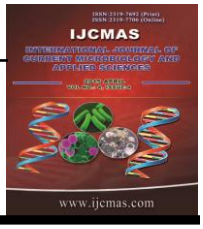
Int.J.Curr.Microbiol.App.Sci (2015) 4(4): 1011-1028

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 4 Number 4 (2015) pp. 1011-1028**
http://www.ijcmas.com



Original Research Article

Identification and Evaluation of Nutritional Status of some Edible and Medicinal Mushrooms in Akoko Area, Ondo State, Nigeria

T.O.Adejumo[1], M.E.Coker[2] and V.O.Akinmoladun[1]

[1]Department of Microbiology, Adekunle Ajasin University, P.M.B. 01, Akungba-Akoko, Ondo State
[2]Department of Pharmaceutical Microbiology, University of Ibadan, Ibadan
**Corresponding author*

Keywords

Edible, Medicinal and Poisonous mushrooms, Nutrients, Akoko people, Nigeria

A B S T R A C T

Nineteen edible, medicinal and poisonous mushrooms collected from different locations in Akoko Area of Ondo State, Nigeria were identified using the habitat, morphological and physical characteristics such as gills, presence of annulus, spore colour, cap type, cap colour, shape of cap, stem size and colour change with Potassium hydroxide. The edible ones include *Chanterelles spp, Flammulina velutipes, Termitomyces microcarpus, T. letestui, T. robusta, Pleurotus ostreatus, P. populinus, P. pulmonarius, Volvariella vovacea,, Lentinus squarrusulus, Psathyrella delineata* and *Russula vesca*, while the medicinal and poisonous ones are: *Ganoderma applanatum, G. lucidium, Absorporus biennis, Trametes versicolor, Trichaptum bioforme, Amanita caesarea* and *Amanita sp*. The results of edible mushrooms showed that the samples contained appreciable amount of essential nutrients, *V. volvacea* was the richest in protein content (42.63%) and highest moisture content (13.36%). *P. ostreatus* was rich in fat (15.38%), calcium (87.50mg/g), sodium (6.52mg/g) and magnesium (51.27mg/g), *T. microcapus* was the richest in ash content (8.16%), while *P. pulmonarius* was rich in crude fibre (8.16%), carbohydrate (37.64%), potassium (7.25mg/g), and vitamin C (14.10mg/g). *Ganoderma lucidium, G. applanatum* and *Amanita caesarea* were also found to contain high food content, they are mainly used for medicinal purposes. Production and consumption of mushrooms can fetch growers its attractive potential, economic benefit, as well as nutritional value if used as drugs and alternative food item.

Introduction

Mushrooms are fruit bodies of macroscopic, filamentous and epigeal fungi. They are made up of hypha 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 tissue of a tree trunk, on a fallen log of wood or in other nourishing substrates (Ingold, 1993). They are cosmopolitan, heterotrophic organisms that are specific in their nutritional and ecological requirements. Presently, mushrooms have continued to

generate a lot of interest, and this is mainly in the areas of their use as food (Chang, 1980), to cure of diseases (Rambelli and Menini, 1983; Oei, 1991; Buswell and Chang, 1993; Stamets, 1993), in bioremediation and as important item of commerce (Smith, 1972; Stamets, 1993). Out of the 14,000 species of mushrooms known, 2,000 are safe for human consumption, and about 650 of these possess medicinal values (Rai et al., 1988). According to Aletor (1995), Fasidi (1996) and Okwulehie and Odunze (2004), mushrooms are rich in protein, minerals and vitamins. The protein content of mushrooms has been reported to be twice that of vegetables and four times that of oranges (Bano, 1993), significantly higher than those of wheat (Aletor, 1990), and of high nutritional quality comparing favourably with meat, egg and milk (Thatoi and Singdevsachan, 2014). It is not surprising therefore that Okwulehie and Odunze (2004) reported that the increased demand for mushrooms could be contingent upon the phenomenal rise in the unit costs of the conventional sources of animal proteins. They have been found to be relatively much cheaper than beef, pork and chicken that contain similar nutrients (Adejumo and Awosanya, 2005). The crude fibre contents values reported by many authors, suggest that mushrooms are potential sources of dietary fibers (Crisan and Sands, 1978; Kurasawa et al., 1982). According to (Alofe et al., 1996), regular consumption of mushroom could increase protein intake. The authors also reported that mushrooms are better source of crude protein than some protein rich Nigerian foods such as shelled melon seeds and groundnuts.

In Nigeria many species of mushrooms are popular and acceptable to the people, which they collect from the wild, either from the forest floor on decayed wood and soil grassland in the rainy season (April to September), and marketed along major highways and urban centers. They are cooked and used for various soup preparations or are sun-dried or smoked for preservation. Mushroom hunting used to be a popular hobby among the village youths, who use it as a source of income. Many edible species have been described and identified in Nigeria (Oso, 1975, 1977, Zoberi, 1972, Alabi, 1991). Although, in some quarters in Nigeria and most African countries, mushrooms have been associated with negative event (allergy) (Yongabi et al., 2004).

