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Full Length Research Paper

Effect of oral administration of aqueous extract of *Moringa oleifera* seeds, gum arabic and wild mushroom on growth performance of broiler chickens

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In Nigeria, antibiotics are administered in poultry drinking water for prevention or control of bacterial contamination and to promote growth performance and health of birds. However, these antibiotics have negative effects and this has led to the search for safe and natural alternatives (like photogenic plants products and medicinal mushrooms) to reduce the continuous use of antibiotics in poultry to promote health and nutrition. In this study, the effect of oral administration of different levels of aqueous extract of *Moringa oleifera* seed, Gum arabic and wild mushroom (*Ganoderma sp*) and their combination on performance characteristics of broiler chickens were evaluated in comparison with antibiotic. Commercial hybrid (Marshal) broiler chicks were procured at day-old from a hatchery in Nigeria and brooded together for the first one week of age to acclimatise. On day 7, the birds were randomly distributed into different treatment groups, T1 - T8 (10 chicks per group) in duplicates. Group T1 = represent broiler chicks administered orally with *Moringa* seed aqueous extract, T2 = Gum arabic, T3 = wild *Ganoderma*, T4 = *Moringa* seed + Gum arabic, T5 = *Moringa* seed + wild *Ganoderma*, T6 = Gum arabic + wild *Ganoderma*, T7 = *Moringa* seed + Gum arabic + wild *Ganoderma*, T8 = antibiotic only as control for comparison. Each group (T1-T8) was administered orally with the respective plants product and wild mushroom treated drinking water at different levels (5% w/v at 2 weeks of age, 10% w/v at 4 weeks, and 20% w/v at 6 weeks). All the chicks in all the groups were fed *ad libitum* with broiler starter diet (22% CP and 2800 Kcal/kg ME) from 1 to 4 weeks of age, and broiler finisher (20% CP and 2649 Kcal/kg ME) from 5 to 8 weeks of age. Daily average feed intake, body weight gain, and feed conversion rates were monitored. Proximate study, minerals and phytochemical composition of the plants products and wild mushroom were evaluated. The results showed that *Moringa* seeds, gum arabic and wild *Ganoderma* contained appreciable levels of crude protein, fatty acids and essential minerals, which are valuable nutritional requirements of poultry. The average daily feed intake, body weight gain, feed conversion rates, carcass and organ weights of broilers administered orally with the aqueous extracts of *Moringa* seed, gum arabic and wild *Ganoderma*, were not significantly affected (P>0.05), as they compared favourably with the use of antibiotics. It was concluded that these plants products and wild mushroom could be utilized as natural alternatives to antibiotic growth promoters and source of feed supplements in broilers. Anti-nutrients in them were low (less than 5%) and this could be reduced during processing or aqueous extraction. These plants products and mushroom are consumed by humans as safe and natural source of food supplement and phytomedicine.

Key words: Food supplement, phytomedicine, growth performance, poultry.

INTRODUCTION

In Nigeria, it is a common practice in the management of poultry to administer antibiotic in drinking water to prevent or control bacterial contamination and as growth promoters. The benefits of such practice is to maintain good health, suppress mortality of birds, and to support maximal growth via improved utilization of nutrients and

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hence to improve profit (Murwani and Murtini, 2009). The action of antibiotics helps to decrease the number of competitive pathogenic bacteria in the gut (of birds) and therefore reducing bacterial load in the gut (Dibner and Richards, 2005).

Due to some negative effects of antibiotics (such as emergence of antibiotic-resistant pathogens, drugs toxicity and drugs residues), which have led to the ban on usage of antibiotics in food animals and poultry since 2006 by the European Union, safe and natural alternative sources are being sought in attempts to promote health and nutrition. The use of medicinal plants either alone or in group (combination) as possible therapeutic measures has become a subject of active scientific investigation (Patwardhan and Vaidya, 2004; Sudha et al., 2010). Some medicinal plants products are known to enhance natural resistance of the host to infection due to the presence of bioactive phytochemicals or phyto-nutrients (Atal et al., 1986; Patwardhan et al., 2004; Murwani, 2008; Murwani and Murtini, 2009; Soetan and Oyewole, 2009; Sudha et al., 2010).

