NUTRITIONAL COMPOSITION AND ANTIMICROBIAL POTENTIAL OF *Lenzites betulina, Pleurotus ostreatus* AND *Bjerkandera adusta* EXTRACTS AS BIOACTIVE INGREDIENTS AGAINST SELECTED PATHOGENIC BACTERIA

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ABSTRACT

Extraction of bioactive component of wild mushrooms (*Lenzites betulina, Pleurotus ostreatus* and *Bjerkandera adusta*) using methanol, ethanol, petroleum ether and distilled water were carried out. The extracts were tested for antibacterial activities on some pathogenic bacteria (*Klebsiella pneumonia, Escherichia coli, Proteus vulgaris, Staphylococcus aureus* and *Pseudomonas aeruginosa*). The *in vitro* bioassay of the mushroom extracts on the tested bacteria was carried out using agar well diffusion method at a concentration of 50 mg/ml. The methanolic extract of *P. ostreatus* showed high inhibition against *E. coli.* The methanolic and ethanolic extracts of *L. betulina* exhibited high zone of inhibition 19.0 ± 0.15 mm and 18.0 ± 0.55 mm against *S. aureus* and *K. pneumonia* while *S. aureus* and *K. pneumonia* showed high resistance to all the mushrooms extract respectively. The proximate composition showed that sundried *P. ostreatus* had high protein content of 27.06 g/100g. Sundried and oven-dried *L. betulina* recorded 25.15 g/100 g and 24.98 g/100 g crude fibre content. Sundried and oven-dried *L. betulina* had low carbohydrate content 37.62% and 37.89%. There was no significant difference ($p<0.05$) in the moisture, fat and ash contents in the mushroom samples.

Keywords: Antimicrobials, antioxidant, edible mushrooms, medicinal plants, proximate composition.

INTRODUCTION

With ever increasing momentum in the quest for newer antimicrobial agents, to counteract the rise in bacterial drug

resistance, mushrooms are being increasingly explored in many parts of the world which may offer a new source of potential activity against ineffective pathogenic microorganisms (Guillamón *et al*., 2010). Though, less available information on the importance of some medicinal and highly nutritional foods has limited their use with major food security and safety concern. Consumption of foods with essential nutrients help in averting malnutrition challenges and promotes good health (Roupas *et al*., 2012).

Recent researches on novel antimicrobial agents from different biological sources are on the increase. Prospect and interest in traditional medicine and demand for more drugs from plant sources is also on the increase. The interest in plant-derived drugs is advancing due to the current widespread belief that green medicine is safe and more dependable than the costly synthetic drugs with adverse side effects (Akyuz1 *et al*., 2010). In folk medicine, the field of phytomedicine specializing in the synthesis of plant-based drugs from medicinal plants have gained appraisal in search for new antimicrobial substances from various sources, like medicinal plants and mushrooms due to their therapeutic, medicinal, functional foods and in tradomedical importance (Wasser and Weis, 1999).

Nowadays, growing of mushrooms and mushroom technology has received worldwide popularity due to the renewed interest in traditional medicine and increase in demand for more drugs from mushroom containing natural bioactive compounds that can serve as antimicrobial agents against pathogenic microorganisms that have developed resistance to synthetic antibiotics (Sofowora, 1993; Quereshi *et al*., 2010; Sánchez, 2010). Research finding on novel antimicrobial chemotherapeutic agents as alternative to commercial antibiotics due to its abuse or misuse in the treatment of diseases have been major concerns in human population.