The common mushrooms in Nigeria include *Termitomyces, Pleurotus, Lentinus, Lenzites, Trametes, Ganoderma, Pycnoporus, Coriolopsis* and others (Aletor, 1993., Alofe et al., 1996; Ola and Oboh, 2001). In most parts of Africa, consumption of mushrooms by many people is based on their organoleptic properties such as aroma, taste, flavour and texture and not on the nutritional and medicinal properties (Osemwegie et al., 2006). *Pleurotus* species are edible mushrooms commonly known as oyster mushrooms. *Pleurotus* species contain high amounts of Glyco-Amino Butyric Acid (GABA) and ornithine. GABA is a non-essential amino acid that functions as a neuro transmitter, whereas ornithine is a precursor in the synthesis of arginine (Manzi et al., 1999). They grow widely in the tropical and subtropical rainforests (Chirinang and Intarapichet, 2009). *Pleurotus* species can be used industrially for mycoremediation purposes; its cultivation can play an important role in managing organic wastes whose disposal has become a problem (Das and Mukherjee, 2007). *P. tuber-regium* is a common species in southern part of Nigeria and it is useful in some combinations to cure headache, stomach ailments, colds and fever (Oso,

1977) asthma, smallpox and high blood pressure (Fasidi and Olorunmaiye, 1994; Oso, 1977) and for bioremediation purposes (Adenipekun, 2008), while *Lentinus tuber-regium* and *L. tigrinus* are used for treating dysentery and blood cleansing respectively. *Auricularia* species have been traditionally used for treating hemorrhoids and various stomach ailments (Chang and Buswell, 1996). *Chanterelles*, *Boletus edulis* and *Lactarius* spp. are used for killing flies, while the puffballs (*Calvatia gigantea*) are used for healing wounds (Harkonen, 1998; Delena, 1999). They are also recommended to diabetic and anemic persons, owing to their low carbohydrate and high folic acid content. Some mushrooms are reputed to possess anti-allergic, anticholesterol, anti-tumor and anti-cancer (Jiskani, 2001).

Termitomyces species is a well-known edible mushroom in Nigeria. They are known to have high protein content (31.4-36.4%) (Ogundana and Fagade,1982). These mushrooms make their appearance after heavy rains and grow in contact with termite nests in forest soil. They usually appear between the months of April through October. In Nigeria, most information on *Termitomyces* species have been on the nutrient and antinutrient compositions (Aletor, 1993; Alofe et al., 1996; Ola and Oboh, 2000; 2001). It has also been found that *Termitomyces* species are important source of enzymes such as xylanase, amylase and cellulase (Khowala and Sengupta, 1992). The nutritional values of *T. clypetus* include carbohydrates (32%), proteins (31%), ascorbic acid (10-14%) and anti-oxidants (Ogundana and Fagade,1982), while the ability of water-soluble polysaccharide isolated from *T. striatus* to activate splenocytes at dose of 10 µg/ml had been demonstrated (Mondal et al., 2006). In essence, *Termitomyces* species has been found to be of great economic importance.

Mushrooms are rich in protein, very low in simple carbohydrates, rich in high molecular weight complex carbohydrates (polysaccharides), high in antioxidants. They lack cholesterol and they are a good source of some B vitamins-riboflavin (B2), niacin (B3), and pantothenic acid (B5) - as well as ergosterols (which upon exposure to ultraviolet light convert to vitamin (D2). They're high in dietary fiber, with edible varieties ranging from 20 percent fiber (by dry weight) for *Agaricus* species (such as button mushrooms) up to 50 percent for *Pleurotus* species (such as the phoenix oyster) (Ayodele and Okhuoya, 2007). They are good sources of essential minerals-especially selenium, copper, and potassium-elements important for immune function and for producing antioxidants to reduce free radicals. Mushrooms also contain numerous medicinal compounds such as triterpenoids, glycoprotein`s, natural antibiotics, enzyme inhibitors that fortify health (Okhuoya, 1995). They also appear to be a good source of vitamins, including thiamine, riboflavin, niacin, biotin and ascorbic acid, and of minerals. Although most fresh mushrooms are 90% water, they can vary in their individual moisture content, so it's best to look at them in terms of dry weight (Ayodele and Okhuoya, 2007). *Ganoderma* spp, *Lentinus edodes*, *Pleurotus* spp, *Coriolus* spp, and *Schizophyllum* spp are well known examples of medicinal mushrooms (Sanchita, 2008). A species of mushroom (*Inonotus obliges*) was used in folk medicine to treat cancers (Chung et al., 2010). A species of *Pleurotus* was confirmed to have chemopreventive effect on inflammation-associated colon carcinogenesis induced 2-amino-1-methyl-6-phenylimibazol, pyridine and promoted by dextran sodium sulfate (Jedinak et al., 2010). Novel Medicinal mushroom blend suppresses growth and invasiveness of human breast cancer cells. According to

Alofe et al. (1996), regular consumption of mushroom decrease the incidence of pyrogenic related disease called pimples, which is linked with cowpea consumption among the Nigerian adolescents.

Among the problems of mushroom resource exploration and exploitation in Africa is the lack of infrastructure and technical supports from national and international agencies, scarcity of mushroom scientists, poor political and legislative support, poor knowledge of mushroom biodiversity due to death of mushroom taxonomists and bad press reports (Labarère and Menini, 2000). African nations are seldom listed among the largest producers and exporters of edible mushrooms and mushroom products (Chang and Miles, 1991; Flegg, 1992). The aim of this study was to assess the potential of edible mushrooms in Akoko Community, as well as determining their nutritional status on the basis of their chemical composition.

Materials and Methods

Collection of edible Mushrooms

The fully matured mushroom species were collected from different parts of Akoko North-west (Arigidi and Ogbagi), Akoko South-west (Akungba-Akoko and Oka), Akoko North-east (Ikare and Ugbe), Akoko South-east (Isua and Epinmi). The photographs of the specimen were taken and the substratum of the mushroom was uprooted with the aid of a scalpel. The mushrooms were immediately transported to the Department of Microbiology`s laboratory, Adekunle Ajasin University Akungba–Akoko where it was preserved in formaldehyde (formalin), oven-dried at 60^0C and kept on the shelf for further analysis.

