

Estimating the Nutritional Value of the Leaves of *Moringaoleifera* on Poultry

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ABSTRACT

In this study, we validated the effect of *Moringa oleifera* leaves as food supplement on poultry. Proximate neutron activation analysis was used in determining the level of some of the vital nutritional minerals and potential toxic elements in the serum of the birds during the experimental process, including Magnesium, Copper, Vanadium, Chlorine, Aluminium, Manganese, Calcium, Mercury, Cadmium, Arsenic, Sodium and Potassium. Incorporation of *Moringa oleifera* leaves in maize meal fed to poultry showed profound, statistically significant effect on their weight ($p < 0.05$) as well as intensity in coloration of the beaks and legs, combs and wattles, in contrast to a control (maize-meal only) feeding of broilers ($p > 0.05$). Moreover, a significant level of the biochemical minerals of serum Calcium ($1.17 - 1.20 \text{ mmol}\cdot\text{L}^{-1}$), Sodium ($141.6 - 152.6 \text{ mmol}\cdot\text{L}^{-1}$), Potassium ($4.1 - 5.7 \text{ mmol}\cdot\text{L}^{-1}$), Chloride ($95 - 110 \text{ mmol}\cdot\text{L}^{-1}$), Albumen ($30 - 55 \text{ mmol}\cdot\text{L}^{-1}$) and Triglyceride ($0.3 - 1.7 \text{ mmol}\cdot\text{L}^{-1}$) were observed in broilers fed with the formulated *Moringa oleifera* leaves and maize meal as compared to the maize meal only (control). Addition of *Moringa oleifera* leaves to poultry feed will lead to high output performance in poultry production.

Keywords: *Moringa oleifera*; Neutron Activation; Serum; Poultry; Broilers

1. Introduction

Moringa is a tree extending in height from 5 - 12 m with an open umbrella-shaped crown, straight trunk between 10 to 30 cm thick and a corky, whitish bark. The plant, subject to climate has leaflets around 2 cm in diameter and about 2.5 cm in length. The tree yields a tuberous tap root which elucidates its acceptance to drought conditions [1]. It is primarily well-thought-out a tree of hot semi-arid regions of annual rainfall ranging from 250 to 1500 mm. *Moringa* is adjustable to a comprehensive array of environmental conditions from hot to humid and wet conditions. The tree is tolerant to light frosts, but does not subsist as a perennial under freezing conditions [2]. *Moringa* matures more speedily, reaching higher heights, when found in well-drained soils with sufficient water, but endures sandy soils, heftier clay soils and water deficient conditions. The tree can be established in marginally alkaline soils up to pH 9 as well as acidic soils as low as pH 4.5 [3] and is soundapt for a wide

range of aggressive environments that would not be appropriate for other fruit, nut and tree crops [4].

Moringa oleifera Lam is one of the 14 species of the family *Moringaceae*, native to India, Africa, and many parts of the world [5]. Based on [6], the *Moringa* tree was made known to Africa from India around the twentieth century where it was to be used as a well-being complement. The plant is cited by a number of names such as horseradish tree, drumstick tree, bean oil tree, and a lot more others [7].

Exploration of the diverse parts of the plant is multidisciplinary, comprising but not restricted to nutrition, ethnobotany, medicine, analytical chemistry, phytochemistry and anthropology [8].

The *Moringa* plant has been expended by humans all over the century in various culinary ways [5]. Virtually all fragments of the plant are used culturally for their nutritional value, ostensible medicinal properties as well as taste and flavor. The leaves of *Moringa oleifera* can be consumed fresh, boiled, or kept as a dried powder for countless months supposedly without any major damage

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of its nutritional value [9]. Epidemiological studies have specified that *Moringa oleifera* leaves are a good source of nutrition and display anti-tumor, anti-inflammatory, anti-ulcer, anti-atherosclerotic and anti-convulsant activities [10] (**Table 1**). The leaves, seeds, flowers, fruit, bark and roots are all used as vegetable [11], and each part is exceptionally harvested and utilized. For example, fresh leaves are picked, shade dried, ground to a powder, and then stored for later use as a food flavoring or additive. Dried or fresh leaves are also used in foods such as soups and porridges, curry gravy and in noodles, rice or wheat [12]. Farmers have included the leaves to animal feed to support a healthy livestock [13-15] while exploiting the manure and vegetable compost for crop growth [16]. Innovative application comprise the use of *Moringa* powder as a fish food in aquacultural systems [17] and the *Moringa* leaves as a protein supplement for animals, such as cows. The feeding value of *Moringa* has been re-counted to be analogous to that of soybeans and rapeseed meal [18]. With the leaves being rich in nutrients, pregnant women and lactating mothers use the powdered leaves to enhance their children's nourishment, principally in under developed countries where malnutrition is common [19,20].

