

## CHEMICAL COMPOSITION OF SOME AGRO BY PRODUCTS: POTENTIALS AND IMPLICATIONS FOR RUMINANT ANIMAL NUTRITION

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### ABSTRACT

*The study determined the proximate, mineral composition, fibre fractions and anti nutritional factors content of Bambara nut offal, cowpea seed coat, cassava peels meal, cashew nut shell, mango seed kernel. The samples analyzed were sourced from and prepared for analyses in Anyigba, Kogi State, Nigeria, The Standard analytical methods of (AOAC, 2005) was used to determine the Dry Matter (DM), Crude Protein (CP), Ether Extract (EE), Crude Fibre (CF) and Nitrogen Free Extract (NFE). The fibre fractions, Hemicellulose, cellulose, lignin, neutral detergent fibre and acid detergent fibre were determined using the method of Van Soest et al., (1991). The minerals were determined using the atomic absorption spectrophotometer, the anti nutritional factors were determined using methods described for determining each of them. Values for crude protein, nitrogen free extracts, hemicellulose and neutral detergent fibre for Bambara nut shell, were 27.10%, 60.76%, 18.78% and 46.50%, for cowpea seed coat it was , 22.40, 58.28, 9.75% and 35.60%. Cassava peels meal had 5.81, 70.88, 14.12 and 41.50%, cashew nut shell had 6.21, 36.60, 7.31 and 24.2%. For mango seed kernel it was 6.96, 70.92, 4.64 and 11.42% respectively. The mineral contents were 1.88 mg/g Sodium in Bambara nut offal, 5.90mg/g potassium in cowpea seed coat, 4.30mg/g Calcium in cassava peels meal, 5.11mg/g magnesium in cashew nut shell and 4.58 mg/g iron in mango seed kernel*

*The anti nutritional factors reported were 1.20mg/kg tannins in Bambara nut offal, 0.65mg/kg phytate in cowpea seed coat, 8.00mg/kg saponin in cashew nut shell, 0.15mg/kg alkaloids in cassava peels meal and 0.05 mg/kg hydrogen cyanide in mango seed kernel, It was concluded that all the agro by products examined contain fairly good array of nutrients suitable for ruminant feeding. Bambara nut offal appears to have the best array of nutrients. All the agro by products determined can serve as components for ruminant feeds Treatment is recommended to improve their nutritive content, palatability and digestibility. Further studies should focus on methods of removing or reducing the levels of the anti nutritional factors present in the by products*

**Keywords:** Agro by Products, Fibre Fractions, Minerals, Ruminant Animal Nutrition Potentials, Proximate Composition,

## **1.0 INTRODUCTION**

The problem of animal protein shortage in Nigeria and other developing nations has attained a deplorable status which calls for urgent remedy to avert the imminent protein malnutrition (Adekunmi *et.al*, 2017)

Livestock feeds have become very expensive resulting in decrease in livestock production (Bamgbose *et al.*, 2004). Unfortunately, there is also an increasing competition between man and livestock for available feedstuffs, for food, feed and as industrial raw materials It was reported that the level of performance of livestock in the livestock production industry has gone down remarkably below expectation due to the high cost of production, mainly arising from the costs of the conventional feed ingredients of protein and energy sources (Dairu and Ogunmodede, 2004). Low supply and high cost of animal proteins such as beef, pork, mutton, chevon, poultry, egg and milk has brought about an acute shortage of animal protein in the diet of most Nigerians. This is mainly due to the high cost of conventional feed ingredients used in formulating rations for livestock (Odedire & Abegunde, 2015). Ajide *et al.* (2023) reported that competition for conventional feedstuffs between man, industries and animals has necessitated the need to look for non-conventional feed materials that are cheap but high in quality. Ruminant animals have a distinct advantage over monogastric animals being capable of converting fibrous organic materials that are unsuitable for human consumption, into products of high nutritive value to man. Nutritional constraints have been implicated as one of the major problems militating against small ruminant production in Nigeria (Achonwa *et.al.*, 2022). This is especially so during the dry season when scarcity of feed materials exists. There is therefore the need to explore unconventional / alternative and cheaper feed stuffs, these alternative feed resources must be cheap, readily available, nutritionally adequate and less competed for by man and industries (Akinmutimi, 2006)

High cost of conventional feed resources such as maize due to high cost and stiff competition amongst man, livestock and industries has contributed to low level of ruminant animal production in the country. The problems associated with the use unconventional feed stuffs are, high fibre content, low protein and energy content, toxic and antinutritional factors, problems of collection in large quantities (Aduku, 2004 ).

