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Potential of a Wild Medicinal Mushroom, *Ganoderma* Sp., as Feed Supplement in Chicken Diet: Effect on Performance and Health of Pullets

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Abstract: Proximate and chemical composition of a wild mushroom, *Ganoderma* sp was evaluated. The phytochemical analysis showed it contained carbohydrates and reducing sugars, steroids, cardiac glycosides, saponins and resins. Proximate analysis revealed crude protein (13.3%±0.2), crude fibre (34.7%±6.4), fats (2.6%±0.3), calcium (0.4%±0.1) and phosphorus (0.3%±0.0). Acidic amino acids (glutamic and aspartic acid) (6.2 g%±1.4 and 5.6 g%± 0.1) and sulphur containing amino acids (cystine and methionine) (1.5 g%±1.3 and 0.7 g%±0.1) were also detected. Of all the essential amino acids detected in the mushroom, leucine was higher (5.3 g%±0.9), followed by phenylalanine (3.7 g%±0.5), alanine (3.3 g%±0.1), isoleucine (3.1g%±0.1), valine (3.0 g%±0.2), lysine (3.0 g%±0.6) and threonine (2.0 g%±0.1). Histidine (1.7 g%±0.3) and methionine (0.7 g%±0.1) were the least. Supplemented diets showed higher leucine content followed by phenylalanine, alanine, isoleucine, valine, lysine, threonine, histidine and methionine. Pullets fed these diets showed improved performance in weight gain and health. The physical qualities of eggs laid by the birds were not affected. Although, feed intake did not show significant difference in all the groups ($p>0.05$) but the feed to gain ratio was better in A (3.3) and B (3.4) than C (3.5) and D (3.6). This showed supplementation with the mushroom resulted in better feed efficiency and the effect is dose dependent. It was concluded that this mushroom can be a valuable source of feed supplement to improve performance and health.

Key words: Mushroom, chemical and nutritional constituents, feed supplement, chickens

INTRODUCTION

Mushroom is the fruiting body of a macro-fungus. It is the part seen growing above the soil or on decaying logs of wood and tree stumps. Information available showed that many mushroom (including *Ganoderma lucidum*) are useful feed supplements for promotion of health and immune functions and for prevention or treatment of certain diseases of the respiratory, circulatory and digestive system in humans (Adejumo and Awosanya, 2005; Anon, 2006; 2007). Zhang *et al.* (1998) reported that mushroom can be used to stimulate the growth of immune organs in Newcastle disease infected chickens. Mushroom was also reported to reduce severity of Marek's disease in chickens (Wei *et al.*, 1997). T-cell immune response characterized by secretion of interferon, cytokine stimulation and macrophage activity were enhanced by mushroom (Guo *et al.*, 2003).

Ganoderma lucidum is a mushroom well known in China, Japan and USA as a useful source of feed supplement and medicine to suppress the growth rate of tumors in patients (Borchers *et al.*, 2004; Chang and Buswell, 1996; Guo *et al.*, 2003; Hobbs, 1995; Jong and Birminghan, 1992; Monro, 2003; Oei, 2003; Wachtel-Galor *et al.*, 2004). Out of 2,327 useful species of mushrooms catalogued worldwide, barely a hundred can be cultivated and little research has been conducted in developing countries like Nigeria on strictly local species. Tanzania is reported as one of the countries in Africa that is actively exploring *Ganoderma* species of mushroom, which are highly prized as supplementary dietary feed (Anon, 2008).

Qualitative and quantitative analysis of these mushrooms showed they contained some biologically active compounds and nutrients such as sugars and amino acids (Hughes *et al.*, 1958; Kadiri, 1990; Ketiku and Ola, 1999; Ogbe, 2008; Ogundana and Fagade, 1981; Zakhary *et al.*, 1983). These bioactive compounds belong to the group of polysaccharides and antioxidants, which protect the body against free radicals that damage body cells to induce diseases and cancers (Monro, 2003; Oei, 2003). The presence of polysaccharides in mushrooms (which are polymers of sugar molecules) suggests they can be useful as natural health-promoters against parasites, bacteria and viruses (Oei, 2003). Treatment of *Eimeria tenella*-infected broilers with wild *Ganoderma* species resulted in amelioration of clinical signs of bloody diarrhea and reduction of faecal oocyst count (Ogbe, 2008; Ogbe *et al.*, 2009).

Aim and objective: Determine the nutrients and chemical compounds of wild *Ganoderma* mushroom as feed supplement in chicken diet.

MATERIALS AND METHODS

Phytochemical and nutritional analysis: Wild *Ganoderma* species were collected at different times of the day from dead wood logs and tree stumps in Vom, Plateau State, Nigeria. Only mature fruiting bodies seen as reddish-brown open caps were collected and washed, sun-dried and milled into powder using pestle and mortar. Proximate analysis was carried out to determine presence of valuable nutrients (AOAC, 1990). Phytochemical analysis was done to determine presence of chemical compounds (Sofowora, 1993). Amino acids assay was carried out according to the method of Spackman *et al.* (1958).

Feed supplementation for pullets: One thousand day old Lorman brown pullets were randomly allotted into different dietary treatments (A, B, C and D) and fed *ad libitum* for 7 days before and after vaccination against infectious bursal disease and later on weekly interval up to point of lay (20 weeks). Diets were supplemented with *Ganoderma* sp at the rate of 2.0 g/kg feed (group A), 1.0 g/kg (B) and 0.5 g/kg (C). Group D (control diet) was not supplemented with *Ganoderma* sp (Ogbe, 2008). Blood/serum from each group of pullets was collected via jugular venipuncture into bijou bottles containing Ethylene Diammine Tetra Acetic Acid (EDTA) using sterile syringes and needles for serological assay by Agar Gel Precipitation Test (AGPT) according to the methods described by Cullen and Wyeth (1975), Ogbe *et al.* (2003) and Ogbe *et al.* (2008).

Statistical analysis: Analysis of variance was used to evaluate nutrient contents expressed as g/100 g, feed intake, weight gain and humoral antibody response against infectious bursal disease vaccinations of pullets (Olawuyi, 1996).

RESULTS

Phytochemical analysis showed the *Gonoderma* sp contained carbohydrates, sugars, steroids, cardiac glycosides, saponins and resins. Proximate analysis showed the mushroom contained appreciable amount of crude protein (13.3% CP±0.2), crude fibre (34.7%±6.4), fat (2.6±0.3), calcium (0.4±0.1) and phosphorus (0.3±0.0) (Table 1). All the diets (A-D) contained about 20% Crude Protein (CP). Acidic amino acids, glutamic acid (6.2 g%±1.4) and aspartic acid (5.6 g%±0.1), as well as leucine (5.3 g%±0.9) and arginine (5.0 g%±0.7) and the sulphur amino acids, cystine (1.5 g%±1.3) and methionine (0.7 g%±0.1) were also detected in the mushroom (Fig. 1). All the essential amino acids were detected in the mushroom, except tryptophan. The following essential amino acids were also detected in all the supplemented diets; leucine (5.3 g%±0.9), phenylanine (3.7 g%±0.5), alanine (3.3 g%±0.1), isoleucine (3.1 g%±0.1), valine (3.0 g%±0.2), lysine (3.0 g%±0.6), threonine (2.0 g%±0.1), histidine (1.7 g%±0.3) and methionine (0.7 g%±0.1).

Pullets (group A and B) fed with the *Ganoderma* supplemented diets recorded an average live body weight of 1.3 kg (Fig. 2) and by 35 weeks of age their average weight was 1.7 kg/bird with a hen-day egg production of 73.8% (Table 2). Although, feed intake did not show significant difference in all the groups ($p>0.05$) but the feed to gain ratio was better in A (3.3) and B (3.4) than C (3.5) and D (3.6), which showed that supplementation with mushroom resulted in better feed efficiency in pullets and the effect is dose dependent. Hen-house egg production was 72.1% and hen-day per bird (eggs laid/bird) was 270. The physical qualities of eggs laid were large brown eggs, 7 cm long, 6 cm wide; the egg weight was 0.1 kg and Egg Shape Index (ESI) of 85.7% (Table 2). The level of humoral antibodies response was highest in group A, AGPT titre (3.4 log2), followed by B and C (3.0 log2) and least D, 2.1 log2 (Fig. 3).

DISCUSSION

This study revealed that wild *Ganoderma* sp contained some bioactive compounds or polysaccharides,

Table 1: Proximate composition of wild *Ganoderma* sp and supplemented chicken diets

Nutrient content of *Ganoderma* sp and supplemented chicken diets (g/100 g dry matter)					
	Feed				
Nutrients (g/100 g DM)	*Ganoderma*	A (2 g/kg)	B (1 g/kg)	C (0.5 g/kg)	D (0 g/kg)
Moisture	7.5±0.1	8.1±1.4	8.0±1.4	8.0±1.1	8.6±0.2
Crude protein	13.3±0.2*	19.7±0.4	20.9±0.8	19.9±0.8	19.9±0.2
Crude fibre	34.7±6.4*	11.1±2.3	13.2±3.2	10.4±0.1	9.9±1.4
Lipid (Fat)	2.6±0.3	6.6±0.6	6.6±0.7	6.9±0.9	7.8±1.0
Total ash	3.2±1.2	6.1±0.2	6.4±0.4	7.7±1.0	7.9±0.1
NFE (Ether)	46.1±5.2	56.5±1.8	52.8±3.5	55.1±2.7	54.5±2.8
Calcium (Ca)	0.4±0.1	1.6±0.1	1.4±0.3	1.2±0.2	1.3±0.3
Phosphorus (P)	0.3±0.0	0.9±0.3	0.8±0.4	0.8±0.1	0.7±0.6

Values are mean±SD of two analysis. *Asterik indicates mean values are significantly different ($p<0.05$) compared to the others along the same horizontal rows

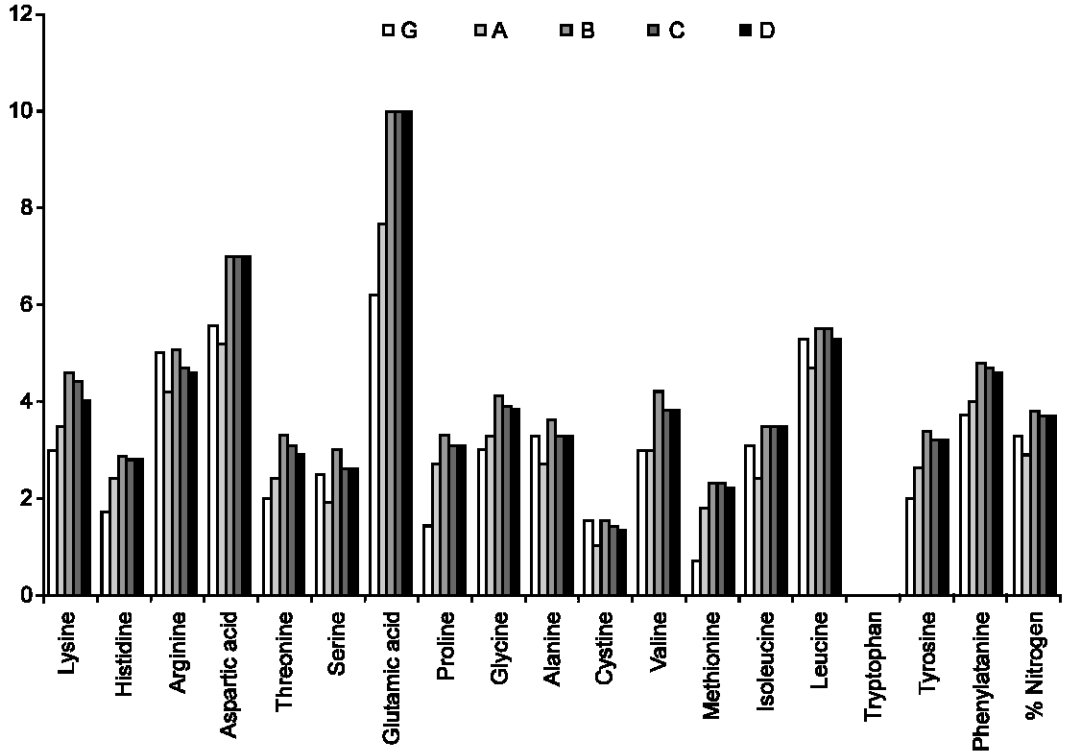

Fig. 1: Amino acid peaks of wild *Ganoderma* sp and supplemented chicken diets

Table 2: Performance and physical qualities of eggs of pullets fed *Ganoderma* supplemented diets

Laying performance and physical qualities of eggs	Observations
Average number of birds/month	830.0
Average number of eggs/bird/month	23.0
Average number of eggs in crates/month	621.0
Hen day per bird (eggs/bird)	269.5
Hen housed egg production (%)	72.1
Hen day egg production (%)	73.8
Age at onset of egg laying (week)	20.0
Age at peak egg production (week)	35.0
Total number of eggs laid in a year	223,665.0
Average final live body weight (kg/bird)	1.7
Egg weight (kg)	0.1
Egg length (cm)	7.0
Egg width (cm)	6.0
Egg Shape Index (ESI)	85.7
Egg shell weight (g)	10.0
Egg size	large

saponins, cardiac glycosides, steroids and resins. Among them, resins are hydrocarbons, composed of volatile fluid, terpenes and organic acids usually secreted by plants like corniferous trees. Resins may contain benzoic acid or cinnamic acids (balsam), which kill insects and fungi and aid in wound healing and elimination of excess metabolites (Anon, 2006). They may be mixed with gum or mucilaginous substances in their natural form (gum resins) of which some contain essential oils and are of therapeutic uses (Anon, 2006).

Steroids are organic compounds related to sterols found in animal tissues, eggs, yeasts and plants. They play a vital role in enhancing the well-being of animals and humans and act as sex hormones. Microbial or fungal biotransformation of steroids has been reported in submerged cultures in large fermenters (Dubey and Masheswari, 2003). Some fungi, *Penecillium* and *Streptomyces* species are known to yield good sources of antibiotics and amino acids (Dubey and Masheswari, 2003). Cardiac glycoside on the other hand is cardio-active and increases the function of myocardial circulation.

The presence of sugars and indigestible crude fibre fractions of carbohydrates or polysaccharides and low fat in *Ganoderma* makes it an important component of a healthy diet. These compounds play a beneficial role in the digestive tract of chickens, thereby increasing growth of non-pathogenic bacteria like *bifidiobacterium* sp (Sundu *et al*., 2006). They also have receptor sites for binding of pathogens, thereby enhancing their elimination along with digesta from the gastrointestinal tract of birds (Spring *et al*., 2000; Sundu *et al*., 2006). Mushroom protein-bound polysaccharide binds to host cell-receptors, thereby preventing colonization of pathogens in the host cells or intestine (Guo *et al*., 2003; Holliday, 2009). Specific polysaccharides (in form of beta-glucans bound to amino acids) were reported to have immune modulating property (Sundu *et al*., 2006).