Identification of the samples

Identification of the samples was done macroscopically and microscopically. Macroscopic identification will be based on colour, odour, morphological characteristics and also the cap of the collected mushroom species where applicable was cut off and placed gill-side-down overnight, a powdery impression reflecting the shape of the gills (or pores, or spines, and others.) was formed (when the fruit body was sporulating) (Wasser, 2007). The colour of the powdery print (spore print) was used for identification.

Microscopic examinations (spore shape), Spores of collected mushroom species was collected from their spore print where applicable and mounted on a glass slide using lacto phenol in cotton blue. The prepared slide will be viewed progressively under the objective lens. The identification of the species will be done according to the above systematical criteria obtained from macroscopic and microscopic examination.

Proximate analysis of the samples

Fresh samples of the mushrooms were used to determine moisture content using the method of A.O.A.C., (1980). Ash content was done as described by AOAC (1990), while Crude fibre was determined using the method of Pearson, 1976. Crude protein was determined by modified Kjeldhal method (Bradstreet, 1965), while fat content and carbohydrate were determined using AOAC, 1995).

Results and Discussion

Table 1 shows identification of twelve edible mushrooms from Akoko Local Governments. They include *Chanterelles spp*, *Flammulina velutipes*, *Termitomyces robusta*, *Pleurotus pulmonarius*, *Volvariella volvacea*, *Lentinus squarrosulus*, *Termitomyces microcarpus*, *Psathyrella delineata*, *P. populinus*, *Russula vesca*, *Termitomyces letestui* and *P. ostreatus*. All

these mushrooms showed no colour change with KOH, confirming that they are edible ones which can be found on the soil or dead wood. Among these mushrooms, only *V. volvacea* had annulus. The stem and cap sizes ranged between 1 to 12 cm. The shape of the cap of *Chanterellus* spp, *F. velutipe*, *T. robusta*, *T. microcarpus*, *L. squarrosulus*, *Psathyrella delineata*, *R.* vesca, *T. letestui*, and *P. pulmonarius* were tapering, *P. pulmonarius* and *populinus* appeared short, while *V. volvacea* had club shape (Plate 1). The spore colour of *Chanterellus* spp, *T. robusta*, *Psathyrella delineata*, *P. ostreatus* were brown, those of *F. velutipes* and *R. vesca* were cream, and those of *P. pulmonarius*, *T. microcarpus*, *L. squarrosulus*, *P. populinus* and *P. ostreatus* were white. The spore colour of only *V. volvacea* appeared pinkish brown.

The stem colour of *Chanterellus* spp, and *V. volvacea* were brown, *T. letestui*, *F. velutipes*, *T. robusta* were cream, *P. populinus*, *P. pulmonarius*, *L. squarrosulus*, *Psathyrella delineata*, *R. vesca* and *P. ostreatus* were white. The shape of cap of *Chanterellus* spp, *T.* robusta, *P. pulmonarius*, *T. microcarpus* were flat, *F. velutipes*, *T. letestui* were convex, *L. squarrusulus* and *P. populinus* were kidney shaped, *V. volvacea* was conical, while *P. ostreatus* was offset. The variation in the spacing of gills was also observed. Gills of *Chanterellus* spp, *P. pulmonarius*, *T. microcarpus*, *R. vesca*, and *T. letestui*, were widely spread, *F. velutipes*, *V. volvacea*, *Psathyrella delineata* were closely spaced, *T. robusta*, *P. populinus*, *L. squarrosulus*, and *P. ostreatus* were crowded.

Table 2 shows identification of medicinal/poisonous mushrooms. Seven mushrooms were identified. They include G*anoderma applanatum*, *Ganoderma lucidium*, *Absorporus biennis*, *Trichaptum bioforme*, *Trametes versicolor*, *Amanita caesarea* and *Amanita spp.* (Plate 2). All the mushrooms changed colours ranging from black, yellowish and white in reaction to KOH confirming that they were non edible, but poisonous. The size of these mushrooms ranged between 5 and 15cm.

Table 3 shows proximate analysis of five edible mushrooms. *V. volvacea* had the highest in both the crude protein (42.63%) and moisture contents (12.36%). *P. pulmonarius* was also observed to have the highest carbohydrate content (37.64%) and highest crude fibre (8.16%). *T. microcarpus* had the highest ash content (24.19%), while the highest fat content (15.38%) was observed in *P. ostreatus*. However, the least crude protein of 23.63% was observed for *P. pulmonarius*, 7.12% moisture content for *P. ostreatus*, 8.27% carbohydrate content for *T. Microcarpus*, and 5.14% crude fibre content for *Volvariella volvacea*, 5.65% ash content for *P. ostreatus*, while *T. robusta* had the least fat content (9.07%).

Table 4 shows the minerals and vitamin C composition. *P. ostreatus* had the highest calcium content (87mg/100g), highest sodium content (6.25mg/100g), highest magnesium content (51.27mg/100g), *P. pulmonarius* had the highest potassium content (7.25mg/100g), highest vitamin C (14.10mg/100g). *V. volvacea* was observed to have the lowest contents in calcium (37.15mg/100g), sodium (1.58mg/100g), potassium (2.62mg/100g) and vitamin C (6.57mg/100g), while *P. pulmonarius* had the least magnesium content (20.75mg/100g).