Mushroom cultivation and production is gaining credence in area of agriculture in more than 100 countries including Nigeria and its production is increasing at the rate of 7% per annum (Degreef *et al.,* 1997). Production of mushroom has already crossed 5 million metric tons annually in the world and is expected to reach around 7 million metric ton in next ten years. Edible mushrooms are regarded as epicurean delicacy. They constitute an important addition to diets in a world threatened by food crisis and ever increasing population (Egwim *et al*., 2011). Nutritionally, tropical mushrooms are highly rich in proteins, minerals, vitamins, crude fiber and carbohydrate but low fat and oil contents. 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 (Adejumo and Awosanya, 2005; Oyetayo and Ariyo, 2013).Mushrooms are composed of neutraceuticals with much medical or health benefits in the prevention and treatment of diseases which can be used as dietary supplements to genetically engineered/modified foods, herbal products and processed products such as cereals, soups and beverages (Akinyele *et al*., 2011; Lindequist, 2013). Mushrooms have received great attention based on their bio-safety and health promoting properties. They possess antitumor, antioxidant, antimicrobial, antidiabetic, anti-inflammatory, anti-fibrotic, anticancer, cholesterol lowering, immunostimulatory properties (Patel and Goyal, 2012). It has also been used in the treatment and prevention of various diseases like hypertension and hypercholesterolemia. Mushrooms produce and secrete antiviral, antibacterial and antifungal compounds to survive in the wild against competing or pathogenic organisms (Jonathan, 2007; Venturini *et al*., 2008).

Mushrooms need antibacterial and antifungal compounds to survive in their natural environment. Hence, they are rich sources of natural antibiotics (Obinna-Echem and Chukunda, 2018). The bioactive component of edible mushrooms enhances its functional and medicinal efficacy. Different bioactive compounds in mushrooms have been identified which include polyphenols, flavonoids, minerals, polysaccharides, vitamins and carotenoids (Kozarski *et al*., 2015). Lot of interest and research focus has been engineered toward mushrooms production, mushroom technology and productivity. Mushrooms can be used as food, curative of infectious diseases, bioremediation of environmental pollutants and as important items with high economic values in Nigeria and all over the world.

Despite the many studies on the chemical composition and antimicrobial efficacy of different mushroom species globally, little information or no work has been carried out on the proximate composition and antimicrobial properties of the edible mushroom under this study in parts of Nigeria. In view of this, the nutritional and antimicrobial properties of several wild edible species of mushrooms are yet to be exploited and this prompted the present work aiming in determining the proximate composition and the antimicrobial efficacy of three selected wild edible Nigerian mushrooms.

MATERIALS AND METHODS

Collection and identification of mushroom samples

The three species of mushroom (*Lenzites betulina, Pleurotus ostreatus* and

Bjenkandera adusta) were obtained from Irele axis ("lat":6.53479, "lng":5.0092) of Ondo Southern Senatorial District of Ondo State, Nigeria on 12th of May, 2021 from decaying trees in the forest scraped and thoroughly washed with sterile water to remove the dirt and sand. The identification and authentication of the mushroom samples were done in the Department of Biological Sciences, Olusegun Agagu University of Science and Technology, Okitipupa and the Department of Microbiology, Federal University Technology, Akure, Nigeria respectively.

Preparation of mushroom extracts

Each of the mushroom samples was weighed and divided into two parts. The first part was sundried and the second part oven dried at 100^{o}C for 5 hours, then pulverized and sieved to give 50 mm mesh size powder. Twenty-five grams of each of the powdered mushrooms were subjected to a cold maceration process for 48 hours with ethanol, methanol, petroleum ether and distilled water to obtain the aqueous extracts and filtered using Whatman No.1 filter paper. The extracts were concentrated under vacuum and evaporated using a rotary evaporator at low temperature (45^{o}C).

Collection of bacterial isolates

Bacterial isolates (*Klebsiella pneumonia, Escherichia coli. Proteus vulgaris, Staphylococcus aureus* and *Pseudomonas aeruginosa*) were collected at the State Hospital in Okitipupa, Ondo State on 15th of June, 2021. The identity of the isolates were confirmed using various biochemical tests in the Microbiology Research Laboratory of the Department of Biological Sciences, Olusegun Agagu University of Science and Technology, Okitipupa.

Proximate composition of mushroom samples

The proximate composition (Fat, Crude fibre, and Ash) was determined on dry basis by the standard method of Association of Official Analytical Chemist (AOAC, 2016), the protein content was determined using the micro-Kjedahl method (N x 6.25) and the carbohydrate determination by difference (AOAC, 2016). Total dietary fibre was determined to dried, fat-free sample according to Megazyme TDF Assay procedure, K-TDFR 05/12 (Megazyme International, Ireland).

