2.52% reported by Fadiyimu *et al.*, (2011). This average tannin content is lower than the 2 — 5% range that can affect digestibility in sheep and cattle or 9% in goat because of threshold capacity to handle dietary tannin of that level (Amuda and Alagbe, 2023). The same applied to the tannin contents in the multivitamin blocks, except 30M0P0B which had a tannin content of 4.25 g/kg. The high tannin content of 30M0P0B could be due to the high inclusion level of molasses in the feed block, which suggests that molasses has a reasonably high content of tannin in it. Cieslak (2013) reported that tannins have been found to be toxic for many of the rumen microbes, especially ciliate protozoa, fibre degrading microbes and methanogenic bacteria, as a result of this property, the methanogenesis in the rumen will also reduce.

The saponin contents of the multivitamin blocks ranged from 1.2% - 1.43% which was observed to be lower compared to the browse plants used (*Chromolena odorata*, *Tithonia diversifolia* and *Merremia aegyptia*). Saponin is a compound in glycosides widespread in plants. It has biological properties, such as haemolytic, antibacterial, antimouse, antiviral, cytotoxic or anticancer activities. Saponin also has a function as defaunation agents in the rumen. Tropical plants contain high amount of saponin and have been found to have antiprotozoal and antimethanogenic activity thereby increasing feed digestibility (Arumsari *et al.* 2021). The decrease in protozoa can increase microbial protein because protozoa in the rumen use microbial protein as feed (Yanuartono *et al.*, 2019). However, it can cause a bitter taste that is disliked by livestock (Pujaningsih *et al.*, 2022).

Micro elements like zinc and copper have favorable contents as they are needed in low quantity by the animal. In the other way round, macro elements like potassium and calcium come in

large quantities, with a range of 17.13g/kg – 18.48g/kg and 193.83 g/kg — 240.55g/kg respectively, which is ideal for animals as they are needed in large quantities. *Chromolaena odorata* and pineapple pulp can serve as good sources of calcium supplements in ruminant feed. It can be used to meet the requirements of the animals where calcium is deficient. On the other hand, MNFBs with molasses contained higher tannin contents. For instance, 30M0P0B was found to contain the highest tannin value of 4.25 g/kg which could be harmful for the animals while 10M20P10M had the highest content of saponin (1.43%) which is less harmful (Ejoh *et al.*, 2007) and thus will reduce the toxicity that results from feeding on a diet with high contents of anti-nutritional factors. The saponin contents of the feed blocks were also favorable, ranging from 1.06% - 1.43%, lower than 1.44% reported by Westerndarp, 2005.

Summary

It can be concluded that the inclusion of browse plants (*Chromolaena odorata*, *Tithonia diversifolia* and *Merremia aegyptia*) browse plants can go a long way in supplementing needed nutrients in ruminants. This indicates that this technology offers various options to ruminant owners in the feeding management of their flocks. Further research could lead to the widening of the scope of utilization of this technology in order to meet specific nutritional requirements of the animals including cows at specific stages for a better production.

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Table 1: Composition of multi nutrient feed blocks

Ingredients %	10M	10M	10M	10M	0M	0M	0M	0M	30M
	20P	20P	20P	20P	30P	30P	30P	30P	0P
	0B	10C	10T	10M	0B	10C	10T	10M	0B
Molasses	10	10	10	10	0	0	0	0	30
Pineapple	20	20	20	20	30	30	30	30	0
Urea	10	10	10	10	10	10	10	10	10
Wheat offal	39.5	39.5	29.5	29.5	39.5	29.5	29.5	29.5	39.5
Palm Kernel Cake	10	10	10	10	10	10	10	10	10
Lime Stone Powder	10	10	10	10	10	10	10	10	10
Chromolena	0	10	0	0	0	10	0	0	0
Tithonia	0	0	10	0	0	0	10	0	0
Mmeremia	0	0	0	10	0	0	0	10	0
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100	100

281 10M20P0B =10% molasses, 20% pineapple pulp, no browse plant

282 10M20P10C=10% molasses, 20% pineapple pulp, 10% *Chromolaena odorata*

283 10M20P10T = 10% molasses, 20% pineapple pulp, 10% *Tithonia diversifolia*

284 10M20P10M= 10% molasses, 20% pineapple pulp, 10% *Mmeremia aegyptia*.

285 0M30P0B=0% molasses, 30% pineapple pulp, no browse plant

286 0M30P10C= 0% molasses, 30% pineapple pulp, 10% *Chromolaena odorata*
287 0M30P10T= 0% molasses, 30% pineapple pulp, 10% *Tithonia diversifolia*
288 0M30P10M= 0% molasses, 30% pineapple pulp, 10% *Mmeremia aegyptia*
289 30M0P0B=30% molasses, 0% pineapple pulp, no browse plant
290
291

292 **Table 2: Mineral composition of browse plants and pineapple pulp**

Minerals	<i>Chromolaena</i>	<i>Tithonia</i>	<i>Merremia</i>	Pineapple pulp	SEM	P-Vavue
	<i>Odorata</i>	<i>Diversifolia</i>	<i>Aegyptia</i>			
Potassium (g/Kg)	20.52 ^b	16.82 ^d	21.31 ^a	20.00 ^c	0.060	>.001
Zinc(mg/Kg)	11.14	11.27	11.25	-	0.070	0.50
Copper (mg/Kg)	0.20	0.63	0.26	0.29	0.069	0.06
Calcium (g/Kg)	132.52 ^a	78.70 ^d	94.92 ^c	131.28 ^b	0.060	>.001
Magnesium (g/Kg)	11.94 ^c	10.26 ^d	12.55 ^b	12.94 ^a	0.075	>.001

