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Nutritional Evaluation of Air Dried *Terminalia mantaly* Leaves as Feed Ingredient

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***Target audience:** Farmers, researchers, feed millers, Animal Nutritionist*

Abstract

The study was carried out to evaluate the nutritional property of air dried Terminalia mantaly leaves (TML). *These leaves were harvested from terminalia trees within the premises of the College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike. Two hundred grams of fresh terminalia leaves were weighed and processed by air-drying. The samples were spread in a well-ventilated room (approximately 28.5°C) for forty-eight hours. The results revealed that TML contained appreciable amounts of crude protein (18.62%), energy(2706kcal/kg), crude fibre (13.49%), ash (7.91%), crude fat (3.17%) and low moisture (11.29%). The results show the presence of potassium(0.77%), sodium(0.25%), magnesium(0.26), calcium(0.24%), phosphorus(0.37%), iron(169.78%), copper(13.66%) and zinc(57.7%). Potassium and phosphorus had the highest concentrations with 0.77% and 0.37% respectively. Anti-nutrients contents analyzed showed saponins(0.27%), cyanogenic glycosides(0.22%), flavonoids(0.0039%), phenol(0.21%), alkaloids(0.18%), tannin(0.06%), phytate(0.26%), steroid(0.0057%), and oxalate(0.14%). The anti-nutritional content in TML is low and so may not cause any adverse effects on animals. In conclusion, the appreciable amounts of protein and mineral contained in Terminalia mantaly leaves are important nutritional requirements for inclusion in the feed of monogastrics as well as ruminant animal. It would be recommended that experimental trials using Terminalia mantaly leaves should be conducted.*

Keywords: *Terminalia, leaves, nutritional, evaluation, chemical, anti-nutrient, mineral*

Description of Problem

Nigeria's rapidly growing population has informed the need to increase livestock production to satisfy her animal protein requirement. Contributions of beef and poultry products to this national dilemma has been indeed marginal, providing succor to only a select few who mostly are urban and peri-urban dwellers, while leaving about 90% of the populace who reside in the hinterlands on consumption of less than 10g as against recommended 35 g animal protein per day (1). This wide nutritional gap has fuelled the need to intensify the production of some livestock species to address the low per capital animal protein intake by Nigerians. Among the livestock of interest is rabbit, which has short generation interval and good meat quality (2). Therefore, in order to maximize food production and meet protein requirements in Nigeria, viable options need to be explored and evaluated. The growth of human population is still increasing rapidly in developing countries including Nigeria. Thus, the search for alternative sources of protein to meet the population challenge is imperative (3).

There is need to jack-up the production of short-cycle animals like rabbit in Nigeria. This is mandated by the rapid population growth with resultant increase in the demand for protein of animal origin. There is low per capita animal protein consumption in developing countries particularly in humid tropics (4). In order to maximize food production and meet protein requirements in Nigeria, viable options need to be explored and evaluated. Rabbits have been identified to play vital role in the supply of quality protein especially in rural and peri-urban areas within the tropics (5).

Common forages fed to rabbits in Nigeria include grasses (e.g. *Panicum maximum* and *Cynodon dactylon*); legumes (e.g. *Pueraria phaseoloides*, groundnut and cowpea haulms); root crops (e.g. sweet potato leaves and cassava leaves); and herbs e.g. *Tridax procumbens* and *Aspilla africana* (6). Yet, optimum growth of rabbits cannot be attained by feeding them forages alone, especially, in the dry season, when forages are scarce, dry, highly fibrous and of low quality, thus, constituting the biggest threat to rabbit production(Chah., et al 2017)

Terminalia mantaly (Umbrella or Madagascar tree) is an evergreen tree native to Madagascar, and exotic to Kenya, Senegal, Somalia, Uganda, Tanzania, Ethiopia, Djibouti and Eritrea (7). The plant is well known for its ethnobotanical and economical important. *Terminalia* is a predominantly tropical and sub-tropical genus belonging to the *Combretaceae* family with two hundred and fifty (250) species occurring in West Africa; *Terminalia* is the second largest genus in its family (8). The tree of *Terminalia mantaly* is commonly use as shelter ornament; the bark of the wood which contain tannins is used for dyeing purpose. The leaf, stem-, root-bark is used in treatment of various diseases in different regions such as: dysentery, diabetes, gastroenteritis, mouth candidiasis, digestive disorders, postpartum care and malaria (9; 10). Even though Terminalia mentally have been reported to have medicinal importance, reports on it nutritive and anti-nutritive composition is scanty.