Determination of antibacterial activity of mushroom extracts

The antibacterial activity of aqueous methanolic, ethanolic, petroleum ether and water extracts of the mushrooms against *K. pneumonia, E. coli, P. vulgaris, S. aureus* and *P. aeruginosa* bacteria was evaluated by using agar well diffusion method (Jonathan *et al.*, 2011).

Muller-Hinton agar plates were inoculated with 100 µl of standardized inoculum (1.0 x 10^6 Cfu/ml) of each selected bacterium and spread with sterile swabs. Wells of 7.0 mm size diameter were made with sterile borer into agar plates containing the bacterial inoculum and the lower portion was sealed with a little molten agar medium. About 0.5 ml of each of the extracts was poured into a well of inoculated plates. Standard antibiotic, ampicillin (10 µg/ml) was used as a positive control which was introduced into a well instead of plant extract while sterile distilled water was used as negative control, which was introduced into the wells instead of the extracts. The prepared plates were left at room temperature for five minutes allowing the diffusion of the extracts into the agar prior incubation. The plates were incubated at 37^{o}C for 24 hours and observed. The antibacterial activity was observed by zone of clearance surrounding the well containing the mushroom extract. The zone of inhibition was measured and expressed in millimeters.

Statistical analysis

Statistical analysis for the antibacterial activities was performed using one way analysis of variance (one-way ANOVA) and the mean separation were carried out using Duncan's Multiple Range test at 5% level of significance i.e. $P \leq 0.05$. (Zar, 2010)

RESULTS

Mushrooms samples

Plates 1-3 show the morphological view of the three mushrooms samples used for the study

Antibiotic Sensitivity

Table 1 shows the antibiotic sensitivity and *L. betulina* extract on bacterial isolates. The bacterial isolates were susceptible to the antibiotic used (ampicillin). The *L. betulina* extract cause inhibition on some of the test bacteria. The ethanolic and methonolic extracts of *L. betulina* exhibited high susceptibility against *K. pneumonia* and *S. aureus* with zone of inhibition 18.0 mm and 19.0 mm respectively. *S. aureus, P. vulgaris, E. coli* and *K. pneumoniae* were resistant to petroleum ether extract of *L. betulina* except *P. aeruginosa* with zone of inhibition 13.0 mm. Distilled water extract of *L. betulina* cause no inhibition on the test isolates.

All the test bacterial isolates considerably showed high susceptibility to the antibiotic used. There was no significant difference in the high susceptibility pattern exhibited by sundried and ovendried methanolic extracts of *P. ostreatus* against the test isolates. Varied degree of zone of inhibition was observed in the ethanolic and petroleum extracts of *P. ostreatus* against the test isolates. The ethanolic extract of *P. ostreatus* exhibited high zone of inhibition (17.0 mm) against *K. pneumoniae.* No significant

inhibition was observed in the sun-dried and oven-dried distilled water extract of *P. ostreatus* against the test isolates (Table 2).

The antibiotic sensitivity and *B. adusta* extract against bacterial isolates is represented Table 3. The antibiotic used exhibited high susceptibility (14.0 mm) against *S. aureus* and *P. aeruginosa. S. aureus* and *K. pneumoniae* showed high resistant to all the mushroom extracts. *P. aeruginosa* and *Escherichia coli* were resistant to methanolic and ethanolic extracts of *B. adusta* with 7.0 mm zone of inhibition. There was no significant difference in the degree of susceptibility of sundried and oven-dried petroleum ether extracts of *B. adusta* against *P. vulgaris* (8.0mm), *P. aureginosa* (11.0 mm) and *E. coli* (10.0 mm).

Proximate composition of mushroom Samples

Table 4 shows the proximate composition of the mushroom samples. The sundried and oven-dried *P. ostreatus* recorded high protein content 27.06 g/100g and 25.27 g/100g respectively. Sundried and oven-dried *L. betulina* had high crude fibre content (25.15 g/100g and 24.98 g/100g). The carbohydrate content values 40.26%, 42.74% and 42.60%, 43.56% were obtained from sundried and oven-dried *P. ostreatus* and *B. adusta* respectively. There was no significant different ($p<0.05$) in the moisture, fat and ash contents in the samples.