Fibre at recommended levels have been reported to have nutritional, physiological and prophylactic functions in animals (Anugwa, 1989). High levels of fibre however have been reported to be detrimental to animals, it impairs feed intake and reduces digestibility (Mc Donalds *et al .*, 2002)

Minerals are very important in ruminant animal nutrition , especially, calcium, phosphorus, magnesium , copper , cobalt etc (Aduku 2004)

Anti nutritional factors (ANFs) are chemical compounds in plants that impair the digestion, absorption, or utilization of nutrients by animals , they are part of plants defense mechanisms(Aduku, 2004)

There is need to evaluate the chemical composition of unconventional feed stuffs, so as to determine their suitability or otherwise as livestock feed stuffs.

This study was therefore designed to evaluate the proximate, mineral composition, fiber fractions and antinutritional factors levels of five (5) agro by products

## **2.0 MATERIALS AND METHODS**

### **2.1 Collection and processing of Agro by Products**

The agro by products were sourced from Anyigba and prepared for analysis, they were then sent to the laboratory for proximate composition and fibre fraction analysis

#### **2.2 Chemical Analysis**

The Proximate composition was determined by The Standard analytical methods (AOAC, 2005) to determine Dry Matter (DM), Crude Protein (CP), Ether Extract (EE), Crude Fibre (CF) and Nitrogen Free Extract (NFE).

##### **2.2.1 Dry matter (DM)**

The agro by products were weighed and put into an oven at 105<sup>0</sup> C for 24 hours to dry up to constant weight. The differences between the original and final weight was determined as follows.

$$\text{Moisture (\%)} = \frac{W1-W2}{W1} \times 100$$

Where W1 = weight of sample + Petri dish before drying

W2 = weight of sample + Petri dish after drying

W = weight of sample

### **2.2.2. Crude protein (CP)**

The crude protein was determined by the Kjeldahl method. This consists of 3 stages as indicated below. About 2.0 g of prepared sample well mixed with 20 ml of Conc H<sub>2</sub>SO<sub>4</sub> was digested. After digestion, the sample was placed in to distillation machine for distillation by adding NaOH to the digested sample which will react with the ammonium sulphate to give NH<sub>4</sub>OH + Na<sub>2</sub>SO<sub>4</sub>. When the distilled samples become green, indicating the presence of a base (NH<sub>3</sub>), the green distillate was carried for titrating with 0. IN HCl. Crude protein will then be obtained by calculation as follows:

$$\%N = \frac{14.01 (\text{ml of titrant sample} + \text{ml of titrant of black}) \times \text{molarity of standard}}{\text{g of sample} \times 10}$$

% Crude Protein N x 6.25 (factor for feeds).

### **2.2.3 Crude fibre (CF)**

About 1.0 g of prepared sample was digested using a digestion reagent consisting of 20 ml trichloroacetic acid, 20 g glacial acetic acid, 500 ml of NHO<sub>3</sub>, all diluted to 1 litre with distilled water. The digested sample was removed and allowed to cool to room temperature and then was filtered through an ashless filter paper that was initially weighed. The paper was then placed in an oven at 80<sup>0</sup>C over night to remove all the moisture and then weighed. The residue after drying (Paper + fibre + ash) is ashed in a muffle of 55<sup>0</sup> C for 3 hours and the ash is weighed. The fibre was determined by calculation using the formula of Van Soest and Wine (1967):

$$\% \text{ Crude fibre} = \text{weight of fibre} \times 100 / 2 \text{ g of sample}$$

### **2.2.4. Ether Extract (EE)**

About 2.0 g prepared sample and 200 ml of petroleum ether was placed into an extraction chamber of soxhlet apparatus. The heating mantle was turned on at a temperature of 60<sup>0</sup> C for 5 hours and

later the flask was oven-dried at 100<sup>0</sup> C for 1 hour, cooled in a dessicator and weighed. Ether extract was calculated as:

$$(\%) \text{ Ether Extract} = \frac{\text{weight of oil flask after extraction} - \text{wt. of empty oil flask}}{\text{Weight of dried material taken}} \times 100$$

### **2.2.5. Nitrogen free extract (NFE)**

This was calculated for each sample by adding together and subtracting the percentages of moisture, crude protein, crude fibre, ether extract and ash from 100. NFE = 100 - (% CP + %CF + %EE + %Ash).

