Mushrooms Indigenous to Nigeria as Potential Source of Myconutraceuticals – A Review

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Abstract
Mushrooms have high contents of qualitatively good protein, crude fibre, minerals and vitamins but are poor sources of lipids. Apart from their nutritional potentials, they are also known to possess promising anticancer, immunostimulatory, cardiovascular, hypcholesterolaemic and antibacterial effects. They are sources of vast and yet largely untapped powerful biopharmaceuticals. It has been estimated that about 140,000 mushrooms are on earth and only 10% are known. A large number of the unknown mushroom resides in Africa and maybe largely in Nigeria because there are no sufficient data on indigenous mushroom in this part of the globe. This write up intend to direct attention of researchers into the potential of Nigerian indigenous mushroom as sources of new myconutraceuticals.

Keywords: Potential, myconutraceuticals, Nigeria, indigenous, mushroom

Introduction
Myconutraceuticals are nutraceutical substances derived from fungi. The word nutraceutical can simply be defined as food or part of food that possess health benefits including prevention and treatment of disease. In essence nutraceuticals possess functional properties in addition to supplying nutrients. In the last three decades, scientist had reasoned that the primary role of a diet is not only to provide enough nutrients to fulfill metabolic requirements of the body but also to modulate various functions of the body. Hence, foods that had functional properties are being promoted for consumption in order to improve health.

For centuries, mushrooms have been appreciated as source of food nutrients. In the orients, mushrooms have been used for medicinal purposes. Yet it is not all medicinal properties of mushrooms that had been exploited. It has been reported that the number of mushrooms on earth is estimated at 140,000 yet maybe 10% (approximately 14,000) named species are known (1). Mushrooms comprise a vast and yet largely untapped source of powerful new pharmacological products (2). This statement is more pertinent to mushrooms that are indigenous to Nigeria. Most mushrooms found in this part of the globe are only considered based on their nutritional contents (3,4,5,6). In many parts of sub-saharan Africa, mushrooms provide a low-cost alternative source of high-quality protein (7).

Nigeria is a home to diverse kinds of mushrooms. However, Termitomyces and Plerotus species are the most widely distributed mushrooms in Nigeria (8). Other common mushrooms found in Nigeria are Psathyrella atroumbata, Lentinus subnudus (Berk), Auricularia auricula (Hoom), Calvatia cyathiformis (Bose) Morgan and Schizophyllum commune. Fr. (9). Trametes, Lozenties and Ganoderma species are also found in association with trunk of trees in the forest. Ganoderma
species is a well known medicinal mushroom in the orient. However, there is little or no any information on the medicinal property of *Ganoderma* species indigenous to Nigeria.

Mushrooms are known to contain pharmacologically active components which cause no harm nor place additional stress to the body (1). They have been used as food and food-flavouring material in soups and sauces for centuries, due to their unique and subtle flavour. They have become attractive as functional foods and as a source of physiologically beneficial medicines, while being devoid of undesirable side-effects (10). The functional properties of mushrooms have been attributed to the presence of some bioactive compounds in mushrooms. The major bioactive compounds found in mushrooms are the polysaccharides. Other bioactive compounds include dietary fibers, lectins and triterpenoids, glycolipids (schizonellin), compounds derived from the shikimic acids (strobilurins and oudemansins), aromatic phenols (drosophilin, amillarisin, amphilone), fatty acid derivatives (filiobetic acid, podoscyphic acid), polyacetylenes (agrocybin, xerulin), polykekides (caloporoside, hericenones A-H), nucleosides (chitocine, nebularines), different sesquiterpenes (protoilludanes, marasmanes, hirsutanes, caryophyllanes, etc), diterpenes (cyathin, stricital), sesterpenes (aleurodscal), and many other substances of different origin (11,12,13).

Most of these bioactive compounds derived from mushrooms are known to function as biological response modifiers (BRM). Biological response modifiers are substances that stimulate the body’s response to infection and disease. The body is known to produce these substances but not in appreciable quantity hence, exogenous supply through diet or dietary supplements are needed. Mushroom nutraceuticals may unarguably be the source of this exogenous supply.

