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Proximate, Mineral and Anti-Nutrient Composition of Wild *Ganoderma lucidum*: Implication on Its Utilization in Poultry Production

Research Article

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ABSTRACT

Some wild *Ganoderma lucidum* were found growing on logs of dead wood and tree stumps at different location of the Nasarawa State College of Agriculture, Lafia and the Faculty of Agriculture, Lafia Campus, during the wet rainy season. The matured fruiting bodies seen as red open caps were removed for proximate, mineral and anti-nutrient evaluation. The result showed that the fruiting bodies contained appreciable amount of crude protein (16.79%±0.13), carbohydrate (63.27%±0.2) and crude fibre (7.77%±0.34). The crude fat (1.52%±0.09) and fatty acid (1.22%±0.07) were low, making it a valuable nutritional ingredient for utilization in poultry production. The ash content of the mushroom (8.42%±0.13) also showed it contained appreciable amount of nutritionally important minerals, Ca (1.99%±0.04), K (1.11%±0.04), Na (229.88±0.34), Fe (121.37±1.82), Mn (71.06±1.56), Zn (51.49±2.16) and P (30.17±1.29) parts per million (ppm). Magnesium (0.34%±0.01) and copper (7.43±0.13) were least. The anti-nutrients, tannins (18.27%±0.30), phytates (2.43%±0.09), trypsin inhibitors (2.39%±0.11), saponins (1.26%±0.06), oxalates (0.57%±0.06) and cyanide content (0.08%±0.01) were low. The presence of these essential nutrients, which are nutritional requirements of poultry, implies it could be utilised as a feed supplement to improve growth performance and health of poultry. It was therefore concluded that wild *Ganoderma lucidum* contained appreciable amount of nutrients and could be utilized to improve growth performance and health status of poultry.

KEY WORDS *Ganoderma lucidum*, minerals, nutrient values, poultry, wild mushroom.

INTRODUCTION

Mushrooms are plant-like microorganisms, which grows like plant but are without chlorophyll. They depend on other organisms or plants for their nutrition. Information available in literature showed that mushrooms were first known to early Greeks and Romans who divided them into edible, poisonous, and medicinal mushrooms (Louis and Krieger, 1967; Zakhary *et al.* 1983). There are also medicinal mushrooms such as *Ganoderma lucidum*, which grow on logs of wood and tree stumps. These mushrooms were considered as parasites of trees (Zakhary *et al.* 1983).

In China and Japan, *Ganoderma lucidum* are cultivated and utilised as useful source of feed supplement and as medicine for promoting health and immune functions in humans, and for prevention and treatment of certain diseases (Jong and Birminghan, 1992; Kupin, 1994; Oei, 2003; Wachtel-Galor *et al.* 2004). These mushrooms are utilised as dried whole, powder or capsules and as tablets for promoting health in humans (Oei, 2003).

In Africa, Tanzania was reported as one of the countries that is actively exploring *Ganoderma* species of mushroom, which are highly prized as supplementary dietary feed. In Nigeria, qualitative and quantitative analysis of wild *Ganoderma lucidum* harvested from Vom in Nigeria was carried out and reported earlier by Ogbe (2008). This wild *Ganoderma* specie was found to contain high amounts of crude fibre (34.7%), protein (13.3%), fat (2.6%) and some bioactive compounds like saponins and resins (Ogbe *et al.* 2009a).

These chemical compounds and nutrients play important roles in nutrition and in maintaining good health and physiological functions of the body. They promote growth performance and humoral immune response to vaccinations (Ogbe *et al.* 2008).

In other studies, *Ganoderma lucidum* supplementation was reported to decrease pain in cancer patients (Kupin, 1994). It also enhances natural killer (NK) cells and cytotoxic lymphocytes (CTL) activity when administered orally (Won *et al.* 1989). Oral and topical administration of *Ganoderma lucidum* also showed anti-inflammatory activity in mice (Stavinoha *et al.* 1991; Stavinoha *et al.* 1995).