### **2.2.6 Fibre Fraction Determination**

The fibre fraction analysis was done according to the methods of Van Soest *et al.*, 1991. The percentage hemicelluloses content was determined by finding the difference between neutral detergent fibre and acid detergent fibre values. The analysis was carried out in triplicates and the mean values taken for each parameter, the values were determined in percentages.

### **2.2.6 Mineral Content Determination**

#### **Mineral Content Determination**

The mineral content of the agro by-products were determined using Atomic Absorption Spectrophotometry (AAS) and Flame Photometry, following standard methods (AOAC, 2019).

#### **3.4.1 Calcium (Ca) and Magnesium (Mg) Determination**

Ca and Mg were analyzed using AAS after digesting the samples with a nitric-perchloric acid mixture (AOAC, 2019).

#### **3.4.2 Phosphorus (P) Determination**

P content was determined using the vanadomolybdate colorimetric method, where absorbance is read at 420 nm (Fiske & Subbarow, 1925).

#### **3.4.3 Sodium (Na) and Potassium (K) Determination**

Na and K were analyzed using a flame photometer, following AOAC (2019) procedures.

#### **3.4.4 Iron (Fe), Zinc (Zn), and Copper (Cu) Determination**

These trace minerals were determined using AAS, with samples digested in concentrated hydrochloric acid (HCl), nitric acid (HNO<sub>3</sub>), and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) (AOAC, 2019).

### **2.2.7 Determination of Anti nutritional Factors Content**

The presence of anti-nutritional factors in the agro by-products were assessed using standard procedures.

#### **3.6.1 Tannin Determination**

Tannin content were determined using the Folin-Denis method (Makkar *et al.*, 1993).

Procedure:

- 0.5 g of sample were extracted with 50 ml of 70% acetone.
- The extract was mixed with Folin-Denis reagent and sodium carbonate.
- The absorbance was read at 760 nm using a spectrophotometer.

#### **3.6.2 Phytate Determination**

Phytate content was analyzed using the Wheeler and Ferrel (1971) method.

- Procedure
- The sample was extracted with HCl (0.2M).
- The extract was treated with ferric chloride solution.
- The precipitate was measured for phosphorus content, from which phytate levels will be calculated.

#### **3.6.3 Oxalate Determination**

Oxalate content was determined using the AOAC (2019) titration method.

Procedure:

The sample was boiled with 0.3M HCl, filtered, and titrated with 0.05M KMnO<sub>4</sub>.

#### **3.6.4 Saponin Determination**

Saponin content was determined using Gravimetric Method (AOAC, 2019).

#### **3.6.5 Trypsin Inhibitor Determination**

Trypsin inhibitors was measured using the Kakade *et al.*, (1974) methods by quantifying enzyme inhibition in a standard protein hydrolysis assay.

## **3.0 RESULTS AND DISCUSSION**

### 3.1 Proximate Composition

Table 1 shows the results of the proximate composition of the five Agro- byproducts. Dry matter values of 88.00 – 91.00 % are good enough, the crude protein content of 20.17% for Bambara nut offal and 22.40% for cowpea seed coat are higher than 12 – 18% crude protein recommended for growing ruminants in the tropics (NRC, 1996), while 5.91, 6.21 and 6.96% respectively for cassava peels meal, cashew nut shell and mango seed kernel were below the critical levels of 7 to 8% that can guarantee adequate rumen ammonia and ensure proper functioning of the rumen (Lakpini *et al.*, 2002) and will thus need supplementation with other protein sources. The Nitrogen free extracts values of 56.60 – 70.92% are adequate for ruminants and together with the ether extracts and crude protein will provide enough metabolizable energy for ruminants. The crude fibre values of 10.02% for cowpea seed coat and 14.70% for cashew nut shell are adequate for ruminants to ensure proper functioning of the rumen, prevent bloat and acidosis, while 6.02, 8.98 and 7.02% for Bambara nut offal, cowpea seed meal and mango seed kernel are inadequate for ruminants and will therefore need other fibre sources to attain balance. Ocheja *et al* (2009) reported the proximate values of bambara nut offal to be dry matter, 88%, crude protein , 18.20%, crude fibre , 16.89%, ether extracts, 5.79%, ash, 4.12% and nitrogen free extracts, 55.03%, , Onyimonyi and Onukwufor (2003) reported 17% and Amaefule and Ironkwe (2007) reported 19.22% for crude protein. Ocheja *et al* (2014) gave the proximate composition of raw cashew nut shell to be crude protein, 7.5%, crude fibre 20.80%, nitrogen free extracts, 31.50%, ether extracts 39.00% and ash 1.20%