(11) reported that *Terminalia mantaly* leaves have not been used as an ingredient for livestock feed formulation, that way, an insight into its suitability for use in diets of livestock at low costs can be searched out. But before recommending such feed ingredient, the nutritional properties and mineral constituents need to be determined.

Therefore the objective of this study is to evaluate the nutritional constituents (proximate composition, mineral contents, phytochemical and energy contents) of *Terminalia mantaly* leaf as feed for grower rabit.

Materials and Method

Experimental Location

This experiment was carried out in the nutrition and biochemistry laboratory of The Department of Animal Nutrition and forage Science, Michael Okpara University of Agriculture, Umudike Umuahia, Abia State, Nigeria. The site is situated on latitude 05º 29' North and longitude 07º 21º East, in the Tropical rain forest zone of Nigerian. It has an annual average rainfall of 2177mm, temperature range between 20° -30°C, with relative humidity of 50-59%, depending on season (12).

Collection and Processing of Experimental Sample

The *Terminalia mantaly* leaves used in this experiment was harvested from its trees within the college of Animal science and animal production premise of Michael Okpara University of Agriculture, Umudike. Two hundred grams (200g) portions of fresh *Terminalia mantaly* leaves were weighed and processed by air-drying. The samples were spread in a well-ventilated room (approximately 28.5°C) for forty-eight hours.

Determination of Proximate Composition

Proximate analysis

Proximate composition of air-dried *Terminalia mantaly* leaves was determined according to the methods of (13), where the moisture, dry matter, crude protein, crude fibre, ash, ether extract and nitrogen free extracts were determined.

Determination of gross energy

The gross energy of air-dried *Terminalia mantaly leaves was determined using gallenkamp Ballistic Bomb calorimeter according to the methods of (13)*

Reagents: Benzoic Acid.

Determination: 0.25gm of *Terminalia mantaly leaf meal* was weighed into the steel capsule. A 10cm cotton thread was attached to the thermocouple to touch the capsule. The Bomb was closed and charged in with oxygen up to 30 atm. The Bomb was fixed up by pressing the ignite switch to burn the sample in an excess of oxygen. The maximum temperature rise in the bomb was measured with the thermocouple and galvanometer system. The rise in temperature was compared with that obtained for 0.25gm of Benzoic acid. The value of the sample was determined by the following stepwise calculations:

Calculations:

Mass of Benzoic Acid = W_1gm

Calorific value of 1gm Benzoic Acid = 6.32 Kcal/g

Heat released from Benzoic Acid = 6.32 x W_1 Kcal

Galvonometer deflection without sample = T_1

Galvonometer deflection of Benzoic Acid = $T_2 - T_1$

Calibration constant = $\frac{6.32 \times W1}{T_2 - T_1} = y$

The standardizing was repeated five times and average value calculated for y.

Mass of sample = 0.25gm

Galvonometer deflection with sample = T_3

Galvonometer deflection of sample = $T_3 - T_1$

Heat released from sample = $(T_3 - T_1)\, y$ Kcal

Calorific value of sample = $\frac{(T_3 - T_1)\, y}{0.25}$ Kcal/g

Determination of Phytochemical Constituents

Tannin determination

Tannin was determined using (14) and (15) methods where 0.20g of *Terminalia mantaly leave* was measured into a 50ml beaker, and 20ml of 50% methanol was added and covered with parafilm and placed in a water bath at 77-80°C for 1 hour. It was shook thoroughly to ensure a uniform mixing. The extract was quantitatively filtered using a double layered Whatman No 41 filter paper into a 100ml volumetric flask, 20ml water was added, while 2.5ml folin-Denis reagent and 10ml of 17% Na_2CO_3 were added and mixed properly. The mixture was made up to mark with water mixed well and allow to stand for 20min, the bluish –green color developed at the end of 20min. Working standard solutions of Tannin of range 0-10ppm were treated similarly as 1ml sample above.