DISCUSSION

The current trend in knowledge driven research into drug development as a result of scientific evolution and technological renaissance is on increase. Drugs from macrofungi have been shown to be effective, readily available and less expensive with minimal or no side effects (Sevindik *et al*., 2018). In this study, the antimicrobial efficacy of the three mushroom extracts was tested against bacteria pathogens different solvents with varied recovery. The result of the antimicrobial activities of the mushroom extracts on selected bacteria pathogens showed their effectiveness and activity against a wide variety of pathogens (Dulger and Gonuz, 2004). The variation in bioactive ingredients of medicinal plants depend on the type solvent used (Campos *et al*., 2002; Akinyele *et al*., 2011).

Considering the antibacterial activities, *L. betulinus* and *P. ostreatus* extracts exhibited high activity on *S. aureus* when compared to the standard antibiotics ampicillin used. Antibiotic resistance and multiple drug resistance by microorganisms have posed a serious threat to the treatment of infectious diseases. Plant based derived antimicrobial substances could be employed to combat several infectious diseases caused by

pathogenic microorganisms. In essence, unexploited edible mushrooms found in Nigeria may be used as natural alternative source of new antimicrobials that can avert the problem associated with drug resistance that is presently becoming a menace in the country.

From literature, extracts from common edible mushrooms have been effectively used against bacteria pathogens such as *Bacillus anthracis, B. cereus, B. subtilis, Micrococcus luteus, S. aureus, E. coli, K. oxytoca, K. pneumoniae, P. vulgaris, Salmonella tompson, S. typhi, S. typhimurium* and *Serratia marcescens* (Heleno *et al*., 2013). The differences observed in the antibacterial activity of mushrooms extracts depend on their relatively inherent bioactive compounds. Tamal *et al*. (2013) had reported antimicrobial activity of some common mushrooms *P. ostreatus, P. sajor-caju, Ganoderma lucidum, Agaricus bisporus* against pathogenic microorganisms.

High antibacterial activity of petroleum ether extract of *P. ostreatus* against *Escherichia coli* suggested that it can be used in the treatment of both gastrointestinal and urinary tract infection. The inhibition caused by petroleum ether and ethanolic extracts of the mushrooms against *Proteus vulgaris* implies that these extracts could be used in the treatment of urinary tract infection. The variation observed in zones of inhibition exhibited by the mushrooms extract could be due to low concentration of diffusion compounds, time of collection of the mushroom samples, constituent of mushrooms and climate.

The high activity of the methanolic extracts verifies the use of the methanolic extraction method by local herbalist, though Farombi (2003) had earlier reported ethanolic extract as best solvent. The antimicrobial properties of *L. betulina* and *P. ostreatus* can be used in the stimulation of drugs to treat some clinical diseases. The strong correlation observed between the results of the antimicrobial activity of both sundried and oven-dried extracts against the test bacteria implies that temperature does not have any effect on the antimicrobial activities.

However, the antimicrobial activity of the mushroom extracts might arise from their genetic structure, physical, biochemical constituents, chemical differences of extracts, solvents and test microorganisms. Research findings have revealed the antimicrobial activity of *G. lucidum* extract against *B. subtilis, S. aureus, E. coli, K. pneumoniae, P. aeruginosa, S. typhi, and S. typhimurium* (Alves *et al*., 2013).

The proximate composition revealed the nutritional contents present in the mushroom samples. The drying techniques cause no changes in the nutritional composition in the mushroom samples. The moisture, fat and ash contents of the

Table 1: Antibiotic sensitivity and *Lenzites betulina* extract on bacterial isolates