Foods having high levels of protein (e.g., soya beans, groundnuts, sunflower seeds) and other feed supplements for poultry production are expensive to purchase while energy foods (e.g., cereal such as maize, sorghum, millets, wheat, rice, maize bran, wheat bran and rice bran by-products) are often plentiful and relatively cheap. This has obligated most poultry farmers to move away from this industry leading to low production of poultry meat and eggs and raised the price of poultry products due to high cost of importation. The energy in the diet-

necessary for production of poultry meat and eggs and for the maintenance of vital functions and body temperature, are largely in the form of carbohydrates, fats and amino acids which can be found in the leaves of *Moringa oleifera*. The production of protein in the body tissues entails an adequate supply of about 20 different amino acids, 10 of which cannot be synthesized by poultry, and must therefore be provided in their diets. These essential amino acids are distributed in the leaves of *Moringa oleifera* all year round [21-23].

The current study sought to validate the potential vital nutritional minerals in the leaves of *Moringa oleifera* and their effect on the weight and other features of broilers fed with maize meal formulated with *Moringa oleifera* leaf powder.

2. Materials and Method

2.1. Materials

Moringa oleifera leaves (MOL) were harvested from an orchard at early flowering stage at Navrongo in the Kasena Nankana District of Upper East Region of Ghana. The plant material was authenticated by Dr. Walter M. Kpikpi, a botanist at the Department of Applied Biology in the Faculty of Applied Sciences of the University for Development Studies, Navrongo Campus.

4-month old broilers were purchased from the Navrongo poultry farm, while maize was obtained from the Navrongo market.

2.2. Preparation of *Moringa oleifera* Leaf Powder and Maize-Meal (MOLMM)

Branches were cut from the *Moringa* trees, threshed

Table 1. Recommended daily intakes of the various minerals.

Minerals (nutritional nutrients)	Major function	RDI (Mg)	Deficiency	Toxicity
Calcium	Component of bone and teeth, blood clotting, nerve transmission, muscle action	800 - 1200	Osteoporosis	Kidney stone
Magnesium	Bone formation, muscle and nerve function	280 - 320	Weakness, muscle pain	Rare
Sodium	Osmotic pressure, nerve transmission	500	Nausea, vomiting, muscle cramps	Possible hypertension
Chlorine	HCl synthesis, osmotic pressure, nerve transmission	700	Rare	Possible hypertension
Potassium	Osmotic pressure, nerve transmission	2000	Heart irregularities, muscle cramps	Slowed heart rate
Copper	Iron metabolism, component of many enzymes	1.5 - 3.0	Anemia	Rare, vomiting
Manganese	Fat synthesis, bone formation	1.8 - 2.3	Poor growth	Weakness; nervous system problems; mental confusion
Vanadium	Enzymatic reactions such as metabolism of carbohydrate and lipids, glucose and protein	<1.8	Rare. Impairs glucose metabolism	Damage to both liver and kidney. Causes gastrointestinal distress, primary diarrhea

Source: USDA nutrient database.

carefully to separate leaves from twigs and weighed. The leaves were spread out on a floor and allowed to air-dry for 4 days under shady and aerated conditions. The dried leaves were ground with mortar and pestle to obtain a leaf powder. The maize was ground at a corn mill to appreciable particle sizes. A 20 g sample of the maize powder was mixed with 5.0 g of the *Moringa oleifera* leaf powder to derive the MOLMM.

2.3. Management of Experimental Animals (Broilers)

Five chicken-broilers were allotted to floor pens (2:2:1), with their respective ID numbers of A1 and A2, B1 and B2, and C1) in a randomized complete block design. Sunlight was used as a source of light during the day and fluorescent tubes were used to illuminate the pens at night. The birds were kept under a deep litter management system and “saw dusts” were used as litter materials to cover the floor to serve as absorbents.

2.4. Experimental Design

A single diet was formulated in two different phases at 3-week intervals. The MOLMM was first fed to the broilers in block “A” for 21 days while those in block “B” and “C” were given only maize meal (MM). After 21 days, block “B” broilers were also given same quantities of MOLMM for 21 days while block “A” and “C” broilers were maintained on MM only. Broilers were made to acclimatize to experimental diet for a period of 7 days prior to data collection. Broilers were provided with ration twice daily at intervals of 7 hours (9:00 am-4:00 pm) and water was provided daily. The weight of each broiler was taken from each block at 3-day intervals during the period of study. Observations of color of their beaks and legs, combs and wattles as well as the activeness of the broilers were made.

2.5. Determination of Nutritional Minerals

Two milliliter blood samples were collected from the broilers in each block using new sterile needles and syringes through the veins in the wings and placed inside vacutainer test tubes labeled appropriately with corresponding treatment IDs. The blood samples were centrifuged at 3000 rpm for 10 minutes in order to separate the serum. Selected blood chemistry was carried out in the analyzer for some nutritional biochemical minerals at the War Memorial Hospital in Navrongo.

2.6. Neutron Activation Analysis of Some Vital Nutritional Minerals in *Moringa oleifera* Leaf

Proximate neutron activation analysis was carried out on

the *Moringa oleifera* leaf powder, using the Research Reactor-1 at the Ghana Atomic Energy and Commission (GAEC) to determine the presence of nutritional elements such as Magnesium, Copper, Vanadium, Chlorine, Aluminum, Manganese, Calcium, Sodium and Potassium as well as the heavy metals Mercury, Cadmium and Arsenic.

2.7. Statistical Analysis

The data were statistically dissected using one-way ANOVA. Results were considered to be statistically significant when ($P < 0.05$).

3. Results

After completion of forty-two (six weeks) treatment the effects of the leaves of *Moringa oleifera* and maize meal on body weight and levels of some vital nutritional components in the serum of chicken-broilers as well as some nutritional content in leaves were investigated in controlled conditions.

The body weight of broilers fed with MOLMM increased significantly over the 21-day period as compared to those fed on the maize meal only diet (**Figures 1 and 2**). There was an increase in weight of broiler A1 initially from day 1 up to day 6, dropped up to day 9, rose from day 10 up to day 15, remained steady up to day 19 and rose till day 21 (**Figure 1**). Broiler A2 showed a similar weight increase pattern except for an initial decrease within the first three days (**Figure 1**). The weight of broiler B1 kept fluctuating over the initial 21-day period when it was fed with only MM (**Figure 2**). It increased up to day 5, dropped by same margin by day 10, stabilized up to day 15, rose and declined by same margin up to day 21 before feeding with MOLMM commenced. Its weight then sharply increased within nine days, dipped slightly for a couple of days, shot up for another five days and stabilized up to day 42. On the other hand, the weight of broiler B2 increased from day one up to three, dropped up to day 6, remained constant up to day 15 and dropped up to day 21. With the change in diet to MOLMM, its weight increased almost steadily up to day 38 with two slight dips in-between, finally stabilizing till day 42 (**Figure 2**). Broiler C1 which was fed with only MM throughout the period of study started with a constant weight for the first 6 days which dropped sharply up to day 9, stabilized for the next 6 days, increased up to day 18 and decreased again till day 21. Finally, it moved up again from day 24 to 27 and remained at that level till the end of the study (**Figure 2**).

Effective yellow coloration of the beaks and legs as well as bright coloration of the combs and wattles was observed in broilers fed with MOLMM as compared with only MM-fed broilers. To determine whether or not there

