DETERMINATION OF THE NUTRITIVE VALUE OF MUNICIPAL ORGANIC FOOD WASTE (*MOFW)* MEAL

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Abstract
This study was carried out to determine the nutritive value of municipal organic food waste (MOFW) meal, Samples were collected from Abraka main market and processed in the Teaching and Research laboratory of Delta State University, Abraka, Delta State. Processed sample were sent for proximate, mineral and phytochemical composition at Crop Research Institute, Umudike. The proximate, mineral and phytochemical compositions were determined by analyzing dry samples of MOFW. Moisture content, crude protein, crude fibre, fat, ash, energy value and nitrogen free extract (NFE) were determined. Proximate composition for minerals sodium, potassium, calcium, phosphorus, magnesium, iron and zinc was observed while phytochemicals of tannin, alkaloid, flavonoid, saponin, phytate and oxalate were investigated. The results of the analysis showed the percentage mean for moisture content (14.51%), crude protein (10.61%), crude fibre (3.68%), fat (4.15%), ash (3.72%), energy (2747.40MEkcal/kg), and NFE (58.95%). The percentage mean for sodium, potassium, calcium, phosphorus, magnesium, zinc and iron content of MOFW were 27.35mg/100g, 197.57mg/100g, 80.62mg/100g, 286.73mg/100g,51.37mg/100g, 4.87mg/100g and 43.88mg/100g respectively, while its phytochemical contents were 3.75mg/100g, 3.93mg/100g, 1.45mg/100g, 2.45mg/100g, 4.17mg/100g and 5.82mg/100g, for alkaloid, flavonoid, saponin, tannin, phytate and oxalate. This study revealed that municipal organic food waste (MOFW) meal have a high nutritive value and can be used in feeding programs for non-ruminant animals. The phytochemical composition is low and can be tolerated by non-ruminant animals. It is therefore recommended for inclusion in non-ruminant diets.
Keywords: Phytochemical, proximate, mineral, municipal organic food waste, determination

Introduction
Waste has always been produced as a result of human tendency to consume more. If there is still a need for goods and services, waste production will continue to increase due to human activity and changes in lifestyle. Based on these trends, an increased amount of materials will require appropriate handling in cities globally to protect and manage the environment. Furthermore, there is a strong relationship between urbanization, population growth, economic development, and improved living standards with the volume, complexity, and type of waste produced in most urban areas, especially in terms of municipal solid waste (Kaza *et al.*, 2018).
Factors such as urbanization, population growth, income levels, the standard of living, and economic prosperity play significant roles in the generation of municipal waste (Ho *et al.*, 2017) globally and cannot be overemphasized. Kaza *et al.*, 2018; Medina, 1997) opined that there are significant relationships when comparing the amount of municipal solid waste generation with urbanization rates.
Food consumption and waste generation are expected to increase as the world population increases. Because food waste has a negative impact on the environment and the economy, it is one of the major worldwide concerns of the twenty-first century (FAO, 2011).In addition to laws and rules, the ongoing increase in food waste has caused a major shift in waste management strategies, moving away from landfill disposal and toward waste treatment through reduction, recycling, and reuse as well as energy and resource recovery from trash. Since the organic fractions have often a very high nutritional value, one of such suggested use would be the re-feeding of animals with this food waste. They may be used to feed livestock, thus, a substitute for traditional feedstuffs for pigs and poultry (García *et al.*, 2005). However, this study was designed to determine the proximate, mineral and phytochemical composition of municipal organic food waste (MOFW) meal as feed ingredient for broiler and layer birds.

Materials and Methods
Sample Collection
The municipal organic food waste (MOFW) used for the study were obtained from Abraka main market, and processed in the Teaching and Research farm of the Delta State University, Campus 1, Abraka.
Preparation of Municipal Organic Food Waste Meal (MOFWM)
The municipal organic food waste (MOFW) meal passed through the following preparatory stages;

- Collection of food waste from the traders (markets).
- Removal of undegradable materials such as nylon, metals, etc
- Chopping/ cutting of waste into smaller pieces.
- Sun drying of waste to constant weight.

