# PROXIMATE ANALYSIS AND CHEMICAL COMPOSITION OF *CORTINARIUS* SPECIES

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## ABSTRACT

Proximate study was conducted on a *Cortinarius* sp found on farmlands in Akinyele Local Government Area of Oyo state of Nigeria to ascertain its nutritional composition. The overall nutritional potential of the *Cortinarius* species was quite good and it shows that the species of mushroom is highly nutritive with crude protein 19.47%, carbohydrates, 48.60% and crude fibre 6.80%. It was however, observed the contents of the following were relatively low; zinc was 0.08mg/100g, riboflavin 0.08mg/100g and thiamine 0.07mg/100g. Potassium was highest and was 221.67mg/100g followed by calcium 183.33mg/100g. Phytochemical screening revealed the presence of varying quantities of alkaloids, saponins, tannins, oxalates, cyanogenic glycosides and phytates. These bioactive compounds may make it useful for therapeutic uses. This study shows that this mushroom has a great potential in complementing protein and minerals deficiencies prevalent in the developing countries.

**Keywords**: *Cortinarius* species, proximate analysis, therapeutic potential, bioactive, phytochemicals.

## INTRODUCTION

Mushrooms are the fruit bodies of macroscopic, filamentous and epigeal fungi made up of hyphae which form interwoven web of tissue known as mycelium in the substrate upon which the fungus feeds; most often their mycelia are buried in the soil around the root of trees, beneath leaf litters, in the tissue of a tree trunk or in other nourishing substrate (Ramsbottom, 1989; Wilkinson and Buezaeki, 1982). They represent only a short reproductive stage in their life cycle (Das, 2010). Mushrooms, though classified as vegetables in the food world, are not technically plants. They belong to the fungi kingdom and provide several important nutrients. They can be epigeous or hypogeous, large enough to be seen with the naked eyes and can be picked by hand (Chang and Miles, 1992). They are saprophytes and consist of two main parts, the mycelium and the fruity body (sporocarp). The mycelium consists of a treelike structure called hyphae. The ability of mushroom species to bio-accumulate minerals from the growth medium into the fruiting body is well documented (Kalac, 2010). Mushrooms generally are classified into four namely, edible, medicinal , poisonous and magic or hallucinogenic mushrooms (Zahid *et al*., 2010). Edible mushrooms are ideal healthy foods and may contribute enormously to the supply of both macro and micro nutrients in our diet. From the time immemorial, mushrooms are appreciated not only for texture and flavor but also for their chemical and nutritional properties (Manzi *et al*., 1999). Many health promoting substances e.g. antimicrobial, anticancer, antioxidant, cholesterol lowering property, immunostimulatory, antiviral, antiparasitic, antiinflammatory, antiproli-ferative, anti malarial, anti Alzheimer, antitumour, cytotoxic, antidiabetic, anticoagulant, hepato-protective compounds, among other effects have been documented for some species (Barros *et al*., 2007; Akinyele *et al*., 2011; Wasser and Weis, 1999; Smith & Sullivan 2004, Lindequist et al., 2005; Ajith and Janardhanan, 2007; De Silva et al. 2012a, De Silva et al. 2012b, De Silva et al. 2013).

Mushrooms represent one of the world's greatest untapped resources of nutritious food with the cultivation of saprophytic edible ones being probably the only currently economical biotechnology for lignocellulose organic waste recycling that combines the production of protein rich food with the reduction of environmental pollution (Obodai et al., 2003). In Nigeria edible mushrooms are highly priced, both as food and in traditional medicine (Oso, 1977a) assuming greater importance in the diets of both rural and urban dwellers, unlike previously when consumption was confined to rural dwellers. The protein content of mushrooms has been reported to be twice that of vegetables and four times that of oranges and significantly higher than that of wheat (Fasidi, 1996; Okwulehie and Odunze, 2004). They fall between the best vegetables and animal protein source and are considered as source of proteins, fats, carbohydrates, amino acids and vitamins (Chang and Buswell, 1996; Jiskani, 2001) such as vitamins B, C and D and mineral elements (Fasidi and Kadiri, 1990; Sivrikaya *et al*., 2002). Some investigations have even contended that the amino acid compositions of mushrooms are comparable to animal proteins (Fink and Hoppenhaus, 1958; Gruen and Wong, 1982), which is particularly important considering the cost of those proteins and the outbreak of diseases connected with animal meat. The nutritional potential and implications of this gradual replacement of meat with mushroom require careful examination involving detailed chemical and biological studies (Alector, 1995).