The absorbance of the Tannic acid standard solutions as well as samples were read after color development on a Spectronic21D spectrophotometer at a wavelength of 760nm. % Tannin was calculated using the formula.

$$\%\text{Tannin} = \frac{\text{absorbance of sample X average gradient factor X Dilution factor}}{\text{Wt. of Sample X 10,000}}$$

Alkaloids determination

Alkaloid was determined using the method described by (16), This is a distillation and titrimetric procedure where 2g of finely ground *Terminalia mantaly leave* sample was weighed into a 100ml beaker and 20mls of 80% absolute alcohol added to give a smooth paste. The mixture was transferred to a 250ml flask and more alcohol added to make up to 100ml and 1g magnesium oxide added. The mixture was digested in a boiling water bath for 1.5hrs under a reflux air condenser with occasional shaking. The mixture was filtered while hot, through a small buchner funnel. The residue was returned to the flask and redigested for 30min with 50ml alcohol after which the alcohol was evaporated, adding hot water to replace the alcohol lost. When all the alcohol has been removed, 3 drops of 10% HCL was added. The whole solution was later transferred into a 250ml volumetric flask, and then 5ml of zinc acetate solution and 5ml of potassium ferrocyanide solution was added, thoroughly mixed to give a homogenous solution.

The flask was allowed to stand for a few minutes, filtered through a dry filter paper and 10ml of the filterate was transferred into a separatory funnel and the alkaloids present were extracted vigorously by shaking with five successive portions of chloroform. The residue obtained was dissolved in 10ml hot distilled water and transferred into a kjeldahl tube with the addition of 0.20g sucrose and 10ml Conc.H_2SO_4 and 0.02g selenium for digestion to a colorless solution to determine %N by Kjeldahl distillation method. %Nitrogen obtained was converted to % total alkaloid by multiplying by a factor of 3.26 i.e.

% Total alkaloid = %N X 3.26

Flavonoids determination

Flavonoid was determined using the method described by (16), where 0.50g of finely ground *Terminalia mantaly leave* sample was weighed into a 100ml beaker and 80ml of 95% Ethanol added and stirred with a glass rod to prevent lumping. The mixture was filtered through a Whatman No.1. filter into a 100ml volumetric flask and made up to mark with Ethanol. 1ml of the extract was pipetted into 50ml volumetric flask, four drops of Conc.HCl added via a dropping pipette after

which 0.5g of magnesium turnings added to develop a magenta red coloration. Standard flavonoid solution of range 0-5ppm were prepared from 100ppm stock solution and treated in a similar way with HCL and magnesium turnings like sample. The absorbance of magenta red coloration of sample and standard solutions were read on a digital Jenway V6300 Spectrophotometer at a wavelength of 520nm.

The percentage flavonoid was calculated using the formula.

$$\frac{\text{Absorbance of sample X average gradient factor X dilution factor}}{\text{Wt. sample X 10,000}}$$

Saponin determination

Saponin was determined using the method described by (16), where 1g of finely ground *Terminalia mantaly leave* sample was weighed into a 250ml beaker and 100ml of isobutyl alcohol was added. The mixture was shaken on a UDY shaker for 5 hours to ensure uniform mixing. Thereafter, the mixture was filtered through a whatman No1 filter paper into a 100ml beaker and 20ml of 40% saturated solution of maganesium carbonate was added. The mixture obtained with saturated $MgCO_3$ was again filtered through a Whatman No1 filter paper to obtain a clear colorless solution. 1ml of the colorless solution was pipetted into 50ml volumetric flask and 2ml of 5% $FeCl_3$ solution was added and made up to mark with distilled water. It was allowed to stand for 30min for blood red color to develop. 0-10ppm standard Saponin solutions were prepared from saponin stock solution. The standard solutions were treated similarly with 2ml of 5% $FeCl_3$ solution as done for 1ml sample above. The absorbance of the sample as well as standard saponin solutions were read after color development in a Jenway V6300 Spectrophotometer at a wavelength of 380min

$$\%\text{Saponin} = \frac{\text{Absorbance of sample X gradient factor X dilution factor}}{\text{Wt.of sample X10000}}$$

Steroids determination

Steroid was determined using the method described by (16). There after, 0.50g of the sample extract was weighed into a 100ml beaker; 20ml of Chloroform-Methanol (2:1) mixture was added to dissolve the extract upon shaking for 30minutes on a shaker. The whole mixture was later filtered through a Whatman No.1filter paper into another dry clean 100ml Conical Flask/Beaker.