Table 5 shows different chemical composition of the identified medicinal/poisonous mushrooms. Among these are the heavy metals including arsenic, lead, mercury, cadmium, organic acid (citric

acid, malic acid, succinic acid) and ergosterol in *Amanita caesaria* and *Amanita* spp. and polysaccharides in *Ganoderma applanatum, Ganoderma lucidium* and *Trametes versicolor.*

Mycophagy or acceptance and consumption of mushrooms vary from one state to another in Nigeria. The mushroom consumption patterns across the states appear to be directly related to availability of wild edible species, with high level of importance attached to its use as food or sold in local markets to augment family income (Osemwegie et al., 2010). The above statement is also true for Akoko land, and it is in agreement with other reports that mushrooms are used as foods and medicine (Odebode, 2005). In this study a total of twelve edible mushrooms were identified, these include *Chanterellus spp, Flammulina velutipes, Termitomyces robusta, Pleurotus pulmonarius, Volvariella volvacea, Lentinus squarrosulus, Termitomyces microcarpus, Psathyrella delineata, Pleurotus ostreatus, Pleurotus populinus, Russula vesca* and *Termitomyces letestui.*

The occurrence of some of these species has been reported by several workers, including *T. letestui* and *T. microcarpus* (Harkonen et al., 1995), *T. robusta* (Buyck, 1994), *V. volvacea (*Oei, 2003) and *Pleurotus* species (Elliott, 1991).

The relatively high carbohydrate contents recorded in *P. pulmonarius, P. ostreatus* and *T. robusta* (Table 3) was a proof of their being highly nutritious and good for human consumption. This is in line with the report obtained by Marlow Foods Ltd. (2001) on their study on mycoproteins, which shares much of its value with mushrooms, especially in their nutritional composition (Trinci, 1992). The high moisture content of some of the mushrooms obtained in this work (7.12 to 12.36%) is an indication that fresh mushrooms cannot be kept for a long time, as high water activity enhances microbial growth (Aletor, 1995). The fat contents obtained (9.07 to 15.38%), especially for *P. ostreatus* was higher than those reported by Crisan and Sands (1978), Kalac (2009) and Aletor (1995).

The protein contents of mushrooms have been reported to vary according to the genetic structure of species, the physical and chemical differences of the growing medium (Sanme et al., 2003). This result is in agreement with the report of Fasidi and Kadiri (1990) for *V. volvacea* and Ola and Oboh (2001) for *T. Robusta,* where higher protein contents were observed. The protein content of edible mushroom has been claimed to be twice that of onion (14%), cabbage (1.4%), potatoes (1.6%), and four to six times that of oranges (1.0%) and apple (0.3%). Therefore, in terms of the relative amount of crude protein, mushroom rank above the aforementioned vegetables and cereal foods (Crisan and Sands, 1978, Chang and Miles 1989). In this study, the high fiber content obtained for *V. volvacea* (5.14%) compared favourably with those earlier reported by Obodai, 1992.

The vitamin content is an important factor in the overall nutritional value of food, because of its antioxidant and therapeutic properties; therefore ascorbic acid (vitamin C) is a valuable food component (Bernas and Jawarska, 2006). The mushroom species in this present study contained a relatively high amount of vitamin C. Those obtained in *Pleurotus pulmonarius* is similar to the results reported for cultivated *Pleurotus spp* (Bernas and Jawarska, 2006), while those of *V. volvacea* obtained fell within the range of those reported in the previous studies on cultivated *Volvariella* spp (FAO, 1972).

Table.1 Identification of Edible Mushroom

Sample	Location	Habitat	Gills	Cap color	Shape of cap	Cap size	Stem color	Shape of stem	Stem size	Annulus	Spore print	Colour change with KOH
Chanterelles spp	AKNW Arigidi	Soil	widely spaced	Brown	Flat	5cm	Brown	tapering	12cm	Absent	Brown	None
Flammulina velutipes	AKSW Oka	dead wood	closely spaced	reddish to brownish	Convex	1.5-1cm	Cream	tapering	10cm	Absent	cream	None
Termitomyces robusta	AKNE Ikare	Soil	Crowded	brown	Flat	10cm	Cream	tapering	8cm	Absent	brown	None
Pleurotus pulmonarius	AKNE Ugbe	dead wood	widely spaced	White	Flat	2-2.5	White	short	1cm	Absent	white	None
Volvariella volvacea	AKSW Akungba	dead wood	closely spaced	grayish brown	Conical	3-6cm	whitish to brownish	club shape	2-5cm	Present	pinkish brown	None
Termitomyces microcarpus	AKSW Akungba	Soil	widely spaced	White	Flat	1cm	White	tapering	4cm	Absent	White	None
Lentinus squarrosulus	AKSW Akungba	dead wood	Crowded	White	kidney shape	5-7cm	White	tapering	5cm	Absent	White	None
Psathyrella delineata	AKSW Akungba	dead wood	closely spaced	reddish to brownish	Conical	1cm	White	tapering	4cm	Absent	Brown	None
Pleurotus populinus	AKNW Arigidi	dead wood	Crowded	White	flat or kidney shape	6.5-7cm	White	short	1-1.5cm	Absent	White	None
Russula vesca	AKSW Oka	dead wood	widely spaced	reddish blue	Flat	3-4cm	White	tapering	4cm	Absent	Cream	None
Termitomyces letestui	AKSW Oka	Soil	widely spaced	Brown	convex to flat	1.5-7cm	Creamy	tapering	6cm	Absent	Brown	None
Pleurotus ostreatus	AKSW Akungba	dead wood	Crowded	whitish grey	Offset	5cm	White	tapering	8cm	Absent	White	None

Table.2 Identification of Medicinal/Poisonous mushrooms

Sample	Location	Habitat	Stem colour	Shape of Cap	Cap Size	Spore Print	Color change with KOH
Ganoderma applanatum	Akoko NEast, Ugbe	Dead wood	White, dirty yellow	Rudimentary	5-25cm	Dingy brown	Flesh and tube black
Ganoderma lucidium	Akoko SW, Arigidi	Dead wood	Brown or yellow	Hemispherical	5-15cm	Yellow or brown	Black
Absorporus biennis	Akoko NW, Oke Agbe	Dead wood	White to cream	Lateral	5-20cm	White, cream or yellow	Black
Trichaptum bioforme	Akoko SE, Isua.	Hard wood	White and cream	Absent	Up to 6cm	White	Yellowish in flesh and cap with KOH
Trametes versicolor	Akoko SW, Oka	Hard wood	Whitish, grayish	Absent	5-15cm	Whitish, tough and leather	Yellowish
Amanita caesarea	Akoko SW, Akungba	Hard wood	Yellowish	Convex	5-15cm		Whitish on flesh
Amanita spp.	Akoko NW, Irun	Hard wood	Yellowish	Convex	5-15cm		Whitish on flesh

Table.3 Proximate composition of edible mushrooms

Sample	Moisture (%)	Ash (%)	Crude protein (%)	Crude fibre (%)	Fat (%)	Carbohydrate (%)
Pleurotus ostreatus	7.12	5.65	32.31	5.97	15.38	33.57
Termitomyces robusta	11.40	13.71	41.19	5.27	9.07	19.36
Volvariella volvacea	12.36	16.10	42.63	5.14	10.60	13.17
Termitomyces microcarpus	9.69	24.19	38.14	5.92	13.81	8.27
Pleurotus pulmonarius	10.99	7.95	23.63	8.16	11.63	37.64

Table.4 Minerals and Vitamin C composition of edible mushrooms

Sample	Calcium (mg/100g)	Sodium (mg/100g)	Potassium (mg/100g)	Magnesium (mg/100g)	Vitamin C
Pleurotus ostreatus	87.50	6.52	2.68	51.27	10.16
Termitomyces robusta	54.10	3.92	4.56	32.42	10.25
Volvariella volvacea	37.15	1.58	2.62	25.22	6.57
Termitomyces microcarpus	38.45	2.67	4.34	40.75	12.15
Pleurotus pulmonarius	40.25	3.59	7.25	20.75	14.10

Table.5 Chemical composition of medicinal/poisonous mushrooms

m Mushroom identified IDENTIFIED	Chemical composition	References
Abortiporus biennis	Thiols, oxalate, laccase	Jarosz-Wilkołazka et al., 1998
Amanita caesarea	Heavy metals (arsenic,lead,mercury,cadmium), Organic acid (citric acid, malic, succinic acid), Ergosterol	Valentao et al**.,** 2005
Ganoderma applanatum	Saponins, flavonoids, cardiac glycosides, phenols, glycopeptides, sterols	Manasseh et al., 2012 Wu and Wang, 2009 Mazzio and Soliman, 2010, Kim et al., 2008
Ganoderma lucidium	Polysacchrides, peptidoglycans, triterpenes, ganoderic acid, steroids, phenols, nucleotides, minerals	Kim et al., 2006, Zhang and Tang, 2008, Borchers et al., 1999. Sanodiya et al., 2009.
Trichaptum bioforme	Biformin	Zjawiony (2004)
Trametes versicolor	Polysaccharide Kureha (PSK)	Dong et al., 1997
Amanita spp	Heavy metals (arsenic, lead, mecury, cadmiun), organic acid (citric acid , malic acid, succinic acid), Ergosterol	Jarosz-Wilkołazka et al., 2008

Plate.1 Photograph of Edible Mushroom

(a) Termitomyces robusta

(b) *Termitomyces letestui*

(c) *Volvariella volvacea*

(d) *Lentinus squarrosulus*

(e) *Pleurotus populinus*

(f) *Pleurotus ostreatus*

(g) *Termitomyces microcarpus*

(h) *Cantherellus spp*

Plate.1 Photograph of Edible Mushrooms contd

(i) *Psathyrella delineata*

(j) *Flammulina velutipes*

(k) *Pleurotus pulmonarius*

(l) *Russula vesca*

Plate.2 Photograph of Medicinal/Poisonous Mushrooms

(a) *Ganoderma applanatum*

(b) *Ganoderma lucidium*

(c) *Trichaptum bioforme*

(d) *Amanita caesarea*

(e) *Trametes versicolor*

(f) *Amanita* spp

(g) *Absorporus bienni*

Mushrooms are known to contain calcium, potassium, magnesium, phosphorus and sodium and these elements are very important in human nutrition. They are required in repairing worn-out cells, strong bone and teeth, building blood cells and maintaining osmotic balance (WHO, 1996). The results on nutritionally valuable minerals show that the five mushrooms species were rich in calcium and magnesium. This is in agreement with the reports of analysis of cultivated mushrooms like *P. ostreatus* (Mattila et al., 2001). *V. volvacea* was observed to have low calcium, sodium, potassium and vitamin C. Minerals in the diet are required for metabolic reactions, transmission of nerve impulses, rigid bone formation and regulation of water and salt balance among others.

Some mushrooms like *Ganoderma lucidium and Ganoderma applanatum* are being used for their medicinal importance. These have been found to contain phytochemicals such as tannins and saponin. Edeoga and Eriata (2001) observed powerful effect of alkaloids in animal physiology and showed their considerable pharmacological activities. Alkaloids and their synthetic derivatives are used as basic medicinal agents for analgesic antispasmodic and bactericidal effect (Stary, 1998). Also, phenols are useful as they form the main constituents of most antiseptics and disinfectants. Thus the presence of phenolic compounds in the mushrooms species may be the reason for the antifungal, antiseptic and therapeutic properties (Gill, 1992).

The presence of flavonoids in the mushrooms indicates their medicinal value too. Flavonoids have antioxidants properties against free radical scavengers which prevent oxidative cell damage and have strong anticancer activity (Okwu, 2004). The high content of saponin in the mushroom is useful in medicinal and pharmaceutical industry due to its foaming ability that produces frothy effect in the food industry. Tannin concentration detected in the mushrooms have been found to possess' astringent properties, which hasten the healing of wounds and inflamed mucous membrane (Okwu, 2004). Mushrooms are great sources of medicines but they can also concentrate heavy metals, especially if their culture is proximate to an industrialized area (Wu et al., 1996). Pollutants from air and water can be taken up from soil and passed directly into the mycelial network (www.purejoyplanet.com), therefore they should be grown organically

Eating mushrooms gathered in the wild is risky. More generally, and particularly with gilled mushrooms, separating edible from poisonous species requires meticulous attention to details; there is no single trait by which all toxic mushrooms can be identified, nor one by which all edible mushrooms can be identified. Additionally, even edible mushrooms may produce allergic reactions in susceptible individuals, from a mild asthmatic response to severe anaphylactic shock.

The knowledge of mushroom identification through their morphological characteristics, spore sprint and other mushroom guides had provided a means differentiating poisonous from edible mushrooms. As the population of the world continue to increase, the amount of food and the level of medicinal care available to individual become limiting, especially those living in the less developed countries, edible mushrooms constitute a cost effective means of supplementing the nutrition of majority of humans. Mushrooms in Nigeria are underutilized; steps must be taken to bring about maximum and sustainable exploitation. The proximate analyses indicated the presence of proteins, fat and carbohydrate in all the samples.

Mushrooms are good sources of protein and carbohydrate which are of great demand in both man and animals. They serve as source of life and better energy source, they will therefore be suitable for diet formulation.

References

Adejumo, T.O. and Awosanya O.B. (2005). Proximate and Mineral Composition of four edible mushroom species in South Western Nigeria. African Journal of Biotechnology. 4 (10): 1084-1088.

Adenipekun, C.O. (2008). Bioremediation of engine-oil polluted soil by Pleurotus tuber-regium Singer, a Nigerian white-rot fungus. African Journal of Biotechnology 7(1): 055-058.

Alabi, R.O. (1991). Mycology and Nigerian culture: past, present and future. Proceedings of 1st Conference on African Mycology; Mauritius, June 10-15, 1990. pp. 43-52.

Aletor, V.A., (1990). Anti-nutritional factors in some Nigerian feedstuffs, herbage byproducts, crop residue and browse plants. A Monograph Prepared for the Presidential Task Force on Alternative Formulation of Livestock Feed Products Development, Quality, Evaluation and Health Implications. Cabinet Office, Lagos, Nigeria.

Aletor, V.A. (1993). Allelochemicals in plant foods and feedingstuffs: 1. Nutritional Biochemical and physiopathological aspects in animal production. Veterinary and human toxicology 35 (1) 57-67.

Aletor, V.A., (1995). Compositional studies on edible tropical specials of mushroom. Food Chem., 54: 256-268.

Alofe, F.V, Odeyemi, A.O, Oke, O.L (1996). Three wild mushrooms from Nigeria Journal of microbiology, vol. 44, No 1, p.29-34.

AOAC (1980). Official Methods of Analysis. 13th Edition. Association of Official Analytical Chemist. Washington D.C.

AOAC (1990). Official Methods of Analysis. 15th Edn., Association of Official Analytical Chemists, Washington, DC., USA., pp: 200-210.

AOAC (1995). Official Methods of Analysis. 16th Edn., Association of Official Analytical Chemists. Washington D.C.

Ayodele, S.M. and Okhuoya, J.A. (2007). Nutritional and phytochemical screening of Psathyrella atroumbonata Pegler, a Nigerian edible mushroom. South African Journal of Science, 105: 158-160.

Bano, Z., (1993). Food value of Mushrooms, Gram Prandyogiki, 3: 224-225.

Bernas, E. and Jawarska G.Z. (2006). Edible mushrooms a source of valuable nutritive constituent Acta Sci. Pol. Technology Aliment.; 5: 5-20.

Borchers A. T, Stern J. S, Hackman R. M, Keen C. L, Gershwin M. E.(1999) Minireview: Mushrooms, tumors and immunity. Proc Soc Exp Biol Med. 221:281–93.

Bradstreet R.B. (1965). The Kjeldahl Method for organic Nitrogen, Academic Press, New York.

Buyck B. (1994). Ubwoba: Les champignons comestibles de I'Ouest du Burundi. Administ. generale de la cooperation au develppement Rue du Trone, 4-1050 Bruxelles. Publication Agricole No 34.

Chang, S.T. (1980). Mushrooms as Human Food. Bioscience 30, 399-401.

Chang S.T, Buswell J.A. (1996). Mushroom Nutriceutical. World J. Microbial. Vol 12: 473-475 Rapid Science Publishers 1996.

Chang S.T. and Miles P.G. (1989). Edible mushrooms and their cultivation florida, CRS Press, Inc. 1989: 27-38.

Chang, S.T. and Miles, P.G. (1991). Recent trends in world production of cultivated edible mushrooms. The Mushroom Journal 503: 15- 18.

Chirinang P and Intarapichet K-O. (2009). Amino acids and antioxidant properties of theoyster mushrooms, Pleurotus ostreatus and Pleurotus sajor-caju. Science Asia 35: 326 - 331.

Chung M.T., Chung C.K., Jeong Y., and Ham S.S., (2010). Nutr Res Pract.; 4(3): 177-182.

Crisan, E.V. and Sands A. (1978). Nutritional Value of Edible Mushrooms. In: The Biology and Cultivation of Edible Mushrooms, Chang, S.T. and W.A. Hayes (Eds.). Academic press, New York, pp: 137-168.

Das S.T. and Mukherjee J.A. (2007). Mushroom Biology and Mushroom Products, The Chinese University Press, Hong Kong, 261 – 266.

Delena T. (1999). Edible and useful plants of Texas and South west –A practical guide University of Texas Press, pp. 542.

Dong Y, Yang M.M, Kwan C.Y (1997). "In vitro inhibition of proliferation of HL-60 cells by tetrandrine and Coriolus versicolor peptide derived from Chinese medicinal herbs", Life Sci 60 (8): 135–40.

Edeoga H. O. & Eriata D. O. (2001). Alkaloids, Tannin and Saponin contents of some Nigerian medicinal plants. J. Med. Aromat Plant Sci. 23:344-349.

Elliott, C.E. (1991). Reproduction In Fungi, First Edition.

FAO. Food and Agriculture Organisation (1972). Food Composition Table for use in East Asia. Food Agriculture Organisation U.N. Rome (1972).

Fasidi, I.O. and M. Kadiri, 1990. Changes in nutritional content of two Nigerian mushrooms (T.robustus and L. subnudus) during sporophore development. Die Nahrung, 34: 415-420.

Fasidi I.O. and Olorunmaiye KS (1994). Studies on the requirements for vegetative growth of Pleurotus tuber-regium (Fr.) Singer, a Nigerian mushroom. Food Chem. 50: 397.

Fasidi, I.O., (1996). Studies on Valvariella escuenta (Mass) Singer, cultivation on agricultural waste and proximate composition of stored mushrooms. Food Chem., 55: 161-163.

Flegg, P.B. (1992). Future strategies for mushroom production. Mushroom Research 1:13-18.

Gill S. (1992). Ethnomedial uses of plants in Nigeria. University of Benin Press, Benin Nigeria, 276p.

Härkönen M (1998). Uses of mushrooms by finns and karelian. Int. J. Circumpolar Health. 57 (1): 40-55.

Härkönen M., Saarimäki T. and Mwasumbi L. (1995). Edible mushrooms of Tanzania. Karstenia 35 suppl. (ed. S. Stenroos), Helsinki.

Ingold C.T. (1993). The biology of fungi, 6th revised edition Chapman and Hall, pp.197-206. Iowa Conservation Education Council, 1994.

Jarosz-Wilkołazka A., Fink-Boots M., Malarczyk E, Leonowicz A. (1998). Formaldehyde as a proof and response to various kind of stress in some Basidiomycetes. Acta Biol. Hung 49: pp. 393-403

Jedinak A, Dudhgaonkar S, Jiang J,Seindusty G, Silva D., (2010). Int Mol Med. 26 (5): 643-50.

Jiskani M.M. (2001). Energy potential of mushrooms. The Dawn Economic and Business Review, p.4.

Kalac, P. (2009). Chemical composition and nutritional value of European species of wild growing mushrooms: A review. Food Chem., 113: 9-16.

Khowala S, and Sengupta, S. (1992). Secretion of b-glucosidase by Termitomyces clypeatus- Regulation by carbon catabolite product(s). Enzyme and Microbiol Technology. 14, 144-149.

Kim H.M, Park M.K, Yun J.W. (2006). Culture pH affects exopolysaccharide production in submerged mycelial culture of Ganoderma lucidum. Appl Biochem Biotechnol. 134:249–62.

Kim M.Y., Seguin P., Ahn J.K, Kim J.J., Chun S., Kim E.H. (2008). Phenolic compound concentration and antioxidant activities of edible and medicinal mushrooms from Kores. J. Agric Food Chem 56: 7265-7270.

Kurasawa, S.L., J. Sugahana and J. Hayashi, (1982). Studies on dietary fibre of mushroom and edible wild plants. Nutr. Rep. Int., 26: 167-173.

Labarère, J and G. U. Menini. (2000). Collection, Characterization, Conservation and utilization of mushrooms, germplasm resources in Africa. In: The Proceedings of the First International Congress for the Characterization, Conservation, Evaluation and Utilization of Mushroom Genetic Resources for Food and Agriculture. FAO, Bordeaux, France; 913.

Manasseh A.T., Jombo, T.A.G.,Emanghe E.U., Oguntayo, O.B. (2012). Phytochemical properties of Ganoderma applanatum as potential agents in the application of nanotechnology in modern day medical practice. Asian Pacific Journal of Tropical Biomedicine S580-S583.

Manzi P, Gambelli L, Marconi S, Vivanti V, Pizzoferrato L. (1999). Nutrient in edible mushrooms: an interspecies comparative study. Food Chem. 65: 477-482.

Marlow Foods Ltd., (2001). Quorn. http://www.quorn.com/uk/index.htm.

Mattila P., Konko K., Eurola M., Pihlaya J.M., Astola J., Vahteristo L., Hietaniemi V., Kumpulainen J. (2001). Contents of vitamin, minerals elements, and some phenolic compounds in cultivated mushrooms J. Agric. Food Chem. 49: 2343-2348.

Mazzio E.A. and Soliman K.F.A (2010). In vitro screening of tumoricidal properties of international medicinal herba. Part II. Phytother Res. 24 (12): 1813-1824.

Mondal, S., Chakraborty, I., Rout, D. and Islam, S.S. (2006). Isolation and structural elucidation of a water soluble polysaccharide (PS-I) of a wild edible mushroom, Termitomyces striatus. Carbohydrate Research 341: 878–886.

Obodai M. (1992). Comparative studies on the Utilization of Agriculture waste by some mushrooms (Pleurotus and Volvariella species). M. Phil. The University of Ghana, Legon 1992.

Odebode S.O. (2005). Contributions of Selected Non-Timber Forest Products to Household Food Security in Nigeria. J. Food, Agric Environ. 3: 138-141.

Oei, P., (1991). Mushroom cultivation with special emphasis on appropriate techniques for developing countries. Tool Publication III, pp: 52-60.

Oei P, (2003.) mushroom cultivation appropriate technology for mushroom growers. Backhugs publisher. Leiden. The Netherlands.

Ogundana, S.K., Fagade, O.E. (1982). Nutritive value of some Nigerian edible

mushrooms. Food chemistry: 8 (4) 263-268.

Okwu D. E. (2004). Phytochemicals and vitamin content of indigenous spices of South-eastern Nigeria. J. Sustain Agric. Environs. 6:30-34.

Okhuoya, J. A. (1995). A low cost technique for the cultivation of Pleurotus tuber-regium (Fr.) Singer in developing tropical countries. Mushroom Grower's Newsletter 4: 2-4.

Okwulehie, I.C. and E.I. Odunze, (2004). Evaluation of the myco-chemical and mineral composition of some tropical edible mushrooms. J. Sustainable Agric. Environ., 6: 163-170.

Ola, F.L., Oboh, G. (2000). Food value of two Nigerian edible mushrooms T.robustus and T.striatus. Journal of technoscience 4: 1-3.

Ola, F.L.and Oboh, G. (2001). Nutrient distribution and zinc bioavailability. Estimation in some tropical edible mushrooms. Nahrung 45: 67-68.

Osemwegie OO, Eriyaremu EG and Abdulmalik J. (2006). A survey of macrofungi in Edo/Delta region of Nigeria, their morphology and uses. Global J Pure and Applied Sci., 12 (2): 149 - 157.

Osemwegie OO, Okhuoya JA, Oghenekaro AO, Evueh GA. (2010. Macrofungi Community in Rubber Plantation and a Forest of Edo State, Nigeria. J Appl. Sci. 10 (5): 391-398.

Oso, B.A. (1975). Mushrooms and the Yoruba people of Nigeria. Mycologia 67(2):311-319.

Oso, B.A. (1977). Pleurotus tuberregium from Nigeria. Mycologia 69: 271-279.

Pearson, D. (1976). The chemical analysis of foods. 6th Edition. Chemical Publishing Company. New York. pp 169-172.

Rambelli, A. and Menini, U.G. (1983). Manual on Mushroom Cultivation. Food and Agricultural Organisation of the United Nations. Rome. Italy, pp: 68.

Rai, R.D., Saxena, S., Upadhyay, R.C.and Sohi, H.S. (1988). Comparative nutritional value of various Pleurotus species grown under identical conditions. Mushroom. J. Tropics. 8:93-98.

Sanchita S. (2008). Training report on Mushroom Cultivation ICAR Research Complex for Eastern Region, Patna, Indian. Food Chem. pp. 23-31.

Sanmee R, Dell B, Lumyong P, Izumori K, Lumyong S. (2003). Nutritive value of popular wild edible mushrooms from northern Thailand. Food Chem. 84: 527-532.

Sanodiya B. S, Thakur G. S, Baghel R. K, Prasad G. B, Bisen P. S. (2009). Ganoderma lucidum: A potent pharmacological macrofungus. Curr Pharm Biotechnol. 10(8):717–42.

Smith, J., (1972). Commercial mushroom production process. Biochemistry, 7: 24-26.

Stamets, P., (1993). Growing Gourmet and Medical Mushroom. Ten Speed Press Berkeley, CA. 610 pp.

Stary F. (1998). The national guide to medicinal herbs and plants. Tiger Books International, London, pp. 12-16.

Thatoi, H. and Singdevsachan, S.K. (2014). Diversity, nutritional composition and medicinal potential of Indian mushrooms: A review. African Journal of Biotechnology. 13 (4): 523-545.

Trinci, A.P.J. (1992). Myco-protein: A twenty-year overnight success story. Mycological Res., 96: 1-13.

Valentão P., Lopes G., Valente M., Barbosa P., Andrade P., Silva B., Baptista, P., Seabra R.M. (2005). Quantitation of Nine Organic Acids in Wild Mushrooms. Journal of Agricultural

and Food Chemistry 53 (9): 3626–3630.

Wachtel-galor, S., J. Yuen, J.A. Bushwell and I.F.F. Benzie (2011). Ganoderma lucidum (Lingzhi or Reshi) a Medicinal Mushroom (Chapter 9) In: Benzie, I.F.F. S. Wachtel-galor, S. Editors, Herbal Medicine : Bimolecular and Clinical Aspects. 2nd Edition. Boca Raton (FL): CRC Press.

http://www.ncbi.nlm.nih books/NBK92757/

Wasser, P.S. (2007). A book review; mycelium running: how mushrooms can help save the world. Herbalgram 76: 50-57.

WHO (1996). World Health Organization Technical series. Trace elements in human nutrition and health. World Health Organization, Geneva, pp' 199-205.

Wu T. N., Yang K.C., Wang C. M., Lai J. S., Ko K.N., Chang P. Y., and Liou S. H. (1996). Lead poisoning caused by contaminated Cordyceps, a Chinese herbal medicine: two case reports. Sci Total Environ, 182: 193–195.

Wu Y., and Wang D. (2009). A new class of natural glycopeptides with sugar moiety-dependent activities derived from Ganoderma lucidum fruiting bodies. J. Proteome Res 8(2): 436-442.

Yongabi, K., Agho, M and Martinez-Carrera, D. (2004). Ethnomycological studies on wild mushrooms in Cameroon, Central Africa. Micologia Aplicada International 16:34-36.

Zhang W. and Tang Y.J. (2008). A novel three-stage light irradiation strategy in the submerged fermentation of medicinal mushroom Ganoderma lucidum for the efficient production of ganoderic acid and Ganoderma polysaccharides. Biotechnol Prog. 24:1249–61.

Zjawiony, J.K. (2004). Biologically active from the Aphyllophorales (Polypore) Fungi. Journal of Natural Products 67 (2), 300-310.

Zoberi, M.H. (1972). Tropical Macrofungi. Macmillian, London, 159p.