**Nutraceutical Importance of Mushroom Polysaccharides**

Many polysaccharides isolated from mushroom are considered to be biological response modifiers (BRM) and have been shown to enhance various immune responses (14). BRMs are substances that stimulate the body’s response to infection and disease. Unlike proteins and nucleic acids; they contain repetitive structural features that are polymers of monosaccharides residues joined to each other by glycosidic linkage (15). Consequently, they offer a high capacity for carrying biological information because of their structural variability (1). The amino acids in proteins and the nucleotides in nucleic acids can only interconnect in one way while the monosaccharides can interconnect at several points to create a wide array of linear and branched molecules that will carry different biological information. The polysaccharides of mushrooms occur mostly as glucans. Some of which are linked by $\beta-(1-3)$, $(1-6)$ glycosidic bonds and $\beta-(1-3)$ glycosidic bonds but many are true heteroglycans. Most often there is a main chain, which is either $\beta(1-3)$, $\beta(1-4)$ or mixed $\beta(1-3)$, $\beta(1-4)$ with $\beta(1-6)$ side chains. Hetero-$\beta$-D-glucans, which are linear polymers of glucose with other D-monosaccharides, can have anticancer activity but $\beta$-D-glucans from mushroom usually lack anticancer activity (1).

Mushrooms represent an unlimited source of polysaccharides with ability to enhance good health in man (2). The mechanism of immunostimulation by polysaccharides involved enhancing immunoreactivity by activation of macrophages, cytotoxic T cells and natural killer (NK) cells (12,16,17,18,19). Wasser (1) stated that the polysaccharides from mushrooms do not attack cancer cells directly, but produce their antitumour effects by activating different immune response in the host. In essence, the anticancer effect of most of these polysaccharides may be
pronounced *in vivo*. In the last two decades or there by, mushroom polysaccharides have drawn the attention of chemists and immunobiologists on account of their immunomodulation and antitumor activities (11,20,21).

Little is known about the immunoceutical potentials of polysaccharides present in mushrooms indigenous to Nigeria. However, an indication of the potential immunoceutical property of two common edible mushrooms, *Termitomyces robustus* and *T. striatus*, indigenous to Nigeria was demonstrated by Adewusi et al. (2). In a recent study, Mondal et al. (23) reported splenocytes activation of rats by polysaccharides isolated from aqueous extract of *T. striatus*. Oyetayo (24) also found that *Termitomyces clypeatus* belonging to the same genus of mushrooms reported above has appreciable level of polysaccharides. The report above shows that polysaccharides present in mushrooms indigenous to Nigeria hold promise as a source of new immunoceutical polysaccharides.

**Nutraceutical Importance of Polyphenols in Mushrooms**

Antioxidant property of compounds is well correlated with the content of their phenolic compounds (25). Antioxidants are needed to combat free radical activities of accelerating ageing processes of tissues and pathologies such as cancer or cardiovascular diseases. Antioxidants are needed to combat free radical activities of accelerating ageing processes of tissues and pathologies such as cancer or cardiovascular diseases. Antioxidants are needed to combat free radical activities of accelerating ageing processes of tissues and pathologies such as cancer or cardiovascular diseases.

Mushrooms had been found to be rich in antioxidant such as phenolic compounds and ascorbic acid (29,30,31,32). Appreciable levels of phenolic compounds have been reported in *Pleurotus, Termitomyces* and *Pseudomyces* species that are indigenous to Nigeria (33,34). In a recent study, Oyetayo (24) using a multimechanistic antioxidant assay which include DPPH radical scavenging, superoxide radical scavenging, hydroxyl radical scavenging and reducing power assay found that ethanol, hot water and petroleum ether extracts of *Termitomyces clypeatus* (Heim) had antioxidant effect comparable to synthetic antioxidant, BHT. The implication of this result is that, this edible mushroom, *Termitomyces clypeatus*, obtained from Nigeria may be a good source of alternative antioxidant to the synthetic antioxidants which are known to have side effect.