- Dried municipal organic wastes were grinded and combined with other feed ingredients that were used in formulating the diets for broiler starter, finisher and layer birds.

The samples were further taken to the Chemistry Laboratory of National Root Crop Research Institute, Umudike, Abia State for proximate, minerals and phytochemical composition analysis according to the standard procedure.

Municipal Organic Food Waste Meal Composition

This includes: seed tomatoes, fresh peppers, green beans, carrot, onion, okra, coconut, cooked corn, plantain back etc.

Data Collection and Computation

Proximate Composition Determination

The determination of moisture, protein, fat, ash, crude fibre, carbohydrates were carried out using AOAC (2010) methods of analysis.

Moisture Content Determination

Petri dish was washed and dried in the oven. Exactly 10g of the sample was weighed into a petri-dish. The weight of the petri-dish and sample was obtained before drying. The petri-dish and sample were put in the oven and heated at 100^{O}C for 1 hour. The result recorded and heated for another 1 hour until a steady result was obtained and the weight was recorded. The drying procedure was continued until a constant weight was obtained.

$$\%\, moisturecontent = \frac{W_1 - W_2}{W_1 - W_0} \times 100$$

Where

W_1 = weight of petri-dish and sample before drying

W_2 = weight of petri-dish and sample after drying

W_o =weight of petri dish only.

Determination of Crude Protein Content of the Condiment

The Kjeldahl method as described by AOAC (2010). This method involves the digestion, distillation and titration. Exactly 0.5g of sample was weighed into a 30ml Kjehdal flask, then the flasks were stoppered and shaken. Then 0.5g of the copper sulfate catalyst mixture was added. The mixture was heated cautiously in a digestion rack under fire until a clear solution appeared. The clear solution was then allowed to stand for 30 minutes and allowed to cool. Exactly 100ml of distilled water was added to avoid caking and then 50ml was transferred to the Kjedahl distillation apparatus.

A 100ml receiver flask containing 5ml of 2% boric acid and indicator mixture containing 5 drops of Bromocresol blue and 1 drop of methylene blue was placed under a condenser of the distillation apparatus so that the tap was about 2cm inside the solution. The 5ml of 40% sodium hydroxide was added to the digested sample in the apparatus and distillation commenced immediately until 50 ml gets into the receiver flask, after which it was titrated to pink colour using 0.01N hydrochloric acid.

Calculations

$$\frac{T - B \times N \times 0.014 \times DF \times 6.25 \times 100}{weightofsample \times 100}$$

Where: 6.25 is a general factor suitable for products in which the protein of specific protein is not well defined.

$\frac{14.01}{1000} = 0.014$is a constant.

T = Titre value after titration

B = Titre value of blank

DF=Distillation factor

Determination of Crude Fat Content of the Condiments

The procedure used was Soxhlet fat extraction method according to AOAC (2010). Dried 250ml clean flask was placed in oven at 110^{O}C for 30 minutes, then transferred into a desiccator and allowed to cool, weighed and labeled. The flask was filled with about 300ml of petroleum ether (boiling point 40-60 ^{O}C) and the extraction thimble was plugged lightly with cotton wool and the Soxhlet apparatus was assembled and allowed to reflux for 6 hours. The thimble was then removed and petroleum ether was collected at the top container of the set up and drained into a container for re-use. The flask was removed and dried at 105-110^{O}C for 1 hour and cooled in a desiccator, then weighed and recorded.

Calculation

$$\%\, crudefat(etherextract) = \frac{W_2 - W_1}{S} \times 100$$

Where W_1= Weight of empty evaporating dish

W_2= Weight of evaporating dish + content after drying

S= Sample weight before soxhlet extraction.