Plants or herbs and wood-rot macrofungi (medicinal mushrooms) and their secondary metabolites were reported to have beneficial effects in promoting health and immune response of chickens (Guo et al., 2003; Ogbe et al., 2008, 2009, 2010; Ogbe and John, 2011, 2012). Medicinal plants products (such as *Moringa oleifera*) are in high demand for their medicinal value. They are reported to have antibacterial properties; as such, a conclusion was made to investigate them as phytotherapeutic agents to combat infectious agents (Patel, 2011). The *Moringa* seeds in particular were reported to be very useful for the treatment of water. The tree (*Moringa oleifera*) grows throughout the year in Nasarawa State, Nigeria where the leaves and seeds are utilized as edible vegetables by the people. The plant leaves are also consumed by farm animals as fodder. Most parts of the plant have been used in folk medicine in Africa and South Asia (Fahey, 2005). Plants extracts (or products) are known to have antiseptic properties and beneficial effects on digestion (Somaieh et al., 2011). For instance, gum arabic or acacia gum is used by traditional herbalists dissolved in water for alleviation of cough, sore throat and digestive disorders (dysentery or diarrhea). Supplementation with gum arabic (as additive in food and beverages) was reported to significantly increase beneficial bacteria flora (*Bifidobacteria* and *Lactobacilli*) in healthy human volunteers in a dose-dependent manner (Calame et al., 2008).

Justification of study

Medicinal plants products (*Moringa* seeds and gum arabic) and wild mushrooms (*Ganoderma sp)* are largely available in Nasarawa State, Nigeria. Wild mushrooms (*Ganoderma sp*) grow on decaying wood logs or tree stumps during the rainy season in Nigeria and was reported to be useful for the control of coccidiosis in broilers (Ogbe et al., 2009). Natural plants products are believed to have minimal side effects (Upadhyaya et al., 2011).

In this study, the effect of oral administration of aqueous extract of *Moringa oleifera* seeds, gum arabic and wild mushroom (*Ganoderma sp*) on growth performance of broiler chickens was evaluated in comparison with antibiotic. The objective of this study was to highlight the nutritional value, phytochemical and mineral composition of *Moringa oleifera* seeds, gum arabic and wild *Ganoderma* and their potential benefits in broiler production.

MATERIALS AND METHODS

Plant material and preparation of extract

Moringa oleifera seeds were collected during the rainy season (June-July) in Lafia Local Government Area of Nasarawa State, Nigeria. The seeds were de-husked and sun-dried at 35°C for 5 days. The dried seeds were milled into powder form using a locally made miller machine (unbranded). The milled *Moringa* seed was used for the preparation of different levels of aqueous extract (5, 10 and 20% w/v) by soaking in boiled drinking water at 100°C for 3 h. Each solution was sieved and the solid matter discarded and filtrate cooled to room temperature (28°C) prior to administration (5w/v concentration at 2 weeks, 10%w/v at 4 weeks and 20%w/v at 6 weeks of age of broiler chicks) according to the method described by Ogbe and John (2012).

The solid granules of gum arabic (a solidified secondary metabolite from the bark of acacia tree) was procured from an open local market, and milled into powder form using a locally made miller machine (unbranded). The milled (powder) particles were sieved and the fine particles used for preparation of different levels of aqueous extract (5, 10 and 20%w/v) as done above for *Moringa* seeds. Also, the wild mushroom (*Ganoderma sp*) was milled and used similarly for preparation of different levels of aqueous extracts. The different percentage (%) solutions from *Moringa* seeds, gum arabic and wild *Ganoderma* were mixed in equal ratio (1:1) to prepare combination of the extracts (5, 10 and 20%w/v), as described by Ogbe and John (2012).

Proximate (nutrients), minerals and phytochemical analysis

Proximate study was carried out to determine the nutritional composition (crude protein, crude fibre, fats and ash contents) of *Moringa* seeds, gum arabic and wild *Ganoderma* mushroom, according to the methods of the Association of Official Analytical Chemists (AOAC, 1990). All the proximate determinations were performed in duplicates and the values were reported in percentage

Table 1. Phytochemical composition of *Moringa oleifera* seeds, Gum arabic and wild *Ganoderma sp*.