**Other Potential Nutraceutical Benefits of Mushrooms Indigenous to Nigeria**

**Anticholesterolaemic**

Two common edible mushrooms *Pleurotus tuber-regium* and *Termitomyces clypeatus* indigenous to Nigeria had been reported to possess hypolipidemic properties. In a feeding trial using male albino rat, plasma total cholesterol, low density lipoprotein (LDL) cholesterol, and triglycerides concentrations were found to be significantly lower (P<0.05) while high density lipoprotein (HDL) cholesterol were significantly higher (P<0.05) than control (35). The result (Table 1) implies that the two tropical edible mushrooms have hypolipidemic properties.
Prebiotic property

Prebiotics are food substances that selectively promote the growth of beneficial bacteria in the gut. *Lactobacillus* and *Bifidobacterium* species are regarded as friendly bacteria hence attention is usually directed to any substrate that can encourage their growth in the gastrointestinal tract. The ability of edible mushroom to selectively promote the growth of beneficial bacteria, lactobacilli, in gut had also been reported. In a study, it was observed that *Plerotus sajor-caju*, an edible mushroom used as dietary supplement in a feeding trial of albino rats promoted the growth of intestinal beneficial bacteria, lactobacilli (36). Table 2 shows the faecal lactobacilli counts of rats fed mushroom, *Plerotus sajor caju* diet.

<table>
<thead>
<tr>
<th>Day</th>
<th>Casein diet</th>
<th>Casein diet +Lactobacillus</th>
<th>Mushroom diet</th>
<th>Mushroom diet +Lactobacillus</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6.94±0.01</td>
<td>6.85±0.01</td>
<td>6.87±0.01</td>
<td>6.90±0.01</td>
</tr>
<tr>
<td>28</td>
<td>6.66±0.07</td>
<td>7.29±0.00</td>
<td>6.81±0.01</td>
<td>7.32±0.05</td>
</tr>
</tbody>
</table>

Values along rows are significantly different (P<0.05). n=3. Source: Oyetayo and Oyetayo, 2005.

Antimicrobial Property

Mushrooms need antibacterial and antifungal compounds to survive in their natural environment (2). Hence, they are rich sources of natural antibiotics. Many of the externalised secondary metabolites (extracellular secretions by the mycelium) are known to combat bacteria (37, 38, 39) and viruses (40). Several compounds extracted from mushroom revealed antifungal and antibacterial activity (41, 42), namely against *Staphylococcus aureus*, *Bacillus subtilis* and *Escherichia coli* (43). Mothana et al. (44) reported the inhibition of the growth of methicillin-resistant *Staphylococcus aureus* and other bacteria by new sesquiterpenoid hydroquinones produced by European *Ganoderma* species *Ganoderma pfeifferi* Bres. The whole extract of *Ganoderma pfeifferi* Bres had also been reported to inhibit the growth of microorganisms responsible for skin problems (*Pityrosporum ovale, Staphylococcus epidermidis, Propionibacterium acnes*) (2). A lot of the mushroom in Africa, to be specific in Nigeria may have of these potentials too but yet untapped.

Future Perspective

Today, the focus of nutritionists and dieticians are foods that are functionally active and which at the same time contain enough food nutrients. Mushrooms belong to this class of functionally active food. However, there are still
hundreds of species that are yet to be studied especially in Nigeria. Hence, in the search for new myconutraceuticals, mushrooms indigenous to Nigeria may be a good source as some preliminary reports on common edible mushrooms such as *Pleurotus* and *Termitomyces* species showed that they possess antioxidant, immunostimulatory and cholesterol lowering effect. Other potential health promoting attributes such as anticancer, antimicrobial, antiatheriogenic, antiviral, hepatoprotective, antiallergic, and anti-inflammatory properties should be the focus of researchers. Moreover, only very few known mushrooms such as Plerotus, Termitomyces, Pasthyrella had been investigated. There remains tens of hundreds that are yet be studied.

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