Determination of Ash Content of the Condiments

The procedure used was according to AOAC (2010). Empty platinum crucible was washed, dried and the weight was noted. Exactly 2g of the sample was weighed into the platinum crucible and placed in a muffle furnace at 500^{O}C for 3 hours. The sample was cooled in a desiccator after burning and weighed.

Calculations

$$\%\, Ashcontent = \frac{W_3 - W_1}{W_2 - W_1} \times \frac{100}{1}$$

Where

W_1 = weight of empty platinum crucible

W_2 = weight of platinum crucible and sample before burning

W_3 = weight of platinum and ash

Determination of Crude Fibre Content of the Condiments

Determination of crude fibrewas carried out using AOAC (2010) method. Exactly 2g of the sample was defatted with petroleum ether, then boiled under reflux for 30 minutes with 200ml of a solution containing 1.25g of H_2SO_4 per 100ml of solution. The solution was filtered through linen on a fluted funnel, and then washed with boiling water until no longer acid. The residue was transferred to a beaker and boiled for 30 minutes with 200ml of a solution containing 1.25g of carbonate free NaOH per 100ml. The final residue was filtered through a thin but close pad of washed and ignited asbestos in a Gooch crucible. The residue was dried in an electric oven and

weighed, incinerated, cooled and weighed. The loss in weight after incineration × 100 is the percentage of crude fibre.

$$\%\ crudefibre = \frac{W_2 - W_3}{W_1} \times 100$$

Where: W_1=Weight of sample before drying
W_2=Weight of residue after drying
W_3=Weight of residue after ashing.

Estimation of Carbohydrate Content

The carbohydrate content of the condiments will be obtained by difference, that is, as the difference between the total sum of (percentage moisture, fat, fibre, protein and ash) and 100.

$$\%\ carbohydrate = 100 - (\%\ moisture + \%\ fat + \%\ protein + \%\ ash + \%\ fibre).$$

Phytochemicals Composition

Test for Tannins

Analysis used was the method reported by Ejikeme et al. (2014). Each wood powder sample (0.30g)was weighed into a test tube and boiled for 10minutes in a water bath containing 30 cm3 of water. Filtration was carried out after boiling using number 42 (125mm) Whatmanfilter paper. To 5 cm3 of the filtrate was added 3 drops of 0.1% ferric chloride. A brownish green or a blue black colouration showed positive test.

Test for Saponin:Method is as reported by Ejikeme et al. (2014). Distilled water (30 cm3) was added to wood powder samples (0.30 g) and boiled for 10 minutes in water bath and filtered using Whatman filter paper number 42 (125 mm). A mixture of distilled water (5 cm3) and filtrate (10 cm3) was agitated vigorously for a stable persistent froth.The formation of emulsion on addition of three drops of olive oil showed positive result.

Test for Steroid: Analytical method used is according to Ejikeme et al. (2014). Each sample (0.30 g) weighed into a beaker was mixed with 20 cm3 of ethanol; the componentwas extracted for 2 hours. To the ethanolic extract of each sample (5 cm3) was added 2 cm3 acetic anhydride followed with 2 cm3 of concentrated tetraoxosulphate (VI) acid. A violet to blue or green colour change in sample(s) indicates the presence of steroids.

Test for Terpenoids: Method is as reported by Ejikeme et al. (2014). Each wood powder sample (0.30 g) was weighed into a beaker and extracted with 30 cm3 and component extracted for 2 hours. A mixture of chloroform (2 cm3) and concentrated tetraoxosulphate (VI) acid (3 cm3) was added to 5 cm3 of each extract to form a layer. The presence of a reddish brown colouration at the interface shows positive results for the presence of terpenoids.

Test for Flavonoids: The test for flavonoid adopted is as reported by Chuckwuma and Chigozie, (2016). Each sample (0.30 g) weighed into a beaker was extracted with 30 cm3of distilled water for 2 hours and filtered with Whatman filter paper number 42 (125 mm). To 10 cm3 of the aqueous filtrate of each wood extract was added 5 cm3 of 1.0M dilute ammonia solution followed by the addition of 5 cm3of concentrated tetraoxosulphate (VI) acid. Appearance of yellow colouration which disappeared on standing shows the presence of flavonoids.