Components	Mean values (% ±SD) of quantitative phytochemical contents			
	***Moringa* seeds**	**Gum Arabic**	***Ganoderma sp.***	**LOS**
Phytates	5.16 ± 0.20*	2.05 ± 0.12	2.43 ± 0.09	*
Oxalates	1.45 ± 0.10*	0.71 ± 0.16	0.57 ± 0.06	*
Saponins	2.94 ± 0.10*	1.47 ± 0.23	1.26 ± 0.06	*
Tannins	3.30 ± 0.50*	1.52 ± 0.24	1.83 ± 0.27	*
Trypsin inhibitors	1.42 ± 0.10	2.01 ± 0.10	2.39 ± 0.11	NS
Hydrogen cyanide (HCN)	0.05 ± 0.01	0.06 ± 0.01	0.08 ± 0.01	NS

Values represent mean ± standard deviation (SD) of duplicate analysis results; asterisk (*) = indicate significant difference at 5% level (P<0.05); NS = not significant; LOS = level of significance.

(%). Mineral analysis (calcium, magnesium, potassium, sodium, iron, zinc, manganese and copper) was done using Atomic Absorption Spectrophotometer (AAS-Buck 205 model) and phosphorus was carried out colorimetrically, according to the methods of 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). 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. The crude fat was converted into fatty acid by multiplying the value with a conversion factor of 0.80, as described by Akinyeye et al. (2010, 2011). Quantitative phytochemical and anti-nutrients analysis was also carried out on the dried and milled *Moringa* seeds, gum arabic and wild mushroom, according to the methods of Sofowora (1993). All the determinations were done in duplicates.

Experimental birds and management

Commercial hybrid (Marshal) broiler chicks were procured at day-old from a hatchery in Nigeria. The chicks were brooded together for the first one week of age to acclimatise. On day 7, the birds were randomly distributed into different treatment groups, T1–T8 (10 chicks per group) in duplicates. Group T1 = represent broiler chicks that were administered orally with different levels of *Moringa* seeds treated drinking water (5%w/v at 2 weeks of age, 10%w/v at 4 weeks and 20% w/v at 6 weeks), T2 = Gum arabic, T3 = wild *Ganoderma*, T4 = *Moringa* seeds + Gum arabic, T5 = *Moringa* seeds + wild *Ganoderma*, T6 = Gum arabic + wild *Ganoderma*, T7 = *Moringa* seeds + Gum arabic + wild *Ganoderma*, T8 = antibiotic only as control for comparison.

The chicks were kept in separate wire mesh house compartments, each measuring 100×200 cm. The chicks in all the groups were fed with broiler starter mash (22% CP and 2800 kcal/kg ME) from 1 - 4 weeks of age, and finisher mash (20% CP and 2650 kcal/kg ME) from 5 - 8 weeks of age, *ad libitum.* The feed ingredients used were obtained from a local market in Lafia, Nasarawa State, Nigeria. The chicks in all the groups were given routine vaccinations against Newcastle disease and Gumboro disease according to the specifications of the vaccines producer (NVRI, Vom). Vitamins only were administered to all the birds in drinking water for 3 days after each vaccination to prevent post-vaccination stress.

Collection of data and statistical analysis

The daily average feed intake, weight gain and feed conversion rates were determined as described by Ogbe et al. (2009). Organ and carcass analysis was also determined at the end of experiment (9 weeks). All data generated (proximate nutrients, phytochemicals, feed intake and weight gain) were analyzed using descriptive statistic and analysis of variance (ANOVA) as described by Olawuyi (1996). Results were reported as mean (±SD) standard deviation.

RESULTS

Phytochemicals in *Moringa* seeds, Gum arabic and wild *Ganoderma sp.*

Table 1 showed that *Moringa* seeds, gum arabic and wild *Ganoderma* contained tannins, phytates, trypsin inhibitors, saponins, oxalates and traces of hydrogen cyanide. The levels of tannins in *Moringa* seeds (3.3% ± 0.50) was significantly higher (P<0.05) than the levels in gum arabic (1.52% ± 0.24) and wild *Ganoderma* (1.83% ± 0.27). The levels of phytates (5.16% ±0.2) and oxalates (1.45% ±0.1) in *Moringa* seeds were significantly higher (P<0.05) than the levels in gum arabic (2.05% ± 0.12 and 0.71% ± 0.16) and wild *Ganoderma* (2.43% ± 0.09 and 0.57% ± 0.06), respectively. The result also showed that saponins in *Moringa* seeds (2.94% ± 0.1) was significantly higher (P<0.05) than the levels in the gum

Table 2. Proximate (nutrients) composition of *Moringa oleifera* seeds, Gum arabic and wild *Ganoderma sp*.