293 *a,b,Mean values in the same row with different superscripts differ significantly ($p < 0.05$).*

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296 **Table 3: Mineral composition of the multnutrient feed blocks with different inclusion levels of pineapple wastes and molasses**

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Minerals	10M 20P 0B	10M 20P 10C	10M 20P 10T	10M 20P 10M	0M 30P 0B	0M 30P 10C	0M 30P 10T	0M 30P 10M	30M 0P 0B	SEM	P-Value
Potassium(g/kg)	18.01 ^d	18.40	^b 18.05 ^d	18.48 ^a	17.13 ^h	18.11 ^c	17.50 ^f	17.29 ^g	17.81 ^e	0.013	<.001
Zinc(mg/kg)	11.37 ^a	11.26 ^c	11.31 ^b	11.20 ^e	11.21 ^{de}	11.25 ^c	11.22 ^d	11.03 ^g	11.18 ^f	0.003	<.001
Copper(mg/kg)	0.50 ^b	0.44 ^c	0.23 ^f	0.25 ^e	0.27 ^d	0.43 ^c	0.55 ^a	0.22 ^f	0.49 ^b	0.007	<.001
Calcium(g/kg)	220.14 ^c	231.17 ^b	193.83 ⁱ	202.02 ^e	196.12 ^h	240.55 ^a	216.72 ^d	198.39 ^f	197.83 ^g	0.034	<.001
Magnesium(g/kg)	5.22 ⁱ	11.92 ^a	11.34 ^g	11.77 ^c	11.51 ^d	11.90 ^b	11.46 ^f	11.24 ^h	11.48 ^e	0.003	<.001
Sodium (g/kg)	12.64 ^b	11.00 ^f	12.41 ^c	10.76 ^g	11.84 ^e	12.28 ^d	12.26 ^d	10.19 ^h	13.30 ^a	0.010	<.001

298 *a,b,Mean values in the same row with different superscripts differ significantly (p< 0.05).*

299

300 10M20P0B =10% molasses, 20% pineapple pulp, no browse plant

301 10M20P10C=10% molasses, 20% pineapple pulp, 10% *Chromolaena odorata*

302 10M20P10T = 10% molasses, 20% pineapple pulp, 10% *Tithonia diversifolia*

303 10M20P10M= 10% molasses, 20% pineapple pulp, 10% *Mmeremia aegyptia*.

304 0M30P0B=0% molasses, 30% pineapple pulp, no browse plant

305 0M30P10C= 0% molasses, 30% pineapple pulp, 10% *Chromolaena odorata*

306 0M30P10T= 0% molasses, 30% pineapple pulp, 10% *Tithonia diversifolia*

307 0M30P10M= 0% molasses, 30% pineapple pulp, 10% *Mmeremia aegyptia*

308 30M0P0B=30% molasses, 0% pineapple pulp, no browse plant

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311 **Table 4: Anti-nutritional factors (tannin and saponin) present in the following browse plants and pineapple pulp:**

Anti-nutritional factors	<i>Chromolena</i> <i>Odorata</i>	<i>Tithonia</i> <i>diversifolia</i>	<i>Mmeremia</i> <i>Aegyptia</i>	<i>Pineapple Pulp</i>	<i>SEM</i>	<i>P-Value</i>
Tannin (g/Kg)	10.50 ^a	8.45 ^b	8.50 ^b	2.63 ^c	0.015	<.001
Saponin (g/Kg)	3.66 ^a	3.32 ^b	1.58 ^c	1.32 ^d	0.010	<.001

312 *a,b,Mean values in the same row with different superscripts differ significantly ($p < 0.05$).*

313

Table 5: Anti-nutritional factors (tannin and saponin) in multnutrient blocks with different inclusions of pineapple waste and molasses

Anti-nutritional factors	10M 20P 0B	10M 20P 10C	10M 20P 10T	10M 20P 10M	0M 30P 0B	0M 30P 10C	0M 30P 10T	0M 30P 10M	30M 0P 0B	SEM	P-Value
Tannin (g/kg)	1.30 ^{cd}	1.56 ^c	2.06 ^b	2.06 ^b	0.98 ^{de}	1.15 ^{de}	0.88 ^c	0.79 ^c	4.25 ^a	0.109	<.001
Saponin (%)	1.06 ^d	1.20 ^c	1.08 ^d	1.43 ^a	1.30 ^b	1.19 ^c	1.43 ^a	1.24 ^c	1.42 ^a	0.016	<.001

a,b,Mean values in the same row with different superscripts differ significantly ($p < 0.05$).

10M20P0B =10% molasses, 20% pineapple pulp, no browse plant
10M20P10C=10% molasses, 20% pineapple pulp, 10% *Chromolaena odorata*
10M20P10T = 10% molasses, 20% pineapple pulp, 10% *Tithonia diversifolia*
10M20P10M= 10% molasses, 20% pineapple pulp, 10% *Mmeremia aegyptia*
0M30P0B=0% molasses, 30% pineapple pulp, no browse plant
0M30P10C= 0% molasses, 30% pineapple pulp, 10% *Chromolaena odorata*
0M30P10T= 0% molasses, 30% pineapple pulp, 10% *Tithonia diversifolia*
0M30P10M= 0% molasses, 30% pineapple pulp, 10% *Mmeremia aegyptia*
30M0P0B=30% molasses, 0% pineapple pulp, no browse plant