Test for Alkaloids: Test for flavonoid used is as reported by Chuckwuma and Chigozie, (2016). Extraction of component from 2 grams of each wood powder sample was carried out using 5% tetraoxosulphate (VI) acid (H_2SO_4) (20cm3) in 50% ethanol by boiling for 2 minutes and filtered through Whatman filter paper number 42 (125 mm). The filtrate was mad alkaline using 5 cm3 of 28% ammonia solution (NH_3) in a separating funnel. Equal volume of chloroform (5.0 cm3) was used in further solution extraction in which chloroform solution was extracted with two 5 cm3 portions of 1.0Mdilute tetraoxosulphate (VI) acid. This final acid extract was then used to carry out the following test: 0.5 cm3 of Dragendorff'sreagent (Bismuth potassium iodide solution) was mixed with 2 cm3 of acid extract and precipitated orange colour infers the presence of alkaloid.

Determination of Minerals Composition

Determination of Iron

Iron was determined following the phenanthroline method of Lee and Stumm (1960). Five milliliters of digested sample was placed in a 50ml volumetric flask. Then 3ml of phenanthroline solution, two (2) ml of hydrochloric acid and 1ml of hydroxylamine solution were added to the sample in sequence. The sample solution was boiled for 2 minutes and 9ml of ammonium acetate buffer solution was added to the solution. The solution was diluted with water to 50ml volume. The absorbance was determined at 510nm wavelength. Iron standard solution was prepared in order to plot a calibration curve to determine the concentration of the sample. Standard solution containing 100mg/ml of ferric irons was prepared from 1g pure iron wires. The wires were dissolved in 100ml concentrated nitric acid, boiled in a water bath and diluted to 100ml with distilled water after cooling. Standard solutions of known concentrations were prepared by pipetting 2, 4, 6, 8 and 10ml standard iron solution into 100ml volumetric flasks, and made up to volume.

Determination of Calcium

Calcium was determined using the method described by Pearson (1976). Twenty-five milliliter of the digested sample was pipetted into 250ml conical flask and a pinch of Eriochrome Black-T- Indicator (EBT) was added. Thereafter, 2ml of 0.1N NaOH solution was added and the mixture titrated with standard EDTA (0.01M EDTA) solution. Ca (mg/l) = Volume of sample used T× M× E×1000 Where T = titre value M = Morality of EDTA E = Equivalent weight of calcium.

Determination of Phosphorus

Phosphorus in the samples was determined according to Onwuka (2005) by molybdate method using

hydroquinone as a reducing agent. Five milliliters (5ml) of the test solution was pipetted into 50ml graduated flask. Then 10ml of molybdate mixture was added and diluted to mark with water. It was allowed to stand for 30 minutes for colour 31 developments. The absorbance was measured at 660nm against a blank. A curve relating absorbance to mg phosphorus present was constructed. Using the phosphorus standard solution, and following the same procedure for the test sample, a standard curve was plotted to determine the concentration of phosphorus in the sample. % Phosphorus = 100 graph reading x solution volume.

Determination of Potassium

Potassium was determined by a procedure described by Osborne and Voogt (1978) using a flame photometer. Potassium standard was prepared. The standard solution was used to calibrate the instrument read out. The meter reading was at 100% E (emission) to aspire the top concentration of the standards. The %E of all the intermediate standard curves were plotted on linear graph paper with these readings. The sample solution was aspired on the instrument and the readings (% E) were recorded. The concentration of the element in the sample solution was read from the standard curve. Calculation % Potassium = 1million Ppm x 100 x DF

Results and Discussion

The results of the proximate composition are presented in Table 1. The municipal organic food waste (MOFW) has crude protein of 10.61% and ash content of 3.68%, which were in the same range with crude protein (10–30%) and ash content (3–5%) of kitchen waste. (Paritosh *et al.,* 2017). Crude protein enhances maintenance, growth and production of animal, while ash content is an indicator for mineral elements (Offor, 2014). The moisture (14.51%) and fat content (4.15%) of MOFW were lower than values reported for moisture (60–80%) and fat (15–40%) in kitchen waste (Paritosh *et al.,* 2017). The crude fibre (10.61%) and NFE content (58.95%) were higher than values obtained for crude fibre (1.49%) and NFE (7.04%) for municipal organic waste (Eneruvie *et al.,* 2020).