The ether extracts value are above the values of 5 -6 % upper limit reported for ruminant diets by Maithison *et al* (1997), which can lead to milk fat depression, impaired appetite and crude fibre digestion

**Table:1 Proximate Composition of Agro By - Products.**

Parameters	BNO	CSC	CPM	CNS	MSK
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Dry Matter (%)	89.60	90.00	88.00	88.40	91.00
Crude Protein (%)	20.17	22.40	5.91	6,21	6.96
Ash content (%)	3.55	7.10	5.10	7.20	3.50
Ether Extract (%)	6,50	2.20	9.10	35.65	11.60
Crude fiber (%)	6.02	10.02	8.98	14.70	7.02
Nitrogen Free Extr	64.76	58.28	70.88	36.60	70.92

BNO- Bambara Nut Offal  
 CSC- Cowpea Seed Coat  
 CPM- Cassava Peels Meal  
 CNS - Cashew Nut Shell  
 MSK – Mango Seed Kernel

### 3.2 Fibre Fractions of The Agro by Products

The fibre fractions composition of the agro by products are presented in Table 2 .The crude fibre content of cashew nut shell was lower than 23.05 % reported by (Ocheja *et al.*, 2015 and 25.70% reported by Okolo *et al*, 2012, and 20.81%(Ocheja *et al* 2013). These disparities can be attributed to differences in soil condition, variety and method of analysis. The moderate NDF values of 11.42 to 46.52% was lower than 60% safe upper limit reported by Meissner, (1981) to guarantees feed intake and digestibility by ruminants. The lignin levels for all the agro by products are low and will facilitate digestibility. The cellulose and hemicellulose levels are moderate. The acid detergent fibre value of 27.20% was slightly lower than 28.20% reported by Ocheja *et al*, (2015).

The cellulose, hemicellulose , lignin, acid detergent fibre and neutral detergent fibre values are 26.16, 18.78, 1.56, 27.72 and 46.50% respectively, for Bambara nut offal , Adebowale, *et al*, (2011) reported 30.00 – 40.00% for neutral detergent fibre , 25.00 to 30.00% for acid detergent fibre and 15.00% for lignin

Adejoro *et al* 2019 reported a range of 50.20 – 65.40% for neutral detergent fibre , 35.10 – 48.60% , acid detergent fibre and 8.15 – 12.50% for lignin

The cellulose , hemicellulose , lignin, acid detergent fibre and neutral detergent fibre values for mango seed kernel were 5.44, 4.64, 1.34, 6.78 and 11.42% respectively.

The values for cassava peels meal were 19.70, 14.10, 7.55, 7.32 and 34.21% for cellulose, hemicellulose , lignin, acid detergent fibre and neutral detergent fibre respectively .

Obadina *et al* ( 2013) reported 60.50 – 75% , 40.10- 55.80% and 10.40 – 15.60% for neutral detergent fibre , acid detergent fibre and lignin respectively .

**Table:2 Fibre Fractions of Agro by Products**

Parameters	BNO	CSC	CPM	CNS	MSK
Cellulose (%)	26.15	23.35	19.77	11.31	5.44
Hemicellulose (%)	18.78	9.75	14.10	7.31	4.64
Lignin (%)	1.56	2.55	7.55	5.58	1.34
Acid Detergent Fibre (%)	27.72	25.90	7.32	16.89	6.78
Neutral Detergent Fibre (%)	46.50	35.63	41.50	24.21	11.42

BNO- Bambara Nut Offal  
 C SC- Cowpea Seed Coat  
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 MSK – Mango Seed Kernel

**3. 3 Mineral Composition of the Selected Agro By - Products (mg/g).**

The mineral composition of the selected agro by products is summarized in Table 3

The values for the minerals ranged from moderate to high, they are capable of sustaining ruminants, ( Lakpini *et al* 2002) though some will need supplementation, through egg shell meals or bone meals in rations or salt lick blocks. Aduku( 2004) stated that minerals are very important in animal nutrition whether ruminants or monogastric

Obadina *et al*,( 2013) reported the values for Potassium (K) in cassava peels meal to be 800–1200 m , Phosphorus (P) 300–400 mg, Magnesium (Mg): 150–200 mg, Calcium (Ca): 80–120 mg, Iron (Fe): 4–6 mg and Zinc (Zn): 2–4 mg