Topical administration of the aqueous *Ganoderma* extract showed improvement of wound healing rate in animal patients (Ogbe *et al.* 2011). Other medicinal mushroom such as turkey tail mushroom (*Coriolus versicolor*) was reported by researchers in new Queensland University of Technology (QUT) to be 100% effective in suppressing prostate tumor development (anti-cancer stem cells) in mice. These medicinal mushrooms had been used in Asian for medicinal benefits.

With all these important attributes of this mushroom, there is need to explore it as alternative feed supplement (or additive) and its medicinal benefits to improve health and growth performance of poultry. The aim of this study therefore was to determine the chemical contents, nutrients and mineral composition of the wild *Ganoderma lucidum* from Lafia, Nasarawa State, Nigeria. The objective was to highlight the implication of utilizing the wild mushroom in poultry production.

MATERIALS AND METHODS

Collection and identification of wild *Ganoderma lucidum*

The wild *Ganoderma* species of mushrooms were collected at different location from dead logs of wood and tree stumps (cassia trees) during the rainy season (June-November) at College of Agriculture, Lafia and the Faculty of Agriculture (Lafia Campus), Nasarawa State University Keffi. Only matured fruiting bodies seen as red open caps were harvested. The wild *Ganoderma lucidum* was identified as described by Ogbe (2008).

Preparation of sample

The freshly harvested wild *Ganoderma lucidum* were washed with water from the borehole and sun-dried (at 35 ˚C) for 3-5 days. The mushrooms were grounded into powder using pestle and mortar, followed by further milling using a locally made miller machine.

Proximate analysis

The methods recommended by the Association of Official Analytical Chemists (AOAC, 1990) were used for determination of moisture, crude fibre, nitrogen and protein, fat and cyanide content of the mushroom. All determinations were done in duplicates. 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) and Akinyeye *et al.* (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). The crude fat was converted into fatty acid by multiplying with conversion factor of 0.8 as described by Akinyeye *et al.* (2010) and Akinyeye *et al.* (2011) and Greenfield and Southgate (2003). The proximate determinations were performed in duplicates. All the proximate values were reported in percentage.

Mineral analysis

The minerals (calcium, magnesium, potassium, sodium, iron, zinc, manganese and copper) were analysed using Atomic Absorption Spectrophotometer (AAS-Buck 205). Phosphorus was determined colorimetrically (AOAC, 1990). All determinations were performed 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 screening and anti-nutrients analysis of the wild mushroom samples were determined using the methods of Sofowora (1993). All determinations were done in duplicates.

Statistical analysis

All data generated were analyzed statistically as described by the method of Olawuyi (1996). Statistical values that were calculated include mean and standard deviation.

RESULTS AND DISCUSSION

Collection and identification of wild *Ganoderma lucidum*

The fruiting bodies of wild *Ganoderma lucidum*, which we-

re identified by their red open cap, were found growing on logs of wood and tree stumps particularly cassia trees on farmlands at different locations during rainy season (June–November) at the Nasarawa State College of Agriculture, Lafia, and the Faculty of Agriculture, Lafia. Only the matured fruiting bodies seen as red open caps were removed and utilized for this study.

Nutrient and mineral composition of wild *Ganoderma lucidum*

The proximate (nutrients) composition of the wild *Ganoderma lucidum* has shown in Table 1.

Table 1 Proximate composition of wild *Ganoderma lucidum* from Lafia, Nasarawa State, Nigeria

Nutrients analyzed (% DW)	Mean composition (%±SD)
Crude protein (CP)	16.79±0.13
Crude fibre (CF)	7.77±0.34
Crude fat (lipid)	1.52±0.09
Ash content	8.42±0.13
Moisture	2.78±0.05
Nitrogen (N)	2.83±0.22
Carbohydrate (CHO)	63.27±0.20
Fatty acid	1.22±0.07
Dry matter (DM)	97.23±0.05
Energy value (kcal/100kg)	1417.26±0.42

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

Table 2 Mineral composition of wild *Ganoderma lucidum* from Lafia, Nasarawa State, Nigeria