Nutrients analyzed (% DW)	Mean nutrients composition (% ± SD)			
	***Moringa* seeds**	**Gum Arabic**	***Ganoderma sp.***	**LOS**
Crude Protein (CP)	14.94 ± 0.70	15.38 ± 0.30	16.79 ± 0.13*	*
Crude Fibre (CF)	12.14 ± 0.30	7.41 ± 0.12	7.77 ±0.34	NS
Crude Fat (lipid)	2.98 ± 0.30*	1.83 ± 0.06	1.52 ±0.10	*
Ash Content	4.92 ± 0.20	9.05 ± 0.11*	8.42 ± 0.05*	*
Moisture	6.82 ± 0.03*	3.00 ± 0.20	2.78 ±0.22	*
Nitrogen (N)	2.39 ± 0.01	2.55 ± 0.20	2.83 ±0.22	NS
Carbohydrate (CHO)	58.22 ± 0.10	62.26 ± 0.50	63.27 ± 0.20	NS
Fatty acid	2.98 ± 0.10*	1.46 ± 0.05	1.22 ±0.07	*
Dry Matter (DM)	93.18 ± 0.10	97.00 ± 0.10	97.23 ± 0.05	NS
Energy value (Kcal/100kg)	1353.11 ± 0.30	1387.59 ± 0.10	1417.26± 0.42	NS

Values represent mean ± standard deviation (SD) of duplicate analysis results; asterisk (*) = indicate significant difference at 5% level (P<0.05); NS = not significant; LOS = level of significance.

Table 3. Mineral composition of *Moringa oleifera* seeds, Gum arabic and wild *Ganoderma sp*.

Minerals (Elements)	Mean mineral composition (% ±SD)			
	***Moringa* seeds**	**Gum Arabic**	***Ganoderma sp.***	**LOS**
Calcium (%)	0.58 ± 0.03	2.10 ± 0.13*	1.99 ± 0.04*	*
Magnesium (%)	0.30 ± 0.01	0.42 ± 0.10	0.34 ± 0.01	NS
Potassium (%)	0.17 ± 0.01	1.30 ± 0.04*	1.11 ± 0.04*	*
Sodium (ppm)	21.3.7 ± 0.60	259.85 ± 1.78*	229.88 ± 0.34*	*
Iron (ppm)	26.19 ± 0.60	98.42 ± 1.55*	121.37 ± 1.82*	*
Zinc (ppm)	13.88 ± 0.40	47.77 ± 1.06*	51.49 ± 2.16*	*
Phosphorus (ppm)	69.81 ± 0.40*	30.11 ± 0.20	30.17 ± 1.29	*
Manganese (ppm)	11.10 ± 0.50	58.83 ± 0.54*	71.06 ± 1.56*	*
Copper (ppm)	6.08 ± 0.10	5.94 ± 0.30	7.43 ± 0.13	NS

Values represent mean ± standard deviation (SD) of duplicate analysis results; asterisk (*) = indicate significant difference at 5% level (P<0.05); NS = not significant; LOS = level of significance; ppm = parts per million (1 mg/kg = 1 ppm).

arabic ((1.47% ± 0.23) and wild *Ganoderma* (1.26% ± 0.06). Generally, the levels of phytochemicals or anti-nutrients detected were low (less than 5%).

Proximate composition of *Moringa* seeds, Gum arabic and wild *Ganoderma sp.*

Table 2 showed that *Moringa* seeds, gum arabic and wild *Ganoderma* contained appreciable levels of nutrients. The crude protein level of wild *Ganoderma* (16.79% ± 0.13) appeared significantly higher (P<0.05) than the levels in the *Moringa* seeds (14.94% ± 0.7) and gum arabic (15.38% ± 0.3).

The moisture content, crude fat and fatty acids in *Moringa* seeds was significantly higher but the high moisture content of the seeds may be due to their low processing duration by sun drying (35°C for 5 days). Presence of significantly high levels of ash content of gum arabic and wild *Ganoderma* also showed that the plant product and the wild mushroom contained valuable amounts of minerals.

Table 3 showed that *Moringa oleifera* seeds, gum arabic and wild *Ganoderma* contained appreciable and valuable amounts of essential minerals. The following minerals in wild *Ganoderma* (calcium = 01.99% ± 0.04, potassium = 1.11% ± 0.04, sodium = 229.00 ± 3.4 (ppm), iron = 121.37 ± 1.82 (ppm), zinc = 51.49 ± 2.16 (ppm), manganese = 71.06 ± 1.56 ppm), and the minerals in gum arabic (calcium = 2.1% ± 0.13, potassium = 1.30% ± 0.04, sodium = 259.85 ± 1.78 (ppm), iron = 98.42 ± 1.55 (ppm), zinc = 47.77 ± 1.06 (ppm) and manganese = 58.83 ± 0.54 ppm) were significantly higher (P<0.05). These differences may be due to species variation and locality of growth.