The resultant residue was repeatedly treated with Chloroform-Methanol mixture until free of Steroids. 1ml of the filterate was pipetted into a 30ml test tube and 5ml of alcoholic KOH was added and shaken thoroughly to obtain a homogenous mixture. The mixture was later placed in a water bath set at 37^0C-40^0C for 90minutes. It was cooled to room temperature and 10 ml of petroleum ether added, followed by the addition of 5ml distilled water. This was evaporated to dryness on the water bath. 6ml of Liebermann Burchard reagent was added to the residue in dry bottle and absorbance taken at a wavelength of 620nm on a Spectronic 21D digital Spectrophotometer.

Standard Steroids of concentration of 0-4mg/ml were prepared from 100mg/ml stock steroid solution and treated similarly like sample as above.

% Steroid was calculated using the formula:

$$\frac{\text{Absorbance of Sample X Gradient X Dilution Factor}}{\text{Wt of sample X 10000}}$$

Phenol determination

Phenol was determined using the method described by (16) where 0.20g of the sample was weighed into a 50ml beaker. 20ml of acetone was added and homogenized properly for 1hr to prevent lumping. The mixture was filtered through a Whatman No.1 filter paper into a 100ml Volumetric Flask using acetone to rinse, and made up to mark with distilled water with thorough mixing.

1ml of sample extract was pipetted into 50ml Volumetric flask, 20ml water added, 3ml of phosphomolybdic acid added followed by the addition of 5ml of 23% $NaCO_3$, mixed thoroughly and made up to mark with distilled water and allowed to stand for 10min to develop bluish-green colour.

Standard Phenol of concentration range 0-10mg/ml was prepared from 100mg/l stock Phenol solution from Sigma-Aldrich chemicals, U.S.A. The absorbances of sample as well as that of standard concentrations of Phenol were read on a Digital Spectrophotometer at a wavelength of 510nm.The percentage Phenol was calculated using the formula:

$$\frac{\text{Absorbance of sample X gradient factor X dilution factor}}{\text{Wt. of sample X 10,000}}$$

Phytate determination

Phytate was determined using the method of (17) where 2g of the sample was weighed into 250ml conical flask. 100mls of 2% Hydrochloric acid was added to soak each sample in the conical flask for 3 hours. This was filtered through a double layer of hardened filter paper. 50ml of each filterate was placed in 0.50ml conical flask and 107mls distilled water was added in each case to give proper acidity. 10mls of 0.3% Ammonium Thiocyanate (NH_4SCM) solution was added into each solution as indicated. This was titrated with standard iron (III) chloride solution which contained 0.00195g Iron per ml. The end point was slightly brownish-yellow which persisted for 5 minutes. The % phytic acid was calculated using the formula:

$$\% \text{ Phytic Acid} = \frac{\text{Titre value x 0.00195 x 1.19 x 100 x 3.55}}{\text{Wt. of Sample}}$$

Oxalate determination

Oxalate was determined using the method described by (18). 2 g of the sample was digested with 10 ml 6 M HCl for one hour and made up to 250 ml in a volumetric flask. The pH of the filtrate was adjusted with conc. NH4OH solution until the colour of solution changed from salmon pink colour to a faint yellow colour. Thereafter, the filtrate was treated with 10 ml of 5% CaC_{l2} solution to precipitate the insoluble oxalate. The suspension was centrifuged at 2500 rpm, after which the supernatant was decanted and precipitate completely dissolved in 10 ml of 20% H_2SO_4. The total filtrate resulting from the dissolution in H_2SO_4 was made up to 300 ml. An aliquot of 125 ml of the filtrate was heated until near boiling point and then titrated against 0.05M of standardized $KMnO_4$ solution to a faint pink colour which persisted for about 30s after which the burette reading was taken. The oxalate content was evaluated from the titre value.

Calculation:

1ml of 0.05N $KMNO_4$ = 0.00225 anhydrous Oxalic Acid

= % Oxalic Acid

$$= \text{Titre} \frac{\text{value x 0.00225}}{1} \text{ x 100}$$

= T.V x 0.1125.

Cyanogenic glycosides determination

Salkowski's test was employed. The extract (2 ml) was dissolved in 2ml of chloroform; then 2ml of sulphuric acid was added carefully and shaken gently. A reddish brown ring colour at the interface signifies the presence of a steroidal ring (i.e., a glycone portion of glycoside) (19).