Elements	Mean composition (%±SD)
Calcium (%)	1.99±0.04
Magnesium (%)	0.34±0.01
Potassium (%)	1.11±0.04
Sodium (ppm)	229.88±0.34
Iron (ppm)	121.37±1.82
Zinc (ppm)	51.49±2.16
Phosphorus (ppm)	30.17±1.29
Manganese (ppm)	71.06±1.56
Copper (ppm)	7.43±0.13

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

Table 3 Phytochemical/anti-nutrients of wild *Ganoderma lucidum* from Lafia, Nasarawa State, Nigeria

Phytochemical / anti-nutrients	Mean values (%±SD)
Phytates	2.43±0.09
Oxalates	0.57±0.06
Saponins	1.26±0.06
Tannins	18.27±0.27
Trypsin inhibitors	2.39±0.11
Hydrogen cyanide (HCN)	0.08±0.01

* Data are mean values ± standard deviation (SD) of duplicate results.

The results showed that the fruiting bodies are a good source of crude protein (16.79%±0.13) and carbohydrates (63.27%±0.2). The carbohydrate content of the mushroom appeared similar to that reported by Ogbe *et al.* (2009a). However, the crude fibre (7.77%±0.34) was lower than that reported by Ogbe *et al.* (2009a). The moisture content of the mushroom was also lower than that of some edible mushrooms reported by other authors (Ogbe *et al.* 2005; Ketiku and Ola, 1999; Zakhary *et al.* 1983). The crude fat (1.52%±0.09) and fatty acid (1.22%±0.07) were low, making it a valuable nutritionally healthy ingredient for poultry. Low fat food reduces cholesterol level (Gordon and Kessel, 2002). The ash content (8.42%±0.13) showed that the wild mushroom contained some nutritionally important minerals.

The wild mushroom (*Ganoderma lucidum*) contained appreciable amount of minerals, Ca (1.99%±0.04), K (1.11%±0.04), Na (229.88±0.34), Fe (121.37±1.82), Mn (71.06±1.56), Zn (51.49±2.16) and P (30.17±1.29) parts per million (ppm). Magnesium (0.34%±0.01) and copper (7.43±0.13 ppm) were least. The values obtained in this study compared favourably with those reported in some edible mushroom by other authors Zakhary *et al.* (1983). The calcium content of the mushroom was higher than that reported for some edible mushrooms by Zakhary *et al.* (1983). However, the potassium level was lower (1.11%) than that reported for *Agaricus sp*. (4.6%). The difference in the composition may be due to the differences in the locality of its growth and the stage at maturity prior to harvesting. With the presence of these valuable nutrients, this wild mushroom will serve as a valuable alternative or complement for promotion of growth performance and health of animals and poultry. The presence of crude fibre fractions of carbohydrate and low fat are important components in diet for promotion of health (Sundu *et al.* 2006).

Minerals are required for good body muscles activity and skeletal development (calcium and phosphorus), 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), and regulation of acid-base balance (phosphorus).

High amount of potassium in the body increases the utilization of iron (Adeyeye, 2002). This is useful in the prevention of anaemia 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 a trace element that is useful for protein synthesis, normal body development and recovery from illness (Muhammad *et al.* 2011).

Phytochemical composition and anti-nutrients of wild *Ganoderma lucidum*

The phytochemical screening revealed the presence of biologically active compounds or substances and anti-nutrients, tannins (18.27%±0.30), phytates (2.43%±0.09), trypsin inhibitors (2.39%±0.11), saponins (1.26%±0.06)

and oxalates (0.57%±0.06). The cyanide content (HCN) of the mushroom was very low (0.08%±0.01). Phytate is an organically bound form of phosphorus in plants. Trypsin inhibitor inhibits the enzymes, trypsin and chymotrypsin, which play a role in digestion of protein in animals. This inhibitor can be controlled by application of heat during processing of plant ingredients. Hydrogen cyanide is toxic when ingested by monogastric animals in large quantity. It is safer if feeds (ingredients) are sun-dried for some days prior to usage as this reduces the cyanide content of the final product. Trypsin inhibitors and cyanide content of the wild *Ganoderma lucidum* is very low; possibly heat application by sun drying had controlled the presence of the anti-nutrients during processing of the mushroom.