Test bacteria	Inhibition zones of antibiotics/extract (mm)								
	AMP	**AMS**	**AES**	**APS**	**ADS**	**AMO**	**AEO**	**APO**	**ADO**
Staphylococcus aureus	14.0±0.11^{c}	19.0±0.18^{a}	11.0±0.14^{a}	0.0	0.0	19.0±0.15^{e}	11.0±0.10^{a,b}	0.0	0.0
Proteus vulgaris	10.0±0.15^{a}	0.0±0.12^{a}	10.0±0.13^{a}	10.0±0.11^{a}	0.0	0.0	10.0±0.09^{a}	10.0±0.07^{a}	0.0
Pseudomonas aureginosa	14.0±0.01^{c}	10.0±0.10^{a}	0.0	13.0±0.11^{b}	0.0	10.0±0.15^{a}	0.0	13.0±0.01^{b}	0.0
Escherichia coli	12.0±0.11^{b}	15.0±0.09^{d}	13.0±0.10^{b,c}	0.0	0.0	15.0±0.14^{d}	13.0±0.20^{b}	0.0	0.0
Klebsiella pneumonia	7.0±0.10^{d}	0.0	18.0±0.01^{e}	0.0	0.0	0.0	18.0±0.55^{e}	0.0	0.0

Values are means of triplicates ±SD, Samples carrying the same superscripts in the same row are not significantly different at ($p<0.05$)
Key: AMP: Ampicillin, AMS: Sundried methanolic extract of *L. betulina,* AMO: Oven dried methanolic extract of *L. betulina,* AES: Sundried ethanolic extract of *L. betulina,* AEO: Oven dried ethanolic extract of *L. betulina,* APS: Sundried Petroleum ether extract of *L. betulina,* APO: Oven dried petroleum ether extract of *L. betulina,* ADS: Sundried distilled water extract of *L. betulina,* ADO: Oven dried distilled water extract of *L. betulina*

Table 2: Antibiotic sensitivity and *Pleurotus ostreatus* extract on bacterial isolates

Test bacteria	Inhibition zones of Antibiotics/extract (mm)								
	AMP	**BMS**	**BES**	**BPS**	**BDS**	**BMO**	**BEO**	**BPO**	**BDO**
Staphylococcus aureus	14.0±0.19^{b}	16.0±0.16^{c}	12.0±0.21^{a}	14.0±0.10^{b}	0.0	16.0±0.12^{c}	11.0±0.13^{a}	12.0±0.18^{a}	0.0
Proteus vulgaris	10.0±0.11^{a}	14.0±0.12^{b}	16.0±0.10^{c}	14.0±0.16^{b}	0.0	14.0±0.14^{b}	10.0±0.10^{a}	16.0±0.12^{c}	0.0
Pseudomonas aureginosa	14.0±0.20^{b}	14.0±0.15^{b}	18.0±0.01^{d}	16.0±0.02^{c}	0.0	14.0±0.16^{b}	0.0	18.0±0.16^{d}	0.0
Escherichia coli	12.0±0.09^{a}	25.0±0.19^{d}	19.0±0.16^{d}	22.0±0.08^{d}	0.0	25.0±0.18^{d}	13.0±0.12^{a}	19.0±0.11^{d,e}	0.0
Klebsiella pneumonia	7.0±0.12^{d}	16.0±0.22^{c}	17.0±0.10^{c,d}	16.0±0.19^{c}	0.0	16.0±0.11^{c}	17.0±0.20^{c,d}	0.0	0.0

Values are means of triplicates ±SD, Samples carrying the same superscripts in the same row are not significantly different at ($p<0.05$)
Key: AMP: Ampicillin, BMS: Sundried methanolic extract of *P. ostreatus,* BMO: Oven dried methanolic extract of *P. ostreatus,* BES: Sundried ethanolic extract of *P. ostreatus,* BEO: Oven dried ethanolic extract of *P. ostreatus,* BPS: Sundried Petroleum ether extract of *P. ostreatus,* BPO: Oven dried petroleum ether extract of *P. ostreatus,* BDS: Sundried distilled water extract of *P. ostreatus,* BDO: Oven dried distilled water extract of *P. ostreatus*

Table 3: Antibiotic sensitivity and *Bjenkandera adusta* extract against bacterial isolates