*Cortinarius* is the largest genus of mushrooms in the world, containing over 2000 different species and found worldwide (Kirk *et al*., 2008). They have cortinas covering their gills when young (hence the name of the genus); sometimes the tiny fibers of the cortina are ephemeral and disappear, but they frequently collapse against the stem to create a ring zone. The spore print is rusty brown and, as a result of the rusty brown spores, the mature gills of *Cortinarius* mushrooms are usually also rusty brown. Also, they are terrestrial and mycorrhizal. It is usually possible to identify a mushroom as being a member of this genus, but extremely difficult to positively identify the species as many of the species are nearly identical (Singer, 1986).
Despite the medicinal, nutritional and economic importance of mushrooms as indicated by various authors and researchers, the nutritional values of some tropical edible mushrooms that are indigenous to South Western Nigeria have not been determined. The objective of this study was to determine the relative nutritive qualities of *Cortinarius* species found in Ibadan, South West, Nigeria in order to encourage people to embark on its husbandry.

## MATERIALS AND METHODS

***Collection of Samples****:* The mushrooms used for this study were collected from a farmland in Moniya, Akinyele Local Government Area, Ibadan, Oyo State. The samples were carefully uprooted by lifting them up holding the stipe gently but firmly very close to the rhizomorph thus carrying some soil along with it .This is to avoid damaging the tissues of the mushrooms.

***Preservation of Samples:*** The samples were air dried for some days and stored in transparent polythene bags that are loosely tightened to allow for proper aeration.

***Identification of Samples:*** The samples were identified by Prof. S. G. Jonathan of Department of Botany, Faculty of Science, University of Ibadan, Ibadan, Nigeria.

**Figure 1: Cortinarius species**

***Nutritional Analysis:*** The mushrooms were harvested fresh, air dried, pulverized and analyzed according to standard procedures.

The proximate analysis of the samples for moisture, ash and carbohydrate contents were determined as described by AOAC (2005). Crude protein, fibre and fat contents were determined by the methods of Pearson (1976) while mineral contents were determined by atomic absorption spectrometry, flame photometry and spectrophotometry according to the methods of AOAC (2003). The phytochemical analysis for the presence of saponins, tannins, alkaloids, and cyanogenic glycosides were carried out according to the methods described by Harborne (1973) and Trease and Evans (1983). The vitamins in the samples were determined by the methods described by AOAC (1990). Each analysis was carried out in triplicate.

## Statistical Analysis

Mean, standard error of mean (SEM) were determined for all nutrients and statistical analysis was done by using Statistical Package for Social Sciences (SPSS/PC; Version12.0; SPSS Inc., Chicago).

## RESULTS

Proximate analyses of the mushrooms are shown in Table 1. It contains 14.23% moisture, 5.23% total ash, 19.47% crude protein, 7.63% crude fat, 6.80% crude fiber and 48.6% carbohydrates.

**Table 1. Proximate Analysis of *Cortinarius* species**

| Parameters | Moisture content (%) | Protein (%) | Ether extract (fat) % | Ash (%) | Crude fibre (%) | Carbohydrate (by difference) % |
|---|---|---|---|---|---|---|
| Values | 14.23±0.15 | 19.47±0.11 | 7.63±0.11 | 5.23±0.11 | 6.8±0.07 | 48.6±2.76 |

Values are means ±SEM (Standard error of means) of triplicate samples.

Phytochemical screening (Table 2) indicates the presence of saponins, tannins, phytates, oxalates, cyanogenic glycosides and alkaloids with cyanogenic glycosides in small quantity. Phytates had the highest values of 63.33mg/100g while the least value was recorded for cyanogenic glycosides of 0.23mg/100g.