The presence of these essential minerals implies *Moringa* seeds, gum arabic and the wild *Ganoderma*

Table 4. Feed intake and growth performance of broiler chickens administered with aqueous extracts from *Moringa oleifera* seeds, Gum arabic and wild *Ganoderma sp*.

Group parameters	Performance characteristics of broiler chicken								
	T1	T2	T3	T4	T5	T6	T7	T8	LOS
Initial weight (g/b)	150	160	155	160	160	170	160	150	NS
Final weight (g/b)	2300	2400	2300	2200	2100	2200	2200	2400	NS
Weight gain (g/b)	2150	2240	2145	2040	1940	2030	2040	2250	NS
Weight gain (g/b/d)	38.40*	40.00*	38.30*	36.43	34.64	36.25	36.43	40.20*	*
Feed intake (g/b/d)	90.54*	94.50*	93.00*	106.07	109.46	106.43	107.32	111.61	*
Final conversion ratio (FCR)	2.36	2.36	2.42	2.91	3.16	2.94	2.96	2.78	*
Mortality (%)	14.00*	0.00	0.00	0.00	0.00	0.00	0.00	4.00	*

Values represent mean ± standard deviation (SD) of duplicate results; asterisk (*) = indicate significant difference at 5% level (P<0.05); NS = not significant; LOS = level of significance; Group T1 = represent broiler chickens administered with *Moringa* seeds extract, T2 = Gum Arabic, T3 = *Ganoderma*, T4 = *Moringa* seeds + Gum Arabic, T5 = *Moringa* seeds + *Ganoderma*, T6 = Gum Arabic + *Ganoderma*, T7 = *Moringa* seeds + Gum Arabic + *Ganoderma*, T8 = Antibiotic only.

could be utilized as nutritionally valuable and healthy ingredients for poultry.

Feed intake and growth performance of broiler chickens

The feed intake and weight gain of broiler chickens that were administered with *Moringa* seeds (T1), Gum arabic (T2) and wild *Ganoderma* (T3) were not significantly different (P>0.05). However, group T2 recorded the highest feed intake (94.5 g/b/d) and weight gain (40 g/b/d). The weight gain of group T1 and T3 did not differ significantly (P>0.05). Among the groups that were administered with either combinations of the plant products and wild mushroom or with antibiotic, group T8 recorded the highest feed intake (111.61g/b/d) and weight gain (40.2 g/b/d). The feed intake and weight gain of birds in groups T4, T5, T6 and T7 did not differ significantly (P>0.05), but the weight gain of broilers in T5 appeared the least (34.64). Also, the weight gain of the broilers in T2 and T8 did not differ significantly (P>0.05). Although the feed intake (109.46 g) and the feed conversion rate (3.16) of the broilers in group T5 was high, the birds recorded the lowest weight gain (34.64 g/b/d). Possibly, the nutrients in the feed of these broiler chicks were unavailable for utilization or conversion into body tissues (growth). Possibly, the presence of anti-nutrients (tannins and phytates) in the plants products may be responsible for the reduction of feed intake and weight gain.

Generally, the carcass and organ weights did not show any appreciable variations (Table 4). However, the cut carcass parts of the broilers, the thigh in group T1 (23.33 ± 0.02), T2 (26.17 ± 0.15) and T3 (25.5 ± 0.10) appeared significantly higher. The breast part of the birds in group T1 (23.45 ± 0.03), T2 (22.69 ± 0.30) and T3 (23.5 ± 0.11) also appeared slightly higher than the others. Also, the rib cage of T1, T2 and T3 were slightly higher than the others. The intestines of T1, T2 and T3 were slightly lower (Table 5). These differences may be due to the lack of uniformity in the growth of the broiler chickens and not necessarily as a result of the plants extracts and the wild mushroom.

DISCUSSION

Generally, the results obtained from this study showed that the plants products (*Moringa* seeds and gum arabic), and wild mushroom (*Ganoderma sp)* contained valuable amounts of crude protein, fatty acids and minerals, which are nutritional requirements of poultry (broilers). Anti-nutrients (phytates and tannins) present in them were low. These anti-nutrients or phytochemicals are non-nutritive chemicals that occur naturally in plants. Certain phytochemicals (such as saponins) were reported to have pharmacologically active effects (Soetan and Oyewole, 2009). Acacia trees (like *Acacia nilotica*) in which gum arabic were obtained was said to contain condensed tannins in the leaves and pods (Nsahlai et al., 2011). These phyto-constituents were reported as antibiotic principles of plants (Ajayi et al., 2011). They offer benefits (prevent cell damage and fight infections) in plants and animals when ingested by them in food.

Certain phytochemicals have anti-nutritional properties (side effects), when ingested in excess. Phytates and tannins bind essential minerals such as calcium, iron, magnesium and zinc in the digestive tract to form insoluble salts, thereby decreasing or reducing bioavailability or absorption of nutrients (Thompson, 1993; De-Bruyne et al., 1999; Dei et al., 2007; Muhammad et al., 2011). Dietary tannins (in excess) are known to reduce feed efficiency and weight gain in chicks (Armstrong et al., 1974; Dei et al., 2007). High levels of saponins in feed can also 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

Table 5. Carcass and organ body weight (%) of broiler chickens administered aqueous extracts from *Moringa oleifera* seeds, Gum arabic and wild *Ganoderma sp*.

Parameter	Group mean weights and organ: body weight ratio (%)								
	T1	T2	T3	T4	T5	T6	T7	T8	LOS
Pre-slaughter weight (kg/b)	2.30 ± 0.01	2.40* ± 0.11	2.35* ± 0.10	2.20 ± 0.01	2.20 ± 0.21	2.20 ± 0.02	2.20 ± 0.02	2.40* ± 0.02	*
Dressed weight (kg/b)	1.91 ± 0.01	2.13 ± 0.13	2.05 ± 0.10	1.96 ± 0.02	2.10 ± 0.21	1.96 ± 0.02	1.96 ± 0.02	1.96 ± 0.02	NS
Dressing percent (%)	84.50 ± 0.02	89.50 ± 0.11	87.00 ± 0.06	89.00 ± 0.01	91.00 ± 0.01	89.00 ± 0.01	89.00 ± 0.01	89.00 ± 0.01	NS
Carcass: body weight ratio (%)									
Thigh (leg)	24.33* ± 0.02	26.47* ± 0.15	25.50* ± 0.10	20.55 ± 0.01	21.46 ± 0.00	21.93 ± 0.07	20.70 ± 0.20	21.66 ± 0.10	*
wings	9.73 ± 0.01	9.66 ± 0.10	9.50 ± 0.10	8.68 ± 0.03	9.38 ± 0.01	8.34 ± 0.04	8.37 ± 0.10	8.18 ± 0.01	NS
Breast	23.45* ± 0.03	22.69* ± 0.30	23.50* ± 0.11	15.41 ± 0.04	14.79 ± 0.01	16.19 ± 0.11	16.05 ± 0.20	17.50 ± 0.02	*
Rib cage (thorax)	7.52* ± 0.05	9.50* ± 0.30	9.50* ± 0.20	6.50 ± 0.02	5.98 ± 0.04	5.92 ± 0.01	5.64 ± 0.10	5.42 ± 0.02	*
Back (bone)	7.96 ± 0.05	7.56 ± 0.45	7.80 ± 0.30	9.71 ± 0.04	9.97 ± 0.04	10.09 ± 0.01	9.43 ± 0.14	8.57 ± 0.10	NS
Shank	3.54 ± 0.06	4.50 ± 0.06	4.25 ± 0.08	4.80 ± 0.02	5.30 ± 0.06	5.06 ± 0.04	4.70 ± 0.01	4.81 ± 0.01	NS
Neck	2.21 ± 0.02	2.50 ± 0.08	2.40 ± 0.04	6.40* ± 0.01	6.14* ± 0.01	4.94* ± 0.01	5.93* ± 0.06	5.19* ± 0.04	*
Head	2.54 ± 0.02	2.10 ± 0.02	2.35 ± 0.10	2.51 ± 0.01	2.50 ± 0.21	2.35 ± 0.02	3.26 ± 0.02	2.31 ± 0.02	NS
Organs: body weight ratio (%)									
Liver	1.11 ± 0.08	1.05 ± 0.07	1.05 ± 0.10	2.11 ± 0.01	2.24 ± 0.01	1.52 ± 0.01	2.12 ± 0.02	1.85 ± 0.01	NS
Kidney	0.13 ± 0.04	0.12 ± 0.02	0.13 ± 0.03	0.11 ± 0.01	0.14 ± 0.01	0.13 ± 0.01	0.14 ± 0.01	0.14 ± 0.01	NS
Gizzard	1.55 ± 0.04	1.26 ± 0.02	1.45 ± 0.03	3.55* ± 0.01	3.96* ± 0.03	3.85* ± 0.03	4.07* ± 0.01	3.76* ± 0.01	*
Heart	0.66 ± 0.02	0.63 ± 0.06	0.65 ± 0.04	0.64 ± 0.01	0.65 ± 0.01	0.66 ± 0.01	0.53 ± 0.01	0.58 ± 0.01	NS
Spleen	0.44 ± 0.04	0.42 ± 0.05	0.42 ± 0.04	0.67 ± 0.01	0.74 ± 0.01	0.59 ± 0.01	0.66 ± 0.01	0.69 ± 0.10	NS
Lungs	0.66 ± 0.05	0.63 ± 0.02	0.65 ± 0.04	0.76 ± 0.01	0.84 ± 0.01	0.61 ± 0.01	0.53 ± 0.01	0.52 ± 0.01	NS
Crop	0.77 ± 0.02	0.68 ± 0.02	0.75 ± 0.04	0.63 ± 0.01	0.81 ± 0.01	0.55 ± 0.01	0.58 ± 0.01	0.52 ± 0.01	NS
GIT (intestine)	3.32* ± 0.02	2.40* ± 0.02	3.35* ± 0.00	6.28 ± 0.04	6.20 ± 0.01	6.14 ± 0.03	6.17 ± 0.02	6.42 ± 0.02	*
Total	**89.92**	**92.17***	**93.25***	**89.31**	**91.10**	**88.87**	**88.88**	**88.12**	*****
Other parts	10.08	7.83	6.75	10.69	8.90	11.13	11.12	11.88	