Bioactive compounds found in mushroom are known to play a vital role in promoting health. The anti-nutrient (phytate) to nutrient (calcium) molar ratio of wild *Ganoderma* showed a mean value of 1.2. This mean value is higher than the critical level (0.2) reported by Hassan *et al.* (2011) and also Muhammad *et al*. (2011). The oxalate to calcium ratio was 0.3, which is lower than the critical value (2.5). Phytate and oxalate can interfere with mineral absorption particularly calcium. They form insoluble salts with the (calcium) minerals (Guil and Isasa, 1997; Muhammad *et al.* 2011).

Dietary ingredients that are high in phytate and oxalate may be a health problem if not properly processed prior to utilization. The level of oxalate in this wild mushroom is low. Some bioactive chemical compounds (such as saponins and tannins) are known to have therapeutic effects against microbes and parasites (Dei *et al.* 2007).

Phytate in food binds essential minerals in the digestive tract, resulting in mineral deficiencies (Bello *et al.* 2008). Phytate has been reported to decrease bioavailability of minerals in monogastric animals (Thompson, 1993). Some of these anti-nutrients (phytate, oxalate and tannins) can be reduced by proper processing of food (Akinyeye *et al.* 2011). Utilization of wild *Ganoderma lucidum* may not lead to health problems in monogastric animals and poultry. Soaking the mushroom in boiled hot water during aqueous extraction would reduce anti-nutritive factors.

In earlier studies, Ogbe *et al.* (2008) reported the beneficial effects of the wild mushroom (*Ganoderma lucidum*) supplementation of feed on the immune response of pullet chickens. Pullet chickens fed with the wild mushroom supplemented diets showed improvement in humoral immune response to infectious bursal disease vaccinations than those not supplemented with the mushroom (Ogbe *et al.* 2008; Ogbe *et al.* 2009a). There were no adverse effects in the physiology or behaviour of the chickens fed the wild *Ganoderma* supplemented diet (Ogbe *et al.* 2008; Ogbe *et al.* 2009a). Specific polysaccharides (such as saponins or in form of beta-glucans bound to amino acids) are known to play a role in modulating immune response (Guo *et al.* 2003; Sundu *et al.* 2006). The wild *Ganoderma lucidum* was reported to contain bioactive chemical compounds like saponins, resins, steroid and amino acids (Ogbe *et al.* 2009a). These compounds are known to play a vital role in the well-being of animals, including poultry (Ogbe *et al.* 2009a).

The presence of essential nutrients and minerals in the wild mushroom imply they could be utilised to improve poultry production and health. Deficiency of these nutrients and minerals are known to affect the performance and health of birds. Deficiency of either calcium or phosphorus results in abnormal bone development and reduced eggs quality. A deficiency of manganese can lead to perosis (enlarged tibia joints) and thin-shelled eggs. Magnesium deficiency can cause slow growth rate, reduced egg production, convulsion and death of birds. Zinc deficiency results into weak chicks and a deficiency of iron and copper can lead to anaemia with a reduction in pack cell volume (PCV). Copper deficient diet can lead to lameness (ataxia and spastic paralysis) in young chickens (Merck, 2005). The presence of appreciable amounts of essential nutrients and minerals in wild *Ganoderma lucidum* imply its use as feed supplement and medicine in poultry production would offer some health benefits. The medicinal benefits of wild *Ganoderma lucidum* harvested from Vom in Plateau State, Nigeria was reported earlier (Ogbe, 2008; Ogbe *et al.* 2008; Ogbe *et al.* 2009b; Ogbe *et al.* 2010; Ogbe *et al.* 2011).

CONCLUSION

In conclusion, the result of this study showed that the wild *Ganoderma lucidum* harvested from Lafia in Nasarawa State, Nigeria contained appreciable amounts of carbohydrate, protein and minerals, which are nutritional requirements of poultry to improve health and growth performance. The anti-nutrients present in the wild *Ganoderma lucidum* were low.

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