**Table 2. Phytochemical composition of *Cortinarius* species**

| Parameters | Alkaloids (mg/100g) | Cyanogenic Glycosides (mg/100g) | Phytates (mg/100g) | Tannins (mg/100g) | Saponins (mg/100g) | Oxalates (mg/100) |
|---|---|---|---|---|---|---|
| Values | 11.67±2.04 | 0.23±0.04 | 63.33±0.04 | 33.33±2.04 | 21.67±2.04 | 16.67±2.04 |

Values are means ±SEM of triplicate samples

Table 3 showed values of the mineral compositions with varying amounts of minerals such as potassium, iron, zinc, magnesium, phosphorus, calcium and phosphorus. The highest mineral was potassium with 221.67mg/100g followed by calcium 183.33mg/100g. The least value was recorded for zinc with 0.57mg/100g.

**Table 3. Mineral composition of *Cortinarius* species**

| Parameters | $F^{++}$ (mg/100g) | $Zn^{++}$ (mg/100g) | $Mg^{++}$ (mg/100g) | $Ca^{++}$ (mg/100g) | $K^{+}$ (mg/100g) | $PO_4^{---}$ (mg/100) |
|---|---|---|---|---|---|---|
| Values | 9.1±0.07 | 0.57±0.11 | 35.00±3.53 | 183.33±5.4 | 42.33±1.78 | 221.67±5.43 |

Values are means ±SEM of triplicate samples.

Table 4 showed the result of vitamin compositions of the mushroom species. It shows the presence of vitamin C and vitamin B.

**Table 4. Vitamin composition of *Cortinarius* species**

| Parameters | Ascorbic (mg/100g) | Thiamine (mg/100g) | Niacin (mg/100g) | Riboflavin (mg/100g) |
|---|---|---|---|---|
| Values | 2.23±0.18 | 0.07±0.00 | 0.17±0.02 | 0.08±0.00 |

Values are means ±SEM of triplicate samples.

## DISCUSSION

The results of the proximate analysis show that the mushroom is enriched with protein, fibre, ash, moisture, fat and carbohydrate. This is in support of the findings of Jiskani (2001); Sadler (2003); Moore and Chi (2005) that mushrooms have nutritional attributes and have potential applications in industries. Gruen and Wong (1982) indicated that mushrooms are highly nutritional and compared favourably with meat and milk; will be a good supplement to cereals or carbohydrate meals (Chang and Buswell, 1996) and a significant dietary component for vegetarians (Breene, 1990). The relatively high carbohydrate and protein contents in this mushroom is similar to the result obtained by Fasidi and Kadiri (1994) and is a proof that mushrooms are highly nutritious and good for human consumption. The carbohydrates of mushroom include polysaccharides (such as glucans, glycogen and chitin), monosaccharides (such as ribose, fucose, glucose and mannose), disaccharides (such as trehalose and sucrose), sugar alcohols (such as mannitol and inositol) and sugar acids (such as galacturonic and glucoronic acids) (Crisan and Sands, 1978; Kurztman, 1997; Beelman *et al*., 2003). The high moisture content accounts for its short shelf life as it deteriorates easily after harvest if preservative measures are not employed. This high water content promotes susceptibility to microbial growth and enzymes activities. However, moisture content of mushroom depends on their harvesting time, maturation period and environmental conditions such as humidity and temperature in growing period and storage conditions (Crisan and Sands, 1978).

The crude fibre content obtained from this study suggests that this mushroom is a potential source of dietary fibre (roughages). High level of fibre is known as anti-tumorigenic and hypocholestrolaemic agent (Okoro and Achuba, 2012). This implies that this mushroom may be recommended for people with cholesterol related problems (Kadiri and Fasidi, 1990;

Chihara, 1993). Low crude fat recorded from this study in comparison to protein suggests that this mushroom could be recommended as good source of food supplement for patient with cardiac problems or at risk with lipid induced disorders.

