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REGULAR ARTICLE

PROXIMATE STUDY, MINERAL AND ANTI-NUTRIENT COMPOSITION OF *MORINGA OLEIFERA* LEAVES HARVESTED FROM LAFIA, NIGERIA: POTENTIAL BENEFITS IN POULTRY NUTRITION AND HEALTH

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ABSTRACT

The leaves of *Moringa oleifera* were harvested from Lafia in Nasarawa State of Nigeria during the rainy season in June 2011 for proximate, mineral and phytochemical analysis. The results of proximate analysis revealed the presence of high crude protein (17.01% ±0.1) and carbohydrate (63.11% ±0.09). The leaves also contained appreciable amounts of crude fibre (7.09% ±0.11), ash (7.93% ± 0.12), crude fat (2.11% ±0.11) and fatty acid (1.69% ±0.09). The total ash content showed it contained minerals, Ca (1.91% ±0.08), K (0.97% ±0.01), Na (192.95±4.4), Fe (107.48±8.2), Mn (81.65±2.31), Zn (60.06±0.3) and P (30.15±0.5) parts per million (ppm). Magnesium (0.38% ±0.01) and copper (6.10±0.19) were the least. The results of phytochemical analysis and anti-nutrients showed presence of tannins (21.19% ±0.25), phytates (2.57% ±0.13), trypsin inhibitors (3.0% ±0.04), saponins (1.60% ±0.05), oxalates (0.45% ±0.01) and cyanide content ((0.1% ±0.01). The presence of these essential nutrients and minerals implies *Moringa oleifera* leaves from Lafia, Nasarawa State could be utilized as a source of feed supplement to improve growth performance and health status of poultry. The benefits of essential nutrients and minerals in maintaining good health were also highlighted in this study.

Keywords: *Moringa oleifera*, leaf extract, nutrients, anti-nutrients, chickens

INTRODUCTION

Antibiotics are utilized as growth promoters at sub-therapeutic levels and for treatment of poultry diseases. The beneficial effects of antibiotic in combating bacterial problems and as growth promoters are well documented. Medication of water using antibiotic helps birds to recover from certain diseases of bacterial origin. However, there may be problems associated with usage of antibiotics such as drugs toxicity, residual effects and development of microbial resistance. The negative impact on consumers of meat or poultry products due to residual effects has also raised some concern. This has led to the ban on the use of antibiotics as growth promoters since 2006 by the European Union. Animal scientists and veterinarians are now turning attention towards alternative sources of natural ingredients such as herbs or plants (phytobiotic) to replace antibiotic. There were reports on the beneficial effects of herbs and mushrooms, which are used as feed supplements or medicines in chickens **(Guo *et al.,* 2003; Ogbe, 2008; Ogbe *et al.,* 2008; Ogbe *et al.,* 2009)**. Certain bioactive chemicals in plants or herbs and mushrooms were reported to be responsible for their therapeutic (medicinal) benefits **(Guo *et al.,* 2003; Ogbe *et al.,* 2009)**.

Plants generally contain chemical compounds (such as saponins, tannins, oxalates, phytates, trypsin inhibitors and cyanogenic glycosides) known as secondary metabolites, which are biologically active **(Soetan and Oyewole, 2009)**. Secondary metabolites may be applied in nutrition and as pharmacologically-active agents **(Soetan and Oyewole, 2009)**. Plants are also known to have high amounts of essential nutrients, vitamins, minerals and fatty acids and fibre **(Gafar and Itodo, 2011)**. Plant oil from seeds and leaves such as *Moringa oleifera* are in high demand for their medicinal value. Apart from the medicinal uses, *Moringa oleifera* was reported to be a good source of vitamins and amino acids **(Olugbemi *et al*; 2010)**. *Moringa oleifera* was claimed to boost immune systems **(Jayavardhanan *et al.,* 1994; Fuglier, 1999; Olugbemi *et al.,* 2010))**. The leaves and green fresh pods are used as vegetables by man and are rich in carotene and ascorbic acid (vitamin C) with a good profile of amino acids **(Makkar and Becker, 1996)**. They are also used in livestock feed and the twigs are reported to be very palatable to ruminants **(Sutherland *et al.,* 1990; Sarwatt *et al.,* 2002; Kimoro, 2002; Kakengi *et al.,* 2007)**. The edible leaves are very nutritious and are consumed in Nigeria. The Moringa seed oil is high in (80.4%) polyunsaturated fatty acid **(Anwar and Rashid, 2007; Ogbunugafor *et al.,* 2011)**. *Moringa oleifera* extract was reported to have antibacterial properties and conclusion was made to investigate it as a phytotherapeutic agent to combat infectious agents **(Patel, 2011)**. Most parts of the plant have been used in folk medicine in Africa and South Asia **(Fahey, 2005)**. The medicinal effects of the plant was ascribed to their possession of anti-oxidants, which are known to suppress formation of reactive oxygen species (ROS) and free radicals **(Sofidiya *et al.,* 2006; Ogbunugafor *et al.,* 2011)**.