Test bacteria	Inhibition zones of antibiotics/extract (mm)								
	AMP	CMS	CES	CPS	CDS	CMO	CEO	CPO	CDO
Staphylococcus aureus	14.0±0.18^{e}	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Proteus vulgaris	10.0±0.11^{c}	0.0	0.0	8.0±0.14^{b}	0.0	0.0	0.0	8.0±0.10^{b}	0.0
Pseudomonas aureginosa	14.0±0.20^{e}	7.0±0.10^{a}	0.0	11.0±0.18^{c,d}	0.0	7.0±0.11^{a}	0.0	11.0±0.10^{c,d}	0.0
Escherichia coli	12.0±0.08^{d}	0.0	7.0±0.08^{a}	10.0±0.12^{c}	0.0	0.0	7.0±0.16^{a}	10.0±0.10^{c}	0.0
Klebsiella pneumonia	7.0±0.14^{a}	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Values are means of triplicates ±SD, Samples carrying the same superscripts in the same row are not significantly different at ($p<0.05$)

Key: AMP: Ampicillin, CMS: Sundried methanolic extract of *B. adusta,* CMO: Oven dried methanolic extract of *B. adusta,* CES: Sundried ethanolic extract of *B. adusta,* CEO: Oven dried ethanolic extract of *B. adusta,* CPS: Sundried Petroleum ether extract of *B. adusta,* CPO: Oven dried petroleum ether extract of *B. adusta,* CDS: Sundried distilled water extract of *B. adusta,* CDO: Oven dried distilled water extract of *B. adusta*

Table 4: Proximate composition of the mushroom samples

Samples	Proximate composition (%)					
	MC	FC	AC	CF	CP	CC
Sundried *Lenzites betulina*	6.02±0.15^{c}	0.19±0.35^{a}	8.50±0.44^{d}	25.15±0.15^{a}	22.52±0.75^{e,f}	37.62±0.08^{f,g}
Sundried *Pleurotus ostreatus*	6.10±0.05^{c}	0.14±0.55^{a}	8.22±0.26^{d}	18.22±0.45^{e}	27.06±0.35^{f}	40.26±0.16^{g}
Sundried *Bjenkandera adusta*	6.09±0.35^{c}	0.16±0.66^{a}	8.42±0.71^{d}	20.85±0.60^{e,f}	21.74±0.19^{e,f}	42.74±0.49^{g}
Oven-dried *Lenzites betulina*	5.40±0.22^{b}	0.18±0.14^{a}	8.28±0.21^{d}	24.98±0.12^{f}	23.27±0.24^{e,f}	37.89±0.60^{f,g}
Oven-dried *Pleurotus ostreatus*	5.66±0.78^{b}	0.19±0.42^{a}	8.30±0.60^{d}	17.98±0.15^{e}	25.27±0.54^{f}	42.60±0.45^{g}
Oven-dried *Bjenkandera adusta*	5.45±0.08^{b}	0.12±0.56^{a}	8.31±0.82^{d}	22.06±0.95^{e,f}	20.50±0.09^{e,f}	43.56±0.25^{g}

Values are means of triplicates ±SD, Samples carrying the same superscripts in the same row are not significantly different at ($p<0.05$)

Key: MC – Moisture Content, FC – Fat Content, AC – Ash Content, CF – Crude Fibre, CP – Crude Protein, CC - Carbohydrate

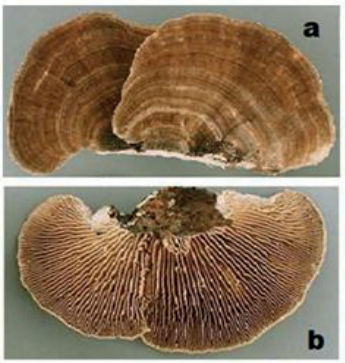

Plate 1: ***Lenzites betulina,*** **a- aerial view, b- back view**

Plate 2: ***Pleurotus ostreatus***

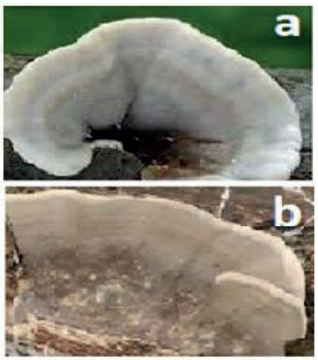

Plate 3: ***Bjerkandera adusta,*** **a- aerial view, b- back view**

mushroom samples were not statistically different. Moisture is required for the normal biochemical activities of micro-organisms. It also ensures in keeping quality of the harvested plant foods. The slight variation observed in the moisture content may be dependent on various factors, such as harvesting time, maturation period, substrate and environmental conditions of growth, heating, grinding and method of storage. Low moisture content in food samples helps in ensuring its shelf-ability and preservation. Conversely, high moisture content in mushroom samples has been accounted for their susceptibility to microbial growth and enzyme activity, perishability, deterioration after harvesting and storage stability (Fasidi and Kadiri, 1993; Adebayo, 2011). Foods noted with high moisture contents that exist in free form are known to have a shorter life span (Amadi, 2014). Elimination of water content of foods to dry state will increase the concentration of nutrient relatively. Thus, drying mushrooms is one method that would extend the shelf life of mushrooms by reducing unnecessary biochemical reaction such as enzymatic browning and lipid oxidation that may lead to quality deterioration (Mattila *et al*., 2002).

Low fat content of the mushroom could help in improving blood cholesterol levels, decrease the risk of cardiovascular disease and promote weight loss (Brown, 2012). Mushrooms may contain some essential free fatty acids and can be recommended as good supplements for patients with cardiac problems (Okwulehie *et al.,* 2008). The result obtained was in agreement with the findings of Muthu and Shanmugasunaram (2016) who reported 0.2 mg/100g fat content of edible mushroom *Agrocybe aegerita*.

The slight variations of the protein contents among edible mushrooms are

affected by a number of factors, namely the type of mushrooms, the stage of development, level of nitrogen available, and the location (Longvah and Deosthale, 1998). Mushrooms proved to have good quality and higher protein content as compared to legumes (Aletor, 1995). High protein content proof mushroom to be highly nutritious and valuable source of protein as complementary foods for man use. The protein content of *L. betulina, P. ostreatus* and *B. adusta* ranging from 10.0-14.0% has reported (Barros *et al.,* 2008). The protein content under ths study corresponds to the findings of Odoh *et al*. (2017) who reported protein content of *Grifola frondosa* and *Morchella* spp ranging from 15.65 to 25.65.

The high dietary fibre and low fat contents of the mushrooms suggested to be ideal traditional plant which have been indicated to function in lowering sugar levels thus; serving as nutraceutical against diabetes and dietetic prevention of hyperglycemia and atherosclerosis which indeed in oriental medicine is prescribed as natural hypocholesterolemic and antisclerotic diet (Alarcon-Aguilara *et al.,* 1998). The ash content is referred to the mineral fractions of the mushroom. The ash contents of the samples were fairly high indicating its relatively high, a reflection of the mineral contents preserved in the food materials (Borokini *et al.*, 2016).

The carbohydrate content was in close range with the findings of Deepalakshmi and Mirunalini (2014) and Obinna and Chukunda (2018) who reported 50-60% carbohydrate to constitute the prevailing component of mushroom dry matter. According to Kalac (2012) the various carbohydrate compounds of mushrooms which include monosaccharides, polysaccharides, glycoproteins and oligosaccharides are important in the proper functioning of the alimentary tract. Papaspyridia *et al*. (2011) had reported nutritional qualities of some edible mushrooms and their potential applications in food and pharmaceutical industries. A variety of branded products have been produced from edible mushrooms and marketed as nutraceuticals. The economic importance, ecological values and medicinal properties of some edible mushrooms have been reported (Familoni *et al*., 2018).

CONCLUSION

The antimicrobial efficacy of the mushroom extracts against the pathogenic bacteria further suggest pharmacological investigation for their use as possible antimicrobial agents in the treatment of gastrointestinal, urinary tract and skin infections. Further investigation on *In vivo* assay needed to be carried out to ascertain their efficacy and medicinal value. The proximate analysis revealed that the mushrooms under this study are

good sources of nutrients such as protein, carbohydrate and dietary fibre and as such, can be ranked as protein rich food due to their relatively high protein content.

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