Table .1: Proximate Composition of Municipal Organic Food Waste (Test Ingredient)

Parameter	Percentage
Proximate (%)	
Moisture content	14.51
Crude protein	10.61
Crude fibre	3.68
Fat	4.15
Ash	3.72
NFE	58.95
Energy (MEkcal/kg)	2747.40

Table 2 shows the mineral element composition of municipal organic waste (MOFW). The content of calcium(80.62mg/100g), Iron(43.88mg/100g) and zinc (4.87mg/100g) of MOFW was higher than what was reported for calcium (2.13mg/100g), iron (5.42mg/100g), and zinc (2.17mg/100g) content of municipal organic waste (MOW) (Eneruvie *et al.,* 2020). Calcium helps in regulation of muscle contraction, transmit nerve impulses and help in bone formation (Offor, 2014). The concentration of sodium, magnesium, phosphorus and potassium of MOFW were (27.35mg/100g), (51.37mg/100g) (286.73mg/100g), and (197.57mg/100g) were also lower than values obtained for sodium, magnesium, phosphorus and potassium respectively (40.37mg/100g), (139.41mg/100g), (318.13mg/100g) and (260.24mg/100g) reported MOW (Eneruvie *et al.,* 2020).

Table 2: Mineral Composition of Municipal Organic Food Waste (Test Ingredient)

Parameter	Percentage
Minerals (mg/100g)	
Calcium	80.62
Sodium	27.35
Magnesium	51.37
Phosphorus	286.73
Potassium	197.57
Iron	43.88
Zinc	4.87

Table 3 shows the phytochemical composition of studied waste meal. The tannin in MOFW was (2.47mg/100g), which was lower than the value of (5.21mg/100g) reported for MOW (Eneruvie *et al.*, 2020). The poor palatability associated with high tannin diets can be ascribed to its astringent properly by reacting with proteins making them less accessible to the gastric juice of the animals (Ologhobo, 2012). The concentration of alkaloid and saponin in MOFW were (3.75mg/100g) and (1.45mg/100g) respectively. These values were lower than the values of (4.82mg/100g) and (3.21mg/100g) reported for MOW (Eneruvie *et al.*, 2020). The values for oxalate and phytate in MOFW was found to be (5.82mg/100g) and (4.17mg/100g) respectively. These values were lower than (15.00mg/100g) and (4750.00mg/100g) found in *Myriathus arborea* leaf meal (Amata, 2010). High oxalate diet can be implicated as a source of kidney stone (Chai and Liebman, 2004). Saponin at high concentrate cause cell damage by disrupting cell membrane and consequently arrest cell growth (Ologhobo, 2012). The flavonoid content of MOFW was (3.93mg/100g), which was higher than fresh MOW (I.46mg/100g) as earlier reported Eneruvie, et al. (2020).

Table 3: Phytochemical Composition of Municipal Organic Food Waste (Test Ingredient)

Parameter	Percentage
Phytochemicals (mg/100g)	
Tannin	2.47
Alkaloid	3.75
Saponin	1.45
Flavonoid	3.93
Oxalate	5.82
Phytate	4.17

Conclusion

This study revealed that municipal organic food waste (MOFW) meal have a high nutritive value and can be used in feeding non-ruminant animals. The phytochemical composition is low and can be tolerated by both non-ruminant and ruminant animals. It is therefore recommended for inclusion in non-ruminant diets.

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