In developing countries (like Nigeria), sources of animal's drinking water may be contaminated with suspended materials and even bacteria but unknown to the animal owner(s). In human, each year, millions of children are known to have died in developing countries as a result of infections caused by unclean water **(Jose *et al.,* 2010)**. *Moringa oleifera* seeds are said to be very good and safe for water treatment; as synthetic chemical compounds (alum) may be carcinogenic **(Ayotunde *et al.,* 2011)**. Plant substances that are foods are of little or no side effects. Most of the prescribed medicines today (about 25%) are substances derived from plants **(Ngaski, 2006)**. However, information is scanty on the utilization of Moringa leaves as feed supplement or medicine for poultry.

This study therefore aimed at evaluating the chemical and nutritional composition of *Moringa oleifera*, and the objective was to highlight its potential as feed supplement and medicinal benefits in poultry production.

MATERIALS AND METHODS

Collection and processing of sample

Moringa oleifera leaves were harvested from an orchard at early flowering stage in Lafia, Nasarawa State. Stem and branches were cut from Moringa trees and spread out under the shade to dry in the sun at 35^{o}C for 3-5 days. The leaves were then removed by hand (manually) and grounded into powder by milling using a locally made Miller machine (unbranded).

Proximate analysis

The methods of the Association of Official Analytical Chemists **(AOAC, 1990)** were used for determination of moisture, crude fibre, protein, fat and cyanide content of the samples. All determinations were done in duplicates. The proximate values were reported in percentage. Moringa leaf samples (5 grams, each) in duplicate was used for determination of moisture content by weighing in crucible and drying in oven at 105 ^{o}C, until a constant weight was obtained. Determination of ash content was done by ashing at 550 ^{o}C for about 3h. The Kjeldah method **(AOAC, 1990)** was used to determine the protein content by multiplication of the nitrogen value with a conversion factor (6.25). The crude fibre content of the samples was determined by digestion method and the lipid was done by Soxhlet extraction method **(AOAC, 1990)**.

Total soluble carbohydrate was determined by the difference of the sum of all the proximate composition from 100%. The calorific (energy) value was obtained according to the methods of **Akinyeye *et al.* (2010, 2011)**. This was done by multiplying the value of carbohydrate, protein and crude fat by the Atwater factors of 17, 17 and 37 respectively **(Akinyeye *et al.*, 2011; Kilgour, 1987)**. Crude fat was converted into fatty acid by multiplying with conversion factor of 0.80 as described by **Akinyeye *et al.* (2010, 2011)** and **Greenfield and Southgate (2003).**

Mineral analysis

The mineral contents (elements) of *Moringa oleifera* leaves: calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), iron (Fe), zinc (Zn), manganese (Mn) and copper (Cu) were determined using the atomic absorption spectrophotometer (AAS-Buck 205), as described the methods of the Association of Official Analytical Chemists **(AOAC, 1990)**. Phosphorus was determined colorimetrically **(AOAC, 1990)**. All the determinations were done in duplicates. The values of calcium, magnesium and potassium were reported in percentage while sodium, iron, zinc, phosphorus, manganese and copper were reported in parts per million (ppm).

Phytochemical analysis and anti-nutrients

Quantitative phytochemical analyses of anti-nutrients were determined using the methods of **Sofowora (1993)**. All determinations were done in duplicates.

Statistical analysis

All data generated were analyzed using descriptive statistic **(Olawuyi, 1996)**. Statistical values that were calculated include mean and standard deviation.

RESULTS AND DISCUSSION

Proximate and mineral composition of *Moringa oleifera* leaves

Table-1 showed the results of proximate analysis of *Moringa* leaves. The results revealed that Moringa leaves contained appreciable amounts of crude protein (17.01% ±0.1) and carbohydrate (63.11% ±0.09). The leaves also contained appreciable amounts of crude fibre (7.09% ±0.11), ash (7.93% ±0.12), crude fat (2.11% ±0.11) and fatty acid (1.69% ±0.09).

Table 1 Nutrient composition of *Moringa oleifera* harvested from Lafia, Nasarawa State, Nigeria

Nutrients analyzed (% DW)	Mean composition (% ± SD)
Crude Protein (CP)	17.01 ± 0.10
Crude Fibre (CF)	7.09 ± 0.11
Crude Fat (lipid)	2.11 ± 0.11
Ash Content	7.93 ± 0.12
Moisture	3.21 ± 0.10
Nitrogen (N)	2.83 ± 0.16
Carbohydrate (CHO)	63.11 ± 0.09
Fatty acid	1.69 ± 0.09
Dry Matter (DM)	96.79 ± 0.10
Energy value (Kcal/100kg)	1440.11 ±0.30

Legend : *Data are mean values ± standard deviation (SD) of duplicate results; DW = dry weight.

Table-2 showed that Moringa leaves contained essential minerals, Ca (1.91% ±0.08), K (0.97% ±0.01), Na (192.95±4.4), Fe (107.48±8.2), Mn (81.65±2.31), Zn (60.06±0.3) and P (30.15±0.5) parts per million (ppm). Magnesium (0.38% ±0.01) and copper (6.10±0.19) were the least. The presence of these essential nutrients and minerals implies *Moringa oleifera* leaves could be utilized as a nutritionally valuable and healthy ingredient for poultry. These nutrients may not be strictly medicinal but could be valuable in preventing diseases that are related to malnutrition.

Table 2 Mineral composition of *Moringa oleifera* harvested from Lafia, Nasarawa State, Nigeria

Elements	Mean composition (±SD)
Calcium (%)	1.91 ±0.08
Magnesium (%)	0.38 ±0.01
Potassium (%)	0.97 ±0.01
Sodium (ppm)	192.95 ± 4.48
Iron (ppm)	107.48 ±8.81
Zinc (ppm)	60.06 ± 0.30
Phosphorus (ppm)	30.15 ±0.47
Manganese (ppm)	81.65 ± 2.31
Copper (ppm)	6.10 ± 0.20

Legend : *Data are mean values ± standard deviation (SD) of duplicate results; ppm = parts per million (1mg/kg = 1ppm).

The dry matter (DM) value of the Moringa leaves in this study was higher than the values reported by **Olugbemi *et al.* (2010)** and **Mutayoba *et al.* (2011)**. They reported DM values of 93.7% and 87.20%, respectively. The value obtained in this study was slightly higher (96.79%). However, the crude protein value reported by **Olugbemi *et al.* (2010)** was higher (27.44%) than the value obtained in this study (17.01%). **Mutayoba *et al.* (2011)** also reported much higher (30.65%) crude protein in *Moringa oleifera* leaves. The crude fibre, fat and ash contents reported by them were also slightly higher than the values obtained in this study. These differences may not be unconnected with variations in the geographical locations of the growth and development or stage of maturity of the plants. The presence of these important nutrients like carbohydrate, low crude fat and fatty acid (1.69% ±0.09) means *Moringa oleifera* leaves could be used as a nutritionally valuable and healthy ingredient to improve poultry health and growth performance. Low fat foods are known to reduce cholesterol level **(Gordon and Kessel, 2002)**.

The Moringa leaves that were used in this study contained appreciable amount of minerals, which compared well with those of other authors. In this study, values obtained for the minerals, Mn (81.65 ±2.3), Zn (60.06 ±0.3) and Cu (6.1±0.2) were higher than those reported by **Mutayoba *et al.* (2011). Mutayoba *et al.* (2011)** reported values of 57.34, 21.70 and 5.73 parts per million for Mn, Zn and Cu, respectively. However, the value of Fe (318.81), Ca (2.47%), K (1.63%) and Mg (1.03%) reported in their work were higher than the values obtained in this study. The differences in the composition may be due to the differences in the locality of its growth and the stage at maturity prior to harvesting. Minerals are required for normal growth, activities of muscles and skeletal development (such as calcium), cellular activity and oxygen transport (copper and iron), chemical reaction in the body and intestinal absorption (magnesium), fluid balance and nerve transmission (sodium and potassium), as well as the regulation of acid-base balance (phosphorus). Iron is useful in prevention of anemia and other related diseases **(Oluyemi *et al.,* 2006)**. Manganese plays a role in energy production and in supporting the immune system **(Muhammad *et al.,* 2011)**. It also works with vitamin K to support blood clotting, and with B complex vitamins to control the effects of stress **(Muhammad *et al.,* 2011)**. Zinc is useful for protein synthesis, normal body development and recovery from illness **(Muhammad *et al.,* 2011)**. Deficiency of these nutrients and minerals are known to affect the performance and health of poultry **(Merck, 2005)**.

Phytochemical composition and anti-nutrients

Table-3 showed that *Moringa oleifera* leaves contained tannins (21.19% ±0.25), phytates (2.57% ±0.13), trypsin inhibitors (3.0% ±0.04), saponins (1.6% ±0.05), oxalates (0.45% ±0.01) and low levels of cyanide ((0.1% ±0.01). The levels of these anti-nutrients were low. Boiling in hot water reduces anti-nutrients of plant products **(Enechi and Odunwodu, 2003)**. Phytate is an organically bound form of phosphorus in plants. Phytates in foods are known to bind with essential minerals (such as calcium, iron, magnesium and zinc) in the digestive tract, resulting in mineral deficiencies **(Bello *et al.,* 2008)**. They bind minerals to form insoluble salts, thereby decreasing their bioavailability or absorption **(Thompson, 1993; Guil and Isasa, 1997; Muhammad *et al.,* 2011)**.

Table 3: Phytochemical composition and anti-nutrients of *Moringa oleifera* from Lafia, Nasarawa State, Nigeria

Phytochemical/anti-nutrients	Mean values (% ±SD)
Phytates	2.59 ± 0.13
Oxalates	0.45 ± 0.01
Saponins	1.60 ± 0.05
Tannins	21.19 ± 0.25
Trypsin inhibitors	3.00 ± 0.04
Hydrogen cyanide (HCN)	0.10 ± 0.01

Legend: *Data are mean values ± standard deviation (SD) of duplicate result

Tannins are plant polyphenols, which have ability to form complexes with metal ions and with macro-molecules such as proteins and polysaccharides **(De-Bruyne *et al.,* 1999; Dei *et al.,* 2007)**. Dietary tannins are said to reduce feed efficiency and weight gain in chicks **(Armstrong *et al.,* 1974; Dei *et al.,* 2007)**.

Saponins are glycosides, which include steroid saponins and triterpenoid saponins **(Dei *et al.,* 2007)**. High levels of saponins in feed affect feed intake and growth rate in poultry **(Sim *et al.,* 1984; Potter *et al.,* 1993; Dei *et al.,* 2007)**. Reduction in feed intake has been ascribed to the bitter taste of saponins **(Cheeke, 1971)** and due to the irritating taste **(Oleszek *et al.,* 1994)**. Saponins (in excess), causes hypocholestrolaemia because it binds cholesterol making it unavailable for absorption **(Soetan and Oyewole, 2009)**. Saponins also have haemolytic activity against RBC **(Khalil and Eladawy, 1994)**. Saponin-protein complex formation can reduce protein digestibility **(Potter *et al.,* 1993; Shimoyamada *et al.,* 1998)**.

Oxalate binds with calcium to form calcium-oxalate crystals which are deposited as urinary calcium (stones) that are associated with blockage of renal tubules **(Blood and Radostit, 1989)**. Trypsin inhibitor inhibits trypsin and chymotrypsin, which play a role in digestion of protein in animals. Trypsin also causes pancreatic enlargement and growth depression **(Aletor and Fetuga, 1987)**. Hydrogen cyanide is toxic when ingested by monogastric animals in large quantity. The levels of these anti-nutrients and cyanide detected in the Moringa leaves were low. Soaking of plant materials or boiling in water is said to reduce toxic effects and improves utilization in terms of feed intake and protein digestibility **(Okai *et al.,* 1995; Dei *et al.,* 2007)**. Environmental factors and the method of preparation of samples may influence the concentration of tannins present. Proper food processing would reduce anti-nutrients **(Akinyeye *et al.,* 2011)**.

In this study, the levels of anti-nutrients detected in Moringa leaves appeared very low. The presence of essential nutrients and minerals in Moringa leaves imply they could be utilized to improve growth performance and health status of poultry. Certain bioactive chemical compounds (like saponins, tannins and other phytochemicals), which are known as secondary metabolites of plants are said to have pharmacologically active agents **(Soetan and Oyewole, 2009).** They have antibacterial and anti-parasites properties. The practical implications or effects of *Moringa oleifera* plant extract on growth performance and health status of broiler chickens are discussed elsewhere by us.

CONCLUSION

In conclusion, the result of this study showed that *Moringa oleifera* leaves from Lafia, Nasarawa State, Nigeria contained appreciable amounts of carbohydrate, protein and minerals, which are nutritional requirements of poultry. Possibly, the leaves from this plant could be useful as feed supplement and as medicine in poultry to improve health and growth performance. The anti-nutritional factors present in this plant parts could be reduced through adequate processing by boiling in hot water during aqueous extraction. It was recommended that experimental trials in chickens using Moringa leaves and seed should be conducted.

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