Mineral Analyses of *Terminalia mantaly* Leaves

Determination of micro and macro minerals

Calcium, Potassium and Sodium Determination

Apparatus: Heating mantle, Crucible, Glass rod, Flame photometer, 100ml volumetric flask, Whatman No. 1 Filter paper, Wash bottle, 10ml pipette, and funnel.

Reagents: 2 MHCL.

Determination: The ash of each sample obtained was digested by adding 5ml of 2 MHCl to the ash in the crucible and heat to dryness on a heating mantle. 5ml of 2 MHCl was added again, heat to boil, and filtered through a Whatman No. 1 filter paper into a 100ml volumetric flask. The filterate was made up to mark with distilled water stoppered and made ready for reading of concentration of Calcium, Potassium and Sodium on the Jenway Digital Flame Photometer (PFP7 Model), using the filter corresponding to each mineral element.

The concentration of each of the element was calculated using the formula: %Ca or %K or %Na = $\frac{\text{Meter Reading (MR) x Slope x Dilution factor}}{1000}$

NB: MR x slope x dilution factor would give you the concentration in part per million (ppm or mg/kg). You get concentration in % when you divide by 10000.

Phosphorus determination (spectrophotometric method)

Phosphorus was determined routinely by the Vanado-molybdate colorimetric or spectrophotometric method.

Apparatus: Spectrophotometer or colorimeter, 50ml volumetric flask, 10ml pipette, filter paper, funnel, wash bottle, glass rod, heating mantle, crucibles.

Reagents: Vanadate – Molybdate yellow solution, 2 MHCl.

Determination: The ash of each sample obtained was treated with 2 MHCl solution as described for calcium determination above. 10ml of the filtrate solution was pipetted into 50ml standard flask and 10ml of vanadate yellow solution was added and the flask was made up to mark with distilled water and left for 10 minutes for full yellow development. The concentration of phosphorus was obtained by taking the optical density (OD) or absorbance of the solution on a Spectronic 20 spectrophotometer or colorimeter at a wavelength of 470nm.

The percentage phosphorus was calculated from using the formula:

$$\%\text{Phosphorus} = \frac{\text{Absorbance x Slope x Dilution factor}}{10000}$$

The meter reading for each element was used to calculate for the concentration of each element using the formula:

Ppm or mg/kg (any of the elements) = Meter reading x Slope or Gradient x dilution

factor.
% (any of the elements) = ppm or mg/kg divided by 10000.
Determination of Mg, Cr, Cu, Mn, Fe and Zn using buck 200 Atomic Absorption Spectroscopy

Result and Discussion

Proximate Composition of *Terminalia mantaly leave*

The proximate composition of *Terminalia mantaly leaves is presented in Table 1*

Table 1: proximate and gross energy composition of *Terminalia mantaly* leaves

Parameters	Composition
Moisture Content (%)	11.29
Crude Protein (%)	18.62
Crude Fibre (%)	13.49
Crude Fat (%)	3.17
Ash (%)	7.91
Dry Matter (%)	88.71
Nitrogen Free Extract (%)	45.50
Gross Energy (kcal/g)	3.910
Metabolisable energy ME (Kcal/kg)	2706

The results revealed that *Terminalia mantaly* leaves contained appreciable amounts of crude protein (18.62%). The leaves also contained appreciable amounts of crude fibre (13.49%), ash (7.91%), crude fat (3.17%) and moisture content (11.29%). The low moisture is adequate for prevention of mold or microorganisms and promotion of shelf-life.

The dry matter (DM) value of the *Terminalia mantaly* leaves in this study (88.71%) was lower than the values reported by (20). They reported DM values of 93.7%.

The crude protein value reported in this study was within the value reported by (20) in *Moringa oleifera* leaves. The value also falls within the range of (15% - 22%) which is reported for some browse plants used in feeding animals (21).

This relatively high amount of protein in *Terminalia mantaly* leaves show that the leave can supplement other dietary sources. Therefore *Terminalia mantaly* leaves can be incorporated into the diets of animals to increase the protein content of the diet.

The crude fibre, fat and ash contents reported by (20) for *Moringa oleifera* leaves, were also within the values obtained in this study. However, the differences obtained may be connected with variations in the geographical locations of the growth and development or stage of maturity of the plants. Fibre when fed with other ingredients or at low dietary level of inclusion act as diluents but it's absence in diet leads to incidence of wide range of diseases (22; 23).