**Table:3 Mineral Composition of Selected Agro By - Products (mg/g).**

Parameters	BNO	CSC	CPM	CNS	MSK
------------	-----	-----	-----	-----	-----

Sodium	1.88	1.92	1.72	1.79	6.92
Potassium	5.50	5.90	6.78	5.48	
Calcium	3.16	2.84	4.30	6.60	5.66
Magnesium	7.04	6.84	8.66	5.11	11.29
Copper	9.98	9.11	12.40	20.11	15.34
Iron	4.21	3.94	4.52	5.22	4.58
Zinc	3.66	3.01	3.92	3.10	3.19

BNO- Bambara Nut Offal

C SC- Cowpea Seed Coat

CP M- Cassava Peels Meal

CNS - Cashew Nut Shell

MSK – Mango Seed Kernel

### **3.4 4Anti-Nutritional Factors in Selected Agro By-Products**

Anti-nutritional factors contents of the Agru byproducts is presented in Table

#### **3.4 Anti-Nutritional Factors in Agro By-Products**

The composition of Anti nutritional factors in the agro by products is shown in Table 4.

Tannins bind to proteins and enzymes, reducing their digestibility. MSK and CPM had the highest levels at 3.65 mg/g and 3.15 mg/g, respectively, indicating potential for reduced protein utilization. BNO had the lowest value (1.20 mg/g), making it more suitable for protein-rich rations (Barry and McNabb, 1999).

Phytates inhibit mineral absorption by chelating essential ions. CNS showed the highest phytate concentration at 4.20 mg/g, which may require dietary supplementation or phytase treatment. MSK, with the lowest level at 0.26 mg/g, is less likely to cause mineral deficiencies (Ravindran *et al.*, 1995).

Saponins influence rumen fermentation and nutrient transport. CNS had a markedly high saponin content (8.00 mg/g), which could impair digestion if fed unprocessed. BNO recorded the lowest (0.07 mg/g), confirming its relative safety (Cheeke, 2000).

These compounds are toxic in high concentrations. CNS contained the highest alkaloid (2.00 mg/g) and HCN (0.20 mg/g) levels, necessitating processing before use. BNO and MSK had the lowest values, indicating minimal toxicity risk. .

Adebowale et al, 92011) reported Tannin in Bambara nut offal to be: 0.5–1.5% higher levels of tannins may inhibit protein digestibility) they also reported Phytic Acid as 0.8–1.2% and added

that high levels reduces mineral bioavailability, Trypsin Inhibitors was reported to reduce protein digestion and at high levels and Oxalates: 0.2–0.5% which may contribute to kidney stone risk at high levels

The analysis confirms that not all agro-industrial by-products are nutritionally equal. Mango Seed Kernel stands out as the most digestible and with the least anti-nutritional, followed by followed by Bambara Nut Offal, which offers balanced fiber and low ANFs. Cashew Nut Shell, although rich in some fibers, contains high levels of indigestible lignin and toxic compounds, making it unsuitable unless properly treated.

These findings support the safe inclusion of MSK and BNO in ruminant rations. Cowpea derivatives (CPSC and CPM) may be utilized after appropriate processing. CNS should be restricted or detoxified before use. Strategic feed formulation based on fiber quality and ANF levels can optimize productivity and minimize costs.

**Table: 4 Anti-Nutritional Factors in Agro By-Products**

sample	Tannin	Alkaloids	HCN	Phytates	Saponin
BNO	1.20	0.03	0.02	1.25	0.07
CPSC	2.31	0.05	0.13	0.65	0.09
CPM	3.15	0.15	0.18	1.28	1.12
CNS	2.70	2.00	0.200	4.20	8.00
MSK	3.65	0.75	0.05	0.26	0.09

BNO- Bambara Nut Offal  
 C SC- Cowpea Seed Coat  
 CPM- Cassava Peels Meal  
 CNS - Cashew Nut Shell  
 MSK – Mango Seed Kernel

#### **4.0 CONCLUSION AND RECOMMENDATIONS**

#### **4.1 Conclusion**

All the agro by products examined contain fairly good array of nutrients suitable for ruminant feeding. Bambara nut offal appears to have the best array of nutrients

The anti nutritional factors are at tolerable levels for most of the by products

#### **4.2 Recommendations**

All the agro by products determined can serve as components for ruminant feeds.

Treatment is recommended to improve their nutritive content, palatability and digestibility

Further studies should focus on removing or reducing the levels of the anti nutritlonal contents of these agro by products

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