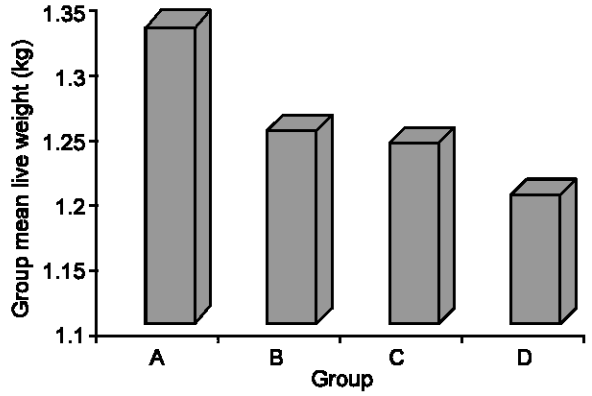

Fig. 2: Effect of feed supplementation with *Ganoderma* sp in improving weight of pullets; 1.2 kg (D) and 1.24 kg (C) = 40 g; 1.25 kg (B) and 1.2 kg (D) = 50 g; 1.33 kg (A) and 1.2 kg (D) = 130 g; 1.33 kg (A) and 1.25 kg (B) = 80 g weight gain

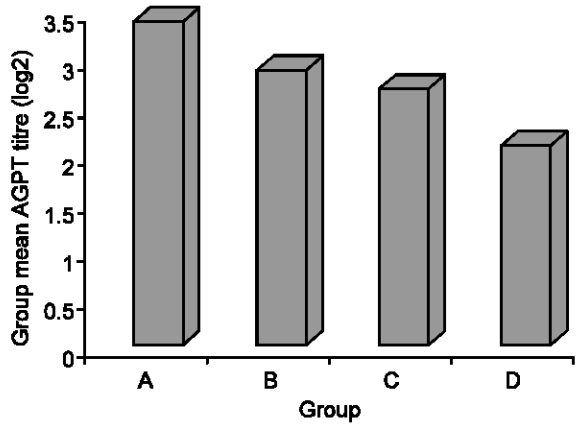

Fig. 3: Humoral immune response to infectious bursal disease vaccinations of pullets fed *Ganoderma* supplemented feeds. A, B and C = vaccinated and given supplemented feed at 2 g/kg, 1 g/kg and 0.5 g/kg feed respectively. D = vaccinated but not given supplemented feed (control)

Although, tryptophan was not detected in the mushroom and supplemented diets but the presence of appreciable amount of amino acids and bioactive compounds in this mushroom makes it a potential valuable product for future research in the food industry and medical drugs development. Tryptophan is usually lost during acid hydrolysis (Spackman *et al*., 1958).

All the groups of pullets that were fed with the mushroom supplemented feeds (A, B and C) and those not fed with the mushroom supplemented feed, D (control) showed humoral immune response at 6 and 8 weeks of age. The highest AGPT titre was recorded in group A (3.4 log2), followed by B and C (3.0 log2) and least D (2.1 log2). Some workers attested that birds vaccinated against IBD sero-convert at 1-3 weeks post-vaccination (Abdu *et al*., 1988; Aba-Adulugba *et al*., 1992). In this present study, sero-conversion was observed 4 weeks after the first vaccination and one week after booster (i.e second vaccination). Other workers reported that almost all the chicks (75-100%) may remain sero-negative despite vaccination but by the 5th week of age 53-100% had ser-converted (Abdu *et al*., 2001). The level of vaccinal antibodies produced are said to be depended on the type of IBD vaccines and the average antibody titre may range between 5 and 6 log2 (Aba-Adulugba *et al*., 1992). The performance and physical qualities of eggs of the pullets fed with mushroom supplemented diets were not affected. However, further studies may be required to assess its effect on interior quality of eggs and embryos, fertility and hatchability in breeders. *Eimeria tenella*-infected broilers treated with aqueous extract of the mushroom were cleared of intestinal parasites (Ogbe *et al*., 2009).

Conclusion: It was concluded that the wild mushroom (*Ganoderma* sp) contained appreciable amount of nutrients and bioactive substances. Pullets fed with the mushroom showed improvement in humoral immune response and it did not affect their production performance and health status. The physical qualities of eggs laid by the birds were also not affected. It appears this wild mushroom can be used as a valuable source of feed supplement to improve poultry health and production. Further research in this area particularly in breeder flocks is therefore recommended.

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