The crude fat content obtained (3.7%) was lower than fresh (7.6%) and air dried (5.10%

) respectively but higher than sundried (2.90%) reported by (6) for *Teminalia mantaly* leaves. animals use fat for energy and also for absorption of fat soluble vitamins. Crude fat can increase palatability but an excess amount can increase risk of obesity, hepatic lipidosis and atherosclerosis (24).

The percentage ash obtained from the proximate analysis (7.91%) was higher when compared to the result reported by (25). According to (26) growing rabbits require about 4-6% dietary ash. Ash in food constitute the residue remaining after all the moisture has been removed as well as the organic material (fat, protein, carbohydrates, vitamins, organic acid etc.) have been incinerated at a temperature of about 5000°C. Ash content is generally taken to be a measure of the mineral content of the original food (27).

The nitrogen free extracts was 45.5%. NFE= (100 - %EE +%CP + %Ash + %CF). The higher the nitrogen free extract the higher the digestible nutrient (28).

Gross energy value of 3.910kcal/g was gotten. The metabolizable energy requirement of growing rabbit is 2400kcal/kg (29). From the analysis *T.mantaly* had a higher energy of 2706kcal/g than the recommended. The presence of these important nutrients like protein, low crude fat and ash content means *Terminalia mantaly* leaves could be used as a nutritionally valuable and healthy ingredient to improve animal health and growth performance. Low fat feeds are known to reduce cholesterol level (30)

Mineral Composition of *Terminalia mantaly leaves*

The **mineral Composition** of *Terminalia mantaly leaves are shown in Table2*

Table 2: Mineral Composition of *Terminalia mantaly* leaves

Minerals	Concentration
K (%)	0.77
Na (%)	0.25
Mg (%)	0.26
Ca (%)	0.24
P (%)	0.37
Fe (mg/kg)	169.78
Cu (mg/kg)	13.66
Zn (mg/kg)	51.70

Minerals are very important in animal diet because of their various functions in the body. They serve as cofactors for physiological factors and many metabolic functions. Data obtained from Mineral Composition of *Terminalia mantaly* leaves showed that they had a high nutritional potential, and their mineral content was comparable to some cultivated plant vegetables as reported by (31). Potassium,

sodium, magnesium, calcium, phosphorus, iron, copper and zinc were analyzed. Potassium and phosphorus have the highest concentrations with 0.77% and 0.37% respectively.

The values obtained are sufficiently adequate compared to the recommended quantity for lactating animals (32) and has the potential of meeting this requirement with increased consumption of the quantity of the plants daily.

The potassium content was 0.77%. The dietary potassium requirement for rabbit is 0.6%- 0.9% (33). Deficiencies include muscle weakness, paralysis and respiratory distress. Most grain and legume such as Alfalfa are rich in potassium and its deficiency is rare in rabbits (33).

Sodium content of *Terminalia mantaly* was 0.25%. Sodium is important in rabbit production because it's needed by rabbit to maintain good heart health. Recommended percentage for rabbit is 0.3% (29).

The magnesium content of *Terminalia mantaly* was 0.26%. Magnesium is a major component of bone and excess of it can be excreted through the urine. (33)

The calcium and phosphorus content recorded were 0.24% and 0.37 % respectively and they are major component of the skeletal system. Calcium helps in bone formation. It's also involved in regulation of acid-base statues of blood (34). Deficiencies in phosphorus and calcium can also result in rickets which causes an unnaturally arched back and enlarged joints in young rabbits. These deficiencies in adult rabbits may cause bone demineralization, increasing the risk of a broken back (24).

Excess calcium is eliminated though the urine. Calcium (>15g/kg) increases the calcification of soft tissues and reduces absorption of phosphorus and zinc which will result to deficiencies in those minerals (35).

The micro minerals:- iron (169.78 mg/kg), copper (1.66mgkg) and zinc (51.70mgkg) values were recorded respectively. Iron Deficiency in rabbits could cause impaired fertility, hair loss and anemia due to impaired hemoglobin formation, which is the oxygen transporter in the blood. Copper is said to be involved in energy metabolism, as well as collagen. Its deficiency result to retarded growth, bone abnormalities and graying of black hair. Zinc functions as a cofactor of numerous enzymes and higher levels are required for fur production (33).

Studies on these elements have revealed their functions in plants and animals which include their role in osmotic regulations of the body fluids, enhance growth, and ensure healthiness of crops and animals (36). It has been reported that deficiency of essential minerals usually leads to skeletal deformities, growth retardation and other ill health conditions (37).

