Education

Nutritional and antinutritional compositions of wild macrofungi found in Gwandu emirate, Kebbi State, Northwestern Nigeria

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Abstract

Mushrooms have continued to attract research interest recent times due to their abundance in almost all parts of Nigeria. However, many people are not aware of their nutritional values. In this study, the nutritional and anti-nutritional properties of some mushrooms collected in Gwandu Emirate of Kebbi State, Northwestern Nigeria have been analyzed. The mushrooms identified, were weighed fresh dry then taken for nutritional and anti-nutritional analyses using the Standard analytical methods for obtaining the proximate composition and anti-nutritional components. The mushroom was identified as: *Coprinus sp*, *Lycoperdon* sp, *Bovista* sp, *Chlorophyllum rachodes*, *Agaricus compestris*, *Podaxis sp*, *Chlorophyllum brunneum Termitomyces* sp, *Volvariella* sp and *Auricularia* sp. The result of the proximate analyses show that moisture content ranged from 26.67% (the highest) in *Termitomyces* sp to 1.67 % (lowest) in *Lycoperdon* sp. Ash content was highest in *Chlorophyllum brunneum* at 4.50% and lowest in *Lycoperdon* sp at 1.33%. Lipid was found to be highest in *Termitomyces* sp and *Auricularia* sp with 3.83% and lowest in *Podaxis* sp with 1.00%. Fibre content was seen to be highest in *Chlorophyllum rachodes* at 43.17% and lowest in *Termitomyces* sp with 11.18%. *Termitomyces* sp recorded the highest protein content of 27.68% and *Podaxis* sp gave the lowest with 1.00%. The highest amount of carbohydrate was 48.74% in *Podaxis* sp and the lowest was 18.31% in *Bovista* sp. The highest value of energy was found in *Chlorophyllum brunneum* with 320.27% while *Chlorophyllum rachodes* gave the lowest energy value of 133.95%. Nitrate ranged from 8.530 in *Chlorophyllum rachodes* to 25.00 in *Coprinus* sp. The cyanide and other anti-nutritional components were low and within permissible range for human consumption. The species of mushroom identified in the study area are, therefore, good for human consumption.

Keywords: mushroom, collection, identification, nutritional and anti-nutritional analyses

1. Introduction

Mushrooms also refer to macro fungi with unique fruiting bodies; they are normally produced above or below the ground level on the soil and are large enough to be visualized with the naked eye and to be picked by other organisms (Edyawati *et al.*, 2019) [5]. Mushrooms include edible, endomycorrhizae, and ectomycorrhizae that are in symbiosis relationship with the roots of some plants or saprophytic species known to grow on plant tissue and plants wastes etc. (Labarere and Menini, 2000) [17]. Macrofungi are reported in various works of literature to vary in size, color, shape and texture.

In Nigeria, many species of mushrooms are popular and acceptable to the people, 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 (Adejumo *et al.*, 2015) [3].

Mushroom has been reported to be consumed in different parts of the world and this could be because of their medicinal, anti-inflammatory, and nutritional benefits. Studies have indicated that tropical mushrooms are low in fat and oil content and significantly rich in proteins, minerals, vitamins, crude fiber, and carbohydrates. According to reports, mushrooms have a protein level that is twice as high as that of vegetables, four times that of oranges, and significantly higher than that of wheat (Egwin *et al.*, 2011) [6].

Mushrooms are beneficiary to plants, humans and the environment, yet they are less appreciated. However, many developed countries across the globe like Asia, Europe and America valued them for their nutritional and therapeutic application with the report of their nutrient content and medicinal values (Osemwegie, 2014) [23]. They decompose dead organic matter, plants, dead trees and wood, carcasses, termite comb, and leaf litter, and aid in the regeneration of new nutrients and fertile soil. They are nature's natural recyclers, where old becomes new and dead matter is broken down to give birth to something new (Venkatesan and Arun, 2019) [28].

It has also been reported that mushrooms' high vitamin content, particularly their high vitamin C and D content, is what gives them their anti-oxidative effect Although there is limited information on the total dietary fiber (TDF) content of mushrooms, mushrooms do contain significant amounts of crude fibers. According to the estimates of crude fiber content reported by different researchers, mushrooms may be sources

of dietary fiber. (Kumari, 2020) [16]. In general, mushrooms have minimal fat and oil content. Patients with heart issues or those at risk for lipid-induced diseases are advised to consume them as an excellent source of dietary supplement due to their low fat and oil content (Egwin *et al.*, 2011) [6].

Wild mushrooms are considered to be of high nutritional value and of medicinal importance (Gbolagade *et al.*, 2006) [8]. Several species of macrofungi in Kebbi State have been reported especially in the Southern part of the State (Keta *et al.*, 2019) [15]. However, information on the nutritional content of these native mushrooms has not been studied. In view of this, it is necessary to study the nutritional compositions of some of these mushrooms.

2. Materials and Methods

Preparation of powder samples for nutritional and anti-nutritional analysis

The method of Obiloma *et al.* (2019) [19], was adopted in the powder sample preparation. Macro fungi were cleaned from mud and other forms of dirt. They were sun dried while the large size mushroom was initially dried to a constant weight in an oven at 50°C, to reduce the water content. They were ground into powder with a blender, sieved through a 120m aperture, and packaged in an airtight polyethylene bag for further analysis. All chemicals and reagents used were of analytical grade.

Proximate/Nutritional analysis

Empty crucibles were cleaned and placed in oven to dry at a temperature of 80ºC for about 30 minutes and weighed (W_O). Two (2) g of the sample were placed in an already weighed empty crucible and weighed (W1) this was then placed in hot air oven and dried at 105^0C for 24 hours. It was cooled in a desiccator for 20 minutes and weighed (W2). The process of drying, cooling and weighing was repeated until a constant weight was obtained (Zainab *et al.*, 2021) [30]. The weight loss due to moisture was obtained by the equation as follows:

Calculation

$$\% \, moisture = \frac{W1 - W2}{W1 - Wo} \times 100 \qquad 1$$

Where; W_0= Weight of empty crucible. W_1= Weight of crucible + sample before drying and W_2= Weight of crucible + sample after drying.

Determination ash content

In a weighed crucible (W_0), 2.0 grams of the sample was placed in the crucible (W_1) and heated in a moisture extraction oven for 5 hours at 100°C before being moved to a 550°C muffle furnace, where it was turned into white and carbon-free. The sample was then removed from the furnace and immediately cooled to room temperature in a desiccator before being reweighted (W_2) (Zainab *et al.*, 2021) [30].

Calculation

$$\% \, Ash = \frac{W1 - W2}{W1 - Wo} \times 100 \qquad 2$$

Where; W_0= Weight of empty crucible. W_1= Weight of crucible + sample and W_2= Weight of crucible + ash sample.

Determination of lipids (fats)

The crude lipid was determined by Soxhlet extraction method by Udo and Oguwele (1986) [27] and adopted by Gafar *et al.* (2011) [7]. Two (2) g of the sample was weighed (W_O) into a porous thimble covered with a white cotton wool. 200ml petroleum ether was poured into the extraction flask which was previously dried in the oven 105^OC and weighed as (W2). The porous thimble was placed into the Soxhlet extraction chamber and the apparatus was assembled. The extraction process is usually about 5 hours. The thimble was then carefully removed and the extraction flask was placed in the water bath so as to evaporate the petroleum ether and then this was dried in the oven at 105^OC to completely free the solvent from any remaining moisture. The flask containing the extracted sample was then cooled in a desiccator and reweighed (w1). The percentage lipid was calculated as follow:

Calculation

$$\% \, lipid \, (fats) = \frac{W1 - W2}{W0} \times 100 \qquad 3$$

Where; W_O = Weight of the sample W1= weight of the flask + oil and W2= weight of the flask

Determination crude fiber

Two (2g) of the residues from the crude lipid extraction was placed in a conical flask; 200ml of distilled water and 20ml of H_2SO_4 was added and the flask was fixed on a heater and boiled for 30 minutes to maintain a constant volume. The sample was filtered with a filter paper and this was rinsed with warm water, and scraped into the flask, where 20ml of H_2SO_4 and 10% NaOH was added to the contents. After 30 minutes, the content was filtered with filter paper and the sample was then rinsed with petroleum ether. The residue was then be allowed to drain, and this was then scraped into a crucible and placed in an oven for one hour at 105^0C before cooling in a desiccator and being weighed (W1). It was then placed in a muffle furnace to ash for two hours at 550- 600 ^{O}C before cooling in a desiccator and being weighed (W2) (Zainab *et al.*, 2021) [30]. The percentage fiber was then calculated as follows.

Calculation

$$\% \, fibre = \frac{W1 - W2}{W0} \times 100 \qquad 4$$

Where; W_0= Weight of sample taken W_1= Weight of crucible + residue before ashing and W_2= Weight of crucible + residue after ashing.

Determination of crude protein

Digestion

About (2) g of sample was placed in a clean, dry 100ml kjeldahl's flask. One tablet of the mixed catalyst and 20ml concentrated H_2SO_4 was added. A small quantity of distilled water was added to the mixture to digest the organic matter present. The flask was then heated in a fume cupboard until a clear solution is obtained, after which the ammonium sulphate and organic matter was converted to carbon (iv) oxide in the presence of oxygen. The liquid was cooled before being transferred to a volumetric flask.

Distillation

Ten (10) mls of aliquot was placed into kjeldahl's flask, 20ml of 40 % NaOH and 50ml distilled water was added to make up the solution to extract out the amount of ammonia present in the sample, which was evaporated into boric acid indicator. 20ml of boric acid indicator was used as the receiver of the nitrogen extracted. The ammonia was liberated into the boric acid until the volume is made up to 40ml in the conical flask. Color change from green to pink was observed.

Titration

The collected sample with ammonia was then titrated against 0.01N HCl to end point, which gave the actual amount of protein in the sample. The colour change from pink to green, the end point and the titre value was recorded (Tonga *et al.*, 2021; Zainab *et al.*, 2021) [26, 30].

Calculation

$$\% N = \frac{TV \times 0.014 \times VD}{VA \times WS} \times 100 \quad (5)$$

% Crude protein = % N × 6.25

Where; TV= Titer value of the sample, VD= Volume of the digest after dilution N= Normality of HCl, VA= Volume of aliquot taken and WS= Weight of the sample used 0.014= Mili-equivalent weight of nitrogen.

Determination of carbohydrate content

The difference in the sum of % moisture, % ash % crude protein, % crude lipid and % crude fibre subtracted from 100%. The difference in value was taken as the percentage total carbohydrate content of each sample.

Calculation

% carbohydrate = 100 - (% moisture + %crude protein + % crude lipid + % crude fibre + % ash (6)

Energy content

The energy was calculated in (Kcal/100g) using the Atwater method as described by Osborne and Voogt (1978) [22] adopted Agbaire and Emoyan (2012) [4] and Okon *et al.* (2015) [21]. This is done by multiplying the value of the fat or lipid, crude protein and carbohydrate by 9, 4 and 4 respectively i.e [(9 x fat) + (4 x protein) + (4 x carbohydrate)].

Determination of anti-nutritional factors

Anti-nutritional factors are plant secondary metabolites that interfere with the absorption or utilization of nutrients in the body.

Determination of phytate

Phytic acid was determined by soaking 4.0 g of the sample in a 100ml of 2% HCL for 3 hours and the mixture was filtered. This was followed by taking 50ml of the filtrate and placing in 250ml beaker and 107ml of distilled water was added to adjust the acidity of the mixture. A known volume of 5ml of 0.3 percent ammonium thiocyanate sodium (NH4SCN) was added to the sample as an indicator and this was titrated against 0.001M standard iron (iii) FeCl3 chloride solution that contain 1.95mg FeCl3 until a brownish yellow color appeared which lasted for 5 minutes.

Phytin-Phosphorus (1 cm3 Fe= 1.19 mg phytin-phosphorus) was determined and the phytate content was calculated by multiplying the value of phytin-Phosphorus by 3.55 (Hassan *et al.*, 2018; Oibiokpa *et al.*, 2017; Zainab *et al.*, 2021) [9, 20, 30].

Calculation

Phytate content mg = Phytinphosphorous x 3.55 (7)

Phytiphosphorous = Titrevalue x 1.19 (8)

Determination of oxalate

The oxalate content of the sample was determined using the titration method described by Day and Underwood (1986). One gram (1g) of each sample was weighed into a 100ml volumetric flask, which was then filled with 75ml of 3N H2SO4 and stirred for one hour. After that, the mixture was filtered through Whatman No. 1 filter paper. 25 ml of the filtrate was taken and titrated against 0.1N KMnO4 solution for at least 30 seