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Geo-Assessment of Chemical Composition and Nutritional Evaluation of *Moringa oleifera* Seeds in Nutrition of Broilers

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Abstract

Chemical composition of *Moringa oleifera* seeds obtained from the middle belt of Nigeria, Benue State, was determined and the seed was blended to form a seed meal. The *Moringa oleifera* Seed Meal, MOSM was included in diets at graded levels of 2.50, 5.00 and 7.50% and the dietary performance of the broiler chicks on the test diets was compared with that of a corn-soy reference diet. Results on the chemical/nutritional composition of MOSM showed that the full-fat seeds contained (%) on proximate basis, reasonable concentration of 90.38 dry matter, 25.37 crude protein, 14.16 crude fat, 4.03 mineral matter, 30.64 crude fiber, 25.80 soluble carbohydrate and 5.79 kcal/g gross energy. Analyses also gave appreciable quantities of the water and fat soluble vitamins, macro - and micro-minerals. Feeding chicks with the seed meal at graded levels in diets resulted in decrease in feed intake and body weight gain as the inclusion level increased in diets relative to the conventional diet ($p < 0.05$). Reduction in feed consumption could be attributed to the full-fat nature of the seed meal used which might have imparted extra-caloric effect in the test diets and slowed digestion and absorption as the analyzed nutrients content of diets. A higher ether extract value on Moringa based diets relative to the control diet was obtained. Phytochemical composition of Moringa namely phenols including tannins, saponins, phytate, cyanogenic glucoside, glucosinolates and other numerous chemical constituents affected the body weight of the chicks negatively with increasing dietary MOSM. Decrease in weight gain following increase in dietary seed meal could also be due to decrease in feed intake as a result of the bitter taste of alkaloids, saponins, acting in concert with the other Moringa phytotoxins in test diets. Survival rate (100%) was not affected indicating that the level of highest inclusion in this study (7.50%) was not fatal to the experimental animal models. Further research is progressing to ascertain the highest inclusion level possible to elicit fatality and attempts to detoxify or treat the seed meal before feeding to animals.

Keywords: *Moringa oleifera*, chemical composition, chicks, performance, phytotoxins

1. Introduction

Plants contain numerous chemical compounds which, depending upon conditions, geographical location, edaphic factors, age, time of harvest and so on, can be beneficial or deleterious in effects on organisms consuming them. Moringa oleifera used in this study is not an exception. Moringa tree belongs to the most widely known of about 13 species of Moringa plants in the family Moringaceae (Price, 2000). The tree offers a lot of benefits and is considered a multipurpose plant cultivated for its nutritional, industrial, traditional medicine uses. It is an important crop in Asia, Florida (USA), Latin America and Africa. Recently in Nigeria, Moringa has become an outstanding source of valuable nutrients, carbohydrate, protein, lipids, vitamin and essential minerals. These nutritional attributes can be highly beneficial to man and animal feeding (Anjorin et al., 2010).

Despite the merits, Moringa plant is shown to contain harmful chemicals, alkaloids and other phytotoxins which have potentially nerve-paralysing properties and other adverse effects when consumed in high doses (Fuglie, 1999; Fahey, 2005). Some examples of the chemical compounds include *moringine*, *moringinine*, *estrogens*, *pectinesterase*, phenols including tannins. The tree also harbours a bacteriocide, spirochin, an antimicrobial

compound, pterygospermin. Other chemical compounds like gadoleic acid, carbonydate, bebenic acid, 4-(alpha-rhamosyloxyl-benzylisothiocyanate etc are present.

In this study, the chemical/nutritional composition and evaluation of *Moringa oleifera* seeds obtained from the middle belt of Nigeria, Benue state was determined to further compliment available data and information on the wonder tree , and the seed meal was added to broiler chicks feed at graded level to study its effect on chickens.

2. Materials and Methods

Moringa oleifera seeds were obtained from fully ripened and matured pods of moringa trees grown on Benue soil. The seeds were further sundried after the removal from the pods to enable grinding into seed meal (MOSM). Seeds for analyses of chemical and/or nutritional composition were sorted out for viability before grinding intro flour.

2.1 Proximate Analysis

The proximate composition of the seeds was determined as described by AOAC (2000). The sample was analyzed for dry organic matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), mineral matter (total ash) while gross energy (kcal/g) was estimated by calculation using the formula by Carpenter and Cleg (1956). Carbohydrate (NFE) was determined by difference.

2.2 Vitamins Determination

All analyses conducted on both the fat and water soluble vitamins were carried out using the methods outlined by AOAC (2000) and vitamins assay (8^{th} edition, 20060 by interscience publications). The B-complex and the other water soluble vitamin determined included B1 (thiamine), B2 (riboflavin), B3 (niacin/nicotinic acid), B6 (pyridoxine), B12 (cynocobalamin) and vitamin C (ascorbic acid). Fat soluble vitamins analyzed for were vitamin A (beta-carotene), vitamin D, vitamin E (tocopherol) and vitamin K.

2.3 Determination of Macro- Micro-Minerals and Heavy Metals

The method of plant analysis for minerals was performed by using nitric-perchloric acid mixtures including hydrochloric acid. Phosphorus (P) was determined in the solution on a spectrophotometer using vanadomolybdate method while sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), zinc (Zn), manganese (Mn), iron (Fe) and the heavy metal, lead (Pb) were determined in the solution using Atomic Absorption Spectrophotometer (AAS) model Buck Scientific 210 Vgp.

2.4 Diets Formulation, Animal Housing and Feeding Trial

Four iso-energy and iso-nitrogenous diets according to the requirements of day-old chicks were formulated (NRC, 1994). The diets (treatments) were made of a corn-soy conventional diet and test diets containing the full-fat *Moringa oleifera* seed meal (MOSM) starting from a base (low) level of 2.50, then 5.00 and 7.50% for diets 2, 3 and 4 respectively. The composition of the experimental diets on as fed basis and the analyzed nutrients content of the diets are shown on Table 1(a &b). Ninety-six day old broiler chicks from a commercial source with an average initial weight of 50g/chick were used for the experiment. A treatment (diet) was replicated thrice and contained 24-chicks, that is 8-chicks per replicate. They were housed in an electrically heated battery brooder cage installed with electric bulbs to supply heat of 32-35°C for the brooding period lasting 4-weeks (Oluyemi & Robert, 1979). The experiment was designed as completely randomized. Birds were full-fed with generous supply of drinking water twice daily, 800 in the morning and 1500 in the afternoon.

As the trial lasted, data was collected on performance characteristics of feed intake, body weight gain, rate of growth, feed efficiency, survival and mortality rates. Information was also provided on the phenotypic observations concerning the experimental animal models.

2.5 Statistics

Analysis of variance (ANOVA) was performed on the result of the dietary performance indices. Mean separation was done where significant differences existed using Duncan multiple range test procedure as described in the SAS release 8.3 software. Significant difference was accepted at $p < 0.05$ (SAS, 2002). Data on the analyses of proximate composition, vitamins B-complex including ascorbic acid, fat soluble vitamins, macro-, micro-minerals and heavy metals was transformed into information using descriptive statistics.

Table 1(a). Composition of the experimental diets on as fed basis (%)

Diets Ingredients	1	2	3	4
Maize	58.25	57.75	60.75	59.75
SBM	38.50	36.50	31.00	29.75
MOSM	0.00	2.50	5.00	7.50
Bone meal	1.50	1.50	1.50	1.50
Oyster shell	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50
DL-methionine	0.25	0.25	0.25	0.25
Premix	0.50	0.50	0.50	0.50
Total	100	100	100	100

Table 1(b). Analyzed nutrients content of diets (%)

Diets Nutrients	1	2	3	4
Dry matter	88.10	88.50	88.40	82.90
Crude protein	22.47	22.46	22.80	22.13
Crude fibre	3.61	4.00	3.97	2.50
Ether extract	3.62	4.40	5.12	6.71
Total ash	6.72	6.92	6.20	8.12
*NFE	38.04	41.59	45.33	41.09

*NFE, Nitrogen Free Extract.

3. Results

Table 1 presented the proximate composition of the full-fat *Moringa oleifera* seed meal. The seeds are shown to be rich in nutrients namely dry organic matter, carbohydrate, protein, fat, mineral matter and gross energy content (5.79 kcal/g).

Analysis of the water soluble vitamins, B-complex and ascorbic acid are given on Table 2. Moringa seed is observed to contain appreciable levels of thiamin, riboflavin, nicotinic acid, pyridoxine, cynocobalamin and ascorbic acid. The fat soluble vitamins, ADEK are shown on Table 3. Moringa seeds contain high concentration of fat soluble vitamins similar to those of the water soluble ones.

Table 2(a). Chemical composition of *Moringa oleifera* seed meal

Chemical	
Dry matter	90.40%
Soluble carbohydrate	25.80%
GE Kcal/g	5.79
Crude protein	25.37%
Crude fat	14.16%
Crude fiber	30.64%
Mineral matter	4.03%
Content of vitamins B-complex and ascorbic acid in *M. oleifera* (Concentration (mg/100g)	
Thiamine, B1	0.38
Riboflavin, B2	0.13
Niacin, B3	4.69
Pyridoxine, B6	2.30
Cynocobalamin, B12	3.60
Ascorbic acid, C	4.31

Table 2(b). Composition of fat-soluble vitamins in *M. oleifera*

Vitamins	mg/100g
Beta-carotene, A	846.31
Vit. D	58.48
Tocopherol, E	518.50
Vit. K	218.67
Macro-minerals and micro-elements in Moringa seeds (ppm)	
Phosphorus, P	1600
Potassium, K	9615
Sodium, Na	7240
Calcium, Ca	2925
Magnesium, Mg	2998
Manganese, Mn	125
Zinc, Zn	41
Copper, Cu	28.25
Lead, Pb	nd*

*nd, not detectable.

Table 3. Dietary effects of graded levels of MOSM on performance indices in broilers

Diets	1	2	3	4	S E M
Parameters					
Feed intake,g/b/d	28.33^{c}	25.59^{b}	22.55^{a}	20.67^{a}	0.36
Weight gain g/b/d	27.64^{b}	26.00^{b}	24.00^{a}	22.00^{a}	0.46
Feed/gain	1.03	0.98	0.94	0.94NS	0.02
Mortality rate, %	_	1	_	_	_

a-b-c means in rows not sharing common letters are significantly different ($p < 0.05$).

NS, no significant difference ($p > 0.05$).

Data on analyzed content of macrominerals, microelements and heavy metal content in seeds are presented on Table 2(b). Moringa seeds obtain from middle belt of Nigeria (Benue state) are observed to contain reasonable quantities of Na, P, K, Ca, Mg as well as the microminerals, Zn, Cu, Mn. The heavy metal, lead (Pb) was however not detected in the seeds.

Dietary performance following ingestion of *M. oleifera* seed meal at graded levels is shown on Table 5. Statistical significant differences were recorded on feed consumption, body weight gain ($p < 0.05$). There was however, no significant difference in the efficiency of feed utilization relative to the reference diet ($p > 0.05$). Survival rate recorded 100% on both the conventional and test diets and the 1% mortality recorded was unconnected with the dietary effect. Phenotypically, all the birds showed no sign of ill-health throughout the experimental period but increment in body weight tended to drop with increasing levels of the seed meal in diets.

4. Discussion

The proximate composition values of Moringa seeds from Benue state of Nigeria as presented in this study confirmed past reports on the nutritional value of *Moringa oleifera* tree and products that the tree and its products are loaded sources of multi-nutrients which could be used for food and feed in nutrition of human beings and animals (Manh et al., 2005).

Analysis on fat and water soluble vitamins indicated that Moringa seed obtained from middle belt of Nigeria is rich in vitamins and their precursors. Results on the vitamins in this work agreed with those of past workers

(Anjorin et al., 2010) who noted similar high concentrations of vitamins in *Moringa oleifera* products. Donovan (2007) noted that *Moringa oleifera* provides twice, the vitamin A in carrots and seven times, the ascorbic acid in citrus.

Analyses of some macro- and micro-minerals revealed the seeds obtained in this region to be high in concentration of phosphorus (1600 ppm), potassium (9615 ppm), sodium (9240 ppm), calcium (2925 ppm), magnesium (2998 ppm) and zinc (41 ppm), copper (28.25 ppm), manganese (125 ppm) respectively. The absence of heavy metal(s), lead present the seeds to be non-toxic in this element since heavy metals do not contribute in any way to the nutritional improvement of a food/feedstuff but rather cause health hazards following their chronic accumulation in the body. Data obtained on mineral composition of Moringa in this analysis confirmed reports of early works (Fahey, 2005; Donovan, 2007) that Moringa products contain 9-times the iron in spinach, 14-times the calcium in milk and 4-times the potassium in bananas and plantains warranting the tree crop products as healthy food/feedstuff sources.

Dietary performance characteristics showed decrease in feed intake and weight gain in groups of birds on the test diets following increasing level of the MOSM. Reduction in feed consumption index following increase in graded inclusion levels and loss in body weight concomitant with increasing level of the dietary seed meal could be due to the bitter taste of alkaloids inherent in *M. oleifera* and the other phytotoxins acting in concert with the high inclusion level since Moringa plants have been shown to harbour alkaloids and chemical compounds like phenols (tannins), saponins, phytate, cyanogenic glucoside, glucosinolates, others (Fahey et al., 2001; Bennet et al., 2003). Makkar and Becker (1997) reported the quantitative levels of the mentioned phytochemicals in unextracted full-fat meal to as 0.04%, 1.40%, 4.10%, 13.10 mg/kg and 65.50 mmol/g for total phenols, saponins, phytate, cyanogenic glucosides and glucosinolates respectively. High levels of these chemicals are likely to decrease the dietary performance and nutrient utilization.

Although Moringa products have been demonstrated to contain numerous valuable nutrients and to be potential sources of cheap carbohydrate, protein, vitamins, lipids, essential minerals, the presence of the toxic chemicals could cause constraints to the enhanced utilization of the seeds in nutrition of man and animal as exemplified in decreasing weight gain or growth rate with increasing intake observed in this study. This claim may be true since Kieg and Fox (1978) reported that toxicants like phenols including tannins and many others can bind or enzymatically destroy particular nutrients present in feeds thereby decreasing availability and utilization.

Survival rate was not influenced on any of the dietary treatments relative to the control diet and the 1% mortality observed on diet 2 was unconnected with the dietary effect. However, evidence abound in literature on the effects of Moringa phytochemicals that when consumed in high doses could prove fatal, hence further research will be carried out to ascertain the toxicity at higher levels than the ones applied in this study.

References

Association of Official Analytical Chemists. (2000). *Official methods of analysis*. Washington, DC: AOAC.

Bennet, R. N., Mellon, F. A. Foidl, N., Pratt, J. H., Dupont, M. S., Perkins, L., & Kroon, P. A. (2003). Profiling glucosinolates and phenolics in vegetative and reproductive tissues of the multipurpose tree *Moringa oleifera* L. (Horseradish tree) and *Moringa stenopetala* L. *Journal of agricultural and food chemistry, 51*, 3546-3553. http://dx.doi.org/10.1021/jf0211480

Carpenter, K. J., & Clegg, K. M. (1956). The metabolizable energy of poultry feeding stuffs in relation to their chemical composition. *Journal of the Science of Food and Agriculture, 7*(1), 45-51. http://dx.doi.org/10.1002/jsfa.2740070109

Donovan, P. (2007). *Moringa oleifera seeds for cultivation*.

Fahey, J. W., Zalcmann, A. T., & Talalay, P. (2001). The chemical diversity and distribution of glucosinolates and isothiocyanates among plants. *Phytochemistry, 56*(10), 5-51. http://dx.doi.org/10.1016/S0031-9422(00)00316-2

Kieg, C., & Fox, H. M. (1978). Fiber and Protein nutritional status. *Cereal Foods World, 23*, 249.

Makkar, H. P. S., & Becker, K. (1997). Nutrients and antiquality factors in different morphological parts of the Moringa oleifera tree. *J. agric Sci., 128*, 311-322. http://dx.doi.org/10.1017/S0021859697004292

Manh, L. H., Dung, N. N. X., & Ngoi, T. P. (2005). Introduction and evaluation of *Moringa oleifera* for biomass production and as feed for goats in the Mekong delta. *Livestock Res. For Rural Dev, 17*(9).

NRC. (1994). *Nutrient requirements of poultry* (9th revised ed.). National Academy Press, Washington, DC.

Oluyemi, J. A., & Robert, F. A. (1979). *Poultry production in warm west climate* (1st ed., pp. 35-79). London: Macmillan Press Ltd.

Price, M. L. (1985). The moringa tree. *Educational Concerns for Hunger Organization (ECHO) Technical Note*.

SAS. (2002). *Statistical Analysis system proprietary software* (Release 8. 3). SAS Institute Inc. carry, NC.