Anti-nutrients Composition of *Terminalia mantaly leaves*

The anti-nutrients Composition of *Terminalia mantaly leaves are presented in Table 3*

Table 3: Anti -nutrients Composition of *Terminalia mantaly* leaves

Anti-nutrient	Level
phytate (%)	0.26
Oxalate (%)	0.14
Tannin (%)	0.06
Flavonoids (%)	0.0039
Cyanogenic glycoside (%)	0.22
Phenol (%)	0.21
saponin (%)	0.27
Steroid (%)	0.0057
Alkaloid (%)	0.18

The result showed saponin was the highest (0.27%) while flavonoid was the lowest (0.009%). The presence of phytochemicals (secondary metabolites) in a plant material is a good indication of the medicinal value of the plant. *Terminalia mantaly* was screened for the presence of saponins, cyanogenic glycosides, flavonoids, phenol, alkaloids, tannin, phytate, steroid, and oxalate. The result obtained showed Alkaloids value at 0.18%, saponin 0.27% and oxalate 0.14%.

The anti-nutritional factor in the leaves of *Terminalia mantaly* was below toxic levels and so may not front any adverse effects on animals.

The phytate content of *Terminalia mantaly* leaves (0.26%) is lower than that of *Colocasia esculenta* leaves (0.79%) (38). The phytate in feed can bind some essential mineral elements such as Ca, Mg, Zn and Fe in the digestive tract and render them not bio-available. Protein and starch solubility digestion was also reported to be affected by phytate (39). Nevertheless, phytate is a potent anti-carcinogen that protects against colon cancer. It is also known to be a potent antioxidant that inhibits Fenton reactions leading to lipid peroxidation and inhibition of polyphenol oxidase (40).

The concentration of oxalate in *Terminalia mantaly* leaves is 0.14% dry weight. The value is lower when compared with that of *Moringa oleifera* leaves (0.872%) (41). High oxalate content causes irritation in the mouth and interferes with the absorption of divalent minerals particularly calcium by forming insoluble salts with them leading to kidney stone which may eventually lead to death (42).

The concentration of tannins in *Terminalia mantaly* leaves was 0.06%. The value is similar to that of *Moringa oleifera* leaves (0.05 mg/100g) (41). The nutritional effect of tannins is mainly related to their interaction with protein (41). Tannins are known to inhibit the activities of enzymes such as trypsin, chemotrypsin, amylase and lipase and also interfere with iron absorption and growth in general (43). The concentration of tannin in the sample (0.06% dry weight) was

than the value 3.7 mg/100kg reported by (42). The cyanogenic glycoside content was 0.22%. The value is lower compared to the value obtained for *Hibiscus sabdariffa* (0.29 mg/100g DW) (44). (44) reported that high cyanogenic glycoside content in the diet causes neurological, respiratory, cardiovascular and thyroid debilities. Low cyanogenic glycoside content of the leaves is an ndication that it can be used in formulating feed for livestock and poultry.

Terminal mantaly leaves had a low flavonoids concentration of 0.0039%. Flavonoids are considered important biological compounds with several biological activities such as anti-oxidant, anticancer, anti-inflammatory and anti-angiogenic (45; 46; 447).

The Phenol concentration was 0.21%. They are chemical component that occur ubiquitously as natural color pigments responsible for the colour of fruits in plants (48).

Saponin and Alkaloid content of *Terminalia mantaly* leaves were 0.27% and 0.18% respectively. Saponins are important therapeutically as they are shown to have hypolipidemic and anticancer activity. And are important source of steroid hormones (49). Alkaloid like phenol, function in the defense of the plant against pathogens. They have pharmacological applications as anesthetic and CNS stimulants (50).

Conclusion and Recommendation

In conclusion, the result of this study showed that *Terminalia mantaly* leaves contained appreciable amounts of protein and minerals, which are nutritional requirements of animals such as weaner rabbits. Therefore, the leaves from this plant could be useful as feed supplement and as medicine to improve health and growth performance of grower rabbits. The anti-nutritional factors present in this plant parts showed a lower level of concentration which may not affect the health status of animals.

It is therefore recommend that a biological evaluation using *Terminalia mantaly* leaf meal be carried out on weaner rabbit to determine their effect on their performance.

Reference

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