Phytochemical analysis revealed the presence of saponins, alkaloids, phytates, tannins, cyanogenic glycosides and oxalates. Schneider and Wolfling (2004) reported that saponins inhibit sodium ions efflux by blockage of the influx of concentration in the cells activating a sodium-calcium ions anti-porter in cardiac muscle and the increase in calcium ions influx through this anti-porter strengthens the contraction of heart muscles. Saponins can also inhibit the growth of cancer cells, boost immune system and energy, lower cholesterol, act as natural anti-inflammatory, antibiotic, and anti-oxidant, and can reduce the uptake of certain nutrients including glucose and cholesterol at the gut through intralumenal physicochemical interaction (Aberoumand 2012; Ray-Sahelian, 2012; De Silva et al. 2013) and have haemolytic activity (Khalil and Eladawy, 1994). Tannin concentration detected in mushrooms has been found to possess astringent properties, which hasten the healing of wounds and inflamed mucous membrane (Okwu, 2004).

Alkaloids have been reported to have stimulating effects and act as tropical anaesthetic in ophthalmology, powerful pain relievers, antipuretic action (Edeoga and Enata, 2001). The presence of alkaloids explains that the mushroom may have anti bacterial activity as explained by Idowu *et al*. (2003) that alkaloids have antibacterial activity. The cyanogenic glucoside levels observed in the present study was much lower than those considered safe by European Commission (EC) regulations. For human consumption, a safety limit of 10 mg HCN equivalent $k^{-1}$ flour has been fixed by FAO/WHO (1991).

The analysis of mineral elements of this mushroom revealed appreciable concentrations of calcium, magnesium, potassium and phosphorus while iron and zinc were in lower concentrations. This observation is similar to studies by Crisan and Sands (1978); Chang and Miles (2004) who reported that the most common minerals in mushrooms are potassium, phosphorous, sodium, calcium and magnesium. The trace metal content of mushrooms are related to species of mushroom, collecting site of the sample, age of fruiting bodies and mycelium, distance from sources of pollution (Kalac et al., 1991) and are mainly affected by acidic and organic matter content of the soil. The presence of these essential nutrients and minerals found in this *Cortinarius* species implies that it can be utilized for its medicinal values in healthcare delivery systems. Potassium and calcium are important in stimulating action potential across nerve endings, and also to enhance heart contractile rate (Jeremy *et al*., 2007). Iron is highly required physiologically for heme formation and to enhance oxygen carrying capacity of red blood cells. Zinc is an important requirement in protein synthesis, normal body development and recovery from illnesses. It is a co-factor in the function of the enzyme carbonic anhydrase required for carbon dioxide transport and as part of peptidases needed for protein digestion (Muhammad et al., 2011); it is also a necessary part of DNA for cell division and synthesis hence its importance in wound healing (innvista.com/health/elements.htm, 2012). Calcium is the major component of bone and assists teeth development [Brody, 1994]. Magnesium is an essential cofactor in many enzymatic reactions in intermediary metabolism (Akpanabiater *et al*., 1998). Calcium and phosphorus are directly involved in the development and maintenance of the skeletal system and participate in several physiological processes and plays an important role in muscle contraction, blood clot formation, and nerve impulse transmission, the maintenance of cell integrity and acid-base equilibrium, and activation of several important enzymes. Phosphorus

is an important constituent of nucleic acids and cell membranes, and is directly involved in all energy-producing cellular reactions (Knochel *et al*., 2006).

The presence of riboflavin and niacin in the vitamin compositions is in agreement with Adedayo (2011) who reported that mushrooms are good source of the B vitamin, riboflavin and niacin which help to break down proteins, fats and carbohydrates so that they can be used for energy. Thus, this *Cortinarius* species may be an important source of B-vitamin for people who do not eat meat (Duyff, 2006; USDA, 2006). The relatively low level of thiamine in this study may be due to antinutritive thiaminases in the mushroom degrading thiamine (Wittliff and Airth, 1970a, 1970b; Wakita, 1976).

## CONCLUSION

This study shows that *Cortinarius* species has a great potential in complementing protein and minerals deficiencies prevalent in the developing countries. It should be incorporated into our diets in order to improve its quality and thereby improve the overall health and general wellbeing of people. However, further studies would be carried out to classify it, determine its molecular and genetic constituents to ensure that it does not contain toxins that are injurious to human health and then its commercialization.

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