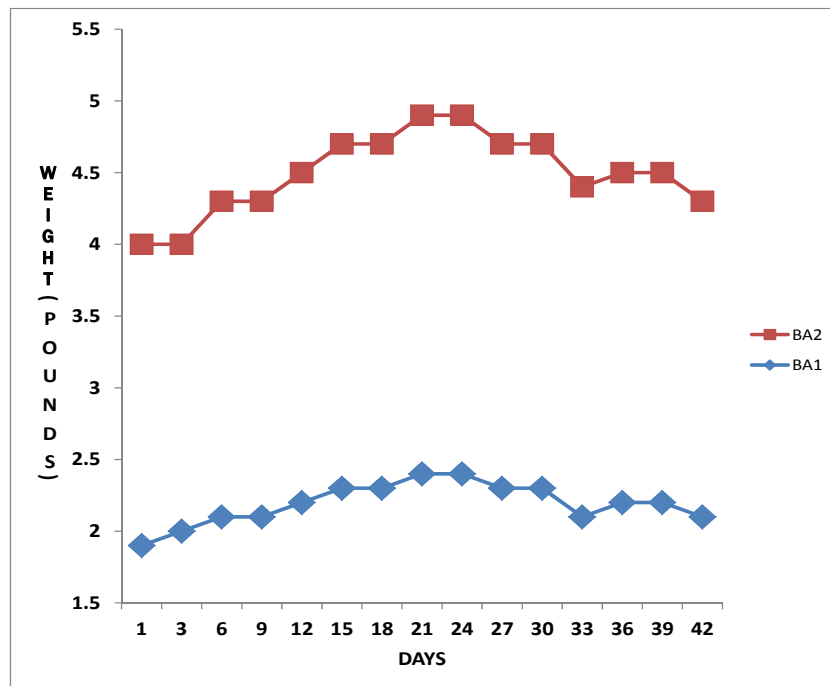


Figure 1. (■) Variations in weight of broiler A1 fed on *Moringa oleifera* leaf powder maize meal (MOLMM) for 21 days, and on only maize meal after 21 days until the 42nd day. (◆) Variations in weight of broiler A2 fed on *Moringa oleifera* leaf powder maize meal (MOLMM) in the first 21 days and on maize meal only after 21 days until the 42nd day.

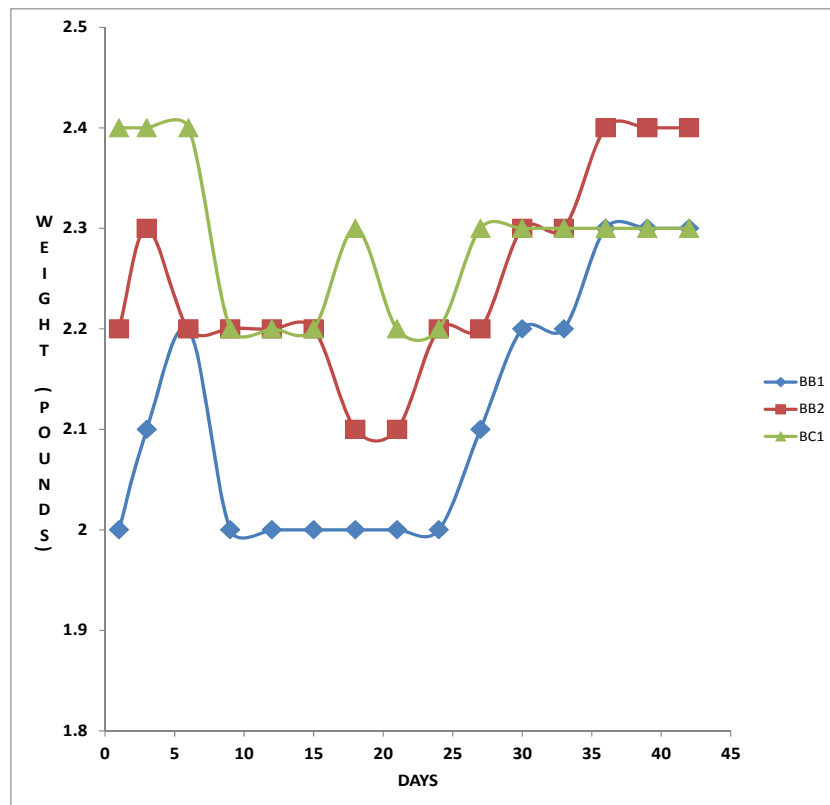


Figure 2. (◆) Variations in weight of broiler B1 fed on maize meal only for 21 days and on *Moringa oleifera* leaf powder maize meal (MOLMM) after 21 days until the 42nd day. (■) Variations in weight of broiler B2 fed on only maize meal for 21 days and on *Moringa oleifera* leaf powder maize meal (MOLMM) after 21 days until the 42nd day. (▲) Variations in weight of broiler C1 fed on only maize meal for the entire study period.

was a statistically significant difference achieved by *Moringa oleifera* leaves meal and maize meal during feeding. A significant effect ($P < 0.05$) on body weight of MOLMM-fed and insignificant ($P > 0.05$) on body weight of MM-fed broilers were observed. Higher activity of broilers fed with MOLMM as compared with those on a MM only diet was also observed.

Initial serum samples were taken after 21 days of feeding the broilers due to the difficulty of drawing samples at the earliest infant stage. The total levels of serum Calcium, Sodium, Potassium, Albumen, Triglyceride and Chloride of broilers fed with MOLMM and MM only as well as the reference ranges are shown in (Table 2). Significant increases in total serum levels of Calcium, Sodium, Potassium, Albumen and Chloride were observed for the broilers fed with the MOLMM over the feeding period. There was, however, reduction in serum Triglyceride level of the broilers when fed with the MOLMM. Generally, there was reduction in biochemical serum minerals of broilers fed with MM only (control).

Proximate neutron activation analysis showed that *Moringa oleifera* leaves abound in vital nutritional minerals namely Magnesium, Copper, Vanadium, Chlorine, Aluminum, Manganese, Calcium, Sodium and Potassium. They were found to be devoid of potential toxic elements such as Mercury, Cadmium, and Arsenic (Table 3).

4. Discussion

The present study reveals that the leaves of *Moringa oleifera* contain most of the major nutritional elements needed for healthy growth as revealed during neutron activation analysis of *Moringa oleifera* leaf (MOL) powder.

There were no detectable peaks (NDP) for the heavy metals of Mercury, Cadmium and Arsenics which can be toxic to the body when ingested; depicting that MOL is safe for consumption.

There was a significant increase in weight of broilers A1 and A2 when they were fed with MOLMM from day

one up to day twenty one and remained stable up to day twenty four. There was then a significant decrease from day twenty four up to day forty two when only MM was used to feed them. The weight remained fairly constant between day twenty one and twenty four when only MM was administered. This could be as a result of the nutritional minerals which were still present in the body. It could be inferred that *Moringa oleifera* leaves had a significant impact on the weight of the broilers fed with MOLMM through the provision of vital biochemical minerals which might have been absent or inadequate in the normal diet of maize meal (MM) as shown for the control samples. From the present study it was revealed that MOL lowered serum Triglyceride level and increased serum Calcium, Sodium, Potassium, Albumen and Chloride. The latter is justified by the levels of these and other minerals detected in MOL powder after the neutron activation analysis.

Broilers A1 and A2 were initially fed with only maize meal for 21 days before swapping to MOLMM, whilst broilers B1 and B2 were fed with MOLMM for 21 days initially. We therefore speculate that there might be few nutritional minerals in the maize meal which might have also influence significantly the absorption of high nutritional mineral content in the MOL making broilers B1 and B2 had substantial weight gain when feed was supplemented with MOL.

The sample size selected for this particular study were low, as a result the data collected with respect to this study is preliminary and the research still on-going with current analysis comprising a large sample size in our laboratory which would be presented in our next manuscript in preparation.

5. Conclusions

Moringa oleifera leaves contain major nutritional minerals needed for healthy growth of animals including poultry. Feeding of poultry with maize meal formulated with *Moringa oleifera* leaf powder can lead to increase in

Table 2. Analysis of Total Serum Calcium, Sodium, Potassium, Albumen, Triglyceride and Chloride levels of broilers at various stages of the experimental process.

Mineral	First two weeks					One month					Forty two days					Standard reference range
	A1	A2	B1	B2	C1	A1	A2	B1	B2	C1	A1	A2	B1	B2	C1	
Calcium (mmol·L ⁻¹)	1.01	1.61	1.03	1.05	1.00	1.05	2.01	1.51	1.32	1.60	1.31	2.21	1.78	2.00	1.40	1.20 - 1.73
Sodium (mmol·L ⁻¹)	138	80.0	115	128	137	157	161	136	158	149	155	138	152	155	148	141.6 - 152
Potassium (mmol·L ⁻¹)	2.96	4.28	4.01	3.71	5.00	3.89	4.25	3.65	5.01	4.81	21.97	4.43	6.56	1.67	4.78	4.1 - 5.7
Albumen (g·L ⁻¹)	32.2	50.3	41.7	40.7	48.7	58.6	38.5	59.8	50.8	50.0	48.6	44.7	59.7	55.8	48.9	30 - 55.0
Triglyceride (mmol·L ⁻¹)	2.32	3.10	1.81	2.81	2.23	2.15	1.00	0.34	0.70	1.68	1.03	1.30	2.85	1.83	1.62	0.30 - 1.70
Chloride (mmol·L ⁻¹)	97.0	101	112	96.0	91.0	117	108	98.0	120	99.0	108	101	108	104	97.0	95 - 110

Table 3. Nutritional mineral content of dried *Moringa oleifera* leaf powder (in ppm) and gamma energy released per nutritional mineral (in Kev).

Nutrient	Content (ppm)	Gamma energy (Kev)
Mg	3322.32	1014
Cu	2.96	1039
V	0.449	1434
Cl	1380.29	1642
Al	458.22	1779
Mn	46.07	1810
Ca	14720	3084
Hg	*NDP	77.4
Cd	*NDP	336
As	*NDP	559
Na	393.02	1369
K	13712	1524

*NDP: No Detectable Peaks.

weight, bright coloration of their combs, wattles, beaks and legs as well as general increase in activity of the birds.

Heavy metals like mercury, arsenic and cadmium which are potentially toxic are absent from the leaves of *Moringa oleifera*, thus making their incorporation into poultry feed safe.

The availability of *Moringa oleifera* in many rural communities in Ghana makes its use as a supplement for poultry feed an economically viable alternative to expensive commercially produced poultry feeds.

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