Values represent mean ± standard deviation (SD) of duplicate results; asterisk (*) = indicate significant difference at 5% level ($P<0.05$); NS = not significant; LOS = level of significance; Group T1 = represent broiler chickens administered with *Moringa* seeds extract, T2 = Gum arabic, T3 = wild *Ganoderma*, T4 = *Moringa* seeds + Gum arabic, T5 = *Moringa* seeds + wild *Ganoderma*, T6 = Gum arabic + wild *Ganoderma*, T7 = *Moringa* seeds + Gum arabic + wild *Ganoderma*, T8 = Antibiotic only.

the bitter and irritating taste of saponins (Cheeke, 1971; Oleszek et al., 1994). 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). Trypsin inhibitor inhibits trypsin and chymotrypsin, which play a role in digestion of protein. High dietary tannins were reported to depress the digestibility of feed by affecting (or suppressing) the activity of the enzymes involved in carbohydrate and protein breakdown (Nsahlai et al., 2011).

In this study, the levels of anti-nutrients (phytates, tannins and oxalates) and the phytochemicals (saponins) were higher in *Moringa*

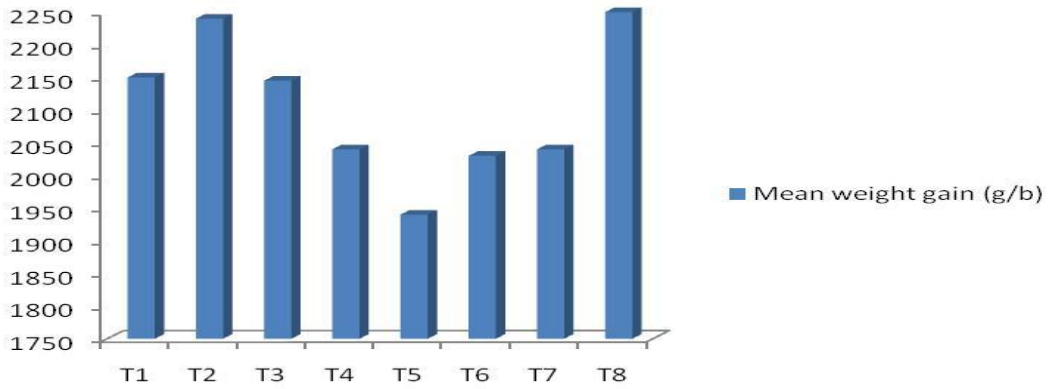

Figure 1. Mean weight gain (g/b) at the end of the experiment (56 days). Group T1 = *Moringa* seeds, T2 = Gum arabic, T3 = *Ganoderma*, T4 = *Moringa* seeds + Gum arabic, T5 = *Moringa* seeds + *Ganoderma*, T6 = Gum arabic + *Ganoderma*, T7 = *Moringa* seeds + Gum arabic + *Ganoderma*, T8 = Antibiotic only.

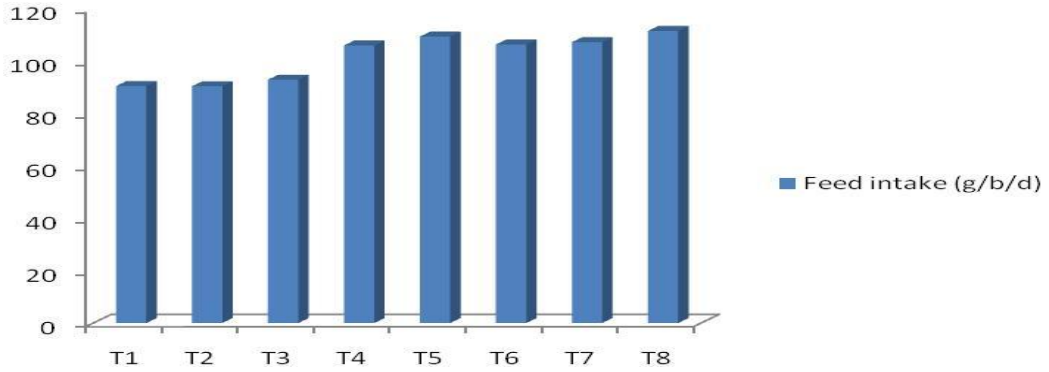

Figure 2. Feed intake (g/b/d) of broiler chickens. Group T1 = *Moringa* seeds, T2 = Gum arabic, T3 = *Ganoderma*, T4 = *Moringa* seeds + Gum arabic, T5 = *Moringa* seeds + *Ganoderma*, T6 = Gum arabic + *Ganoderma*, T7 = *Moringa* seeds + Gum arabic + *Ganoderma*, T8 = Antibiotic only.

seeds (Table 1). This may be responsible for the low weight gain of broilers that were administered aqueous extract from *Moringa* seeds either alone or in combination with gum arabic and wild *Ganoderma* (Figure 1). There is need to further adequately process *Moringa* seeds by heating or boiling in hot water to remove the anti-nutritional factors for proper utilization of this plant products in poultry.

Among the groups that were administered with the plant extracts alone (either *Moringa* seeds, or gum arabic) and wild *Ganoderma*, they did not significantly differ ($P>0.05$). However, group T2 recorded higher feed intake and weight gain. The weight gain of groups T1 and T3 did not differ significantly ($P>0.05$), due to the high content of anti-nutrients. Among the groups that were administered with combinations of the plant extract and wild mushroom (groups T4, T5, T6 and T7), they did not significantly differ in their feed intake ($P>0.05$), but the weight gain of broilers in T5 appeared the least (Figure 2). Possibly, the high anti-nutrients (tannins and phytates) in *Moringa* seeds made the nutrients in the feed of these broiler chicks to be unavailable for utilization or conversion into body tissues (growth).

The presence of high levels of these phyto-constituents or ant-nutrients may bind with protein and minerals to make them unavailable for utilization or conversion into body tissues development. Essential nutrients particularly proteins and minerals are required for normal growth, activities of muscles and skeletal development. Deficiency of these nutrients and minerals are known to affect the performance and health of poultry (Merck, 2005). The toxic effects of anti-nutrients could be reduced by proper food processing such as soaking or boiling of plant materials in water (Akinyeye et al., 2011; Enechi and Odunwodu, 2003). It also improves utilization in terms of feed intake and protein digestibility (Okai et al., 1995; Dei et al., 2007).

Conclusion

In conclusion, the plants products (*Moringa* seeds and gum arabic) and wild *Ganoderma* used in this study were

found to contain valuable amounts of essential nutrients (protein and minerals) and phytochemical compounds, which are nutritional requirements for broiler chickens. These plants products and the wild mushroom are potential sources of feed supplements or phyto-medicine to promote health and growth performance of broilers. Their benefits in broilers are compared favourably with the antibiotics used in this study. Anti-nutrients present in them could be reduced by adequate processing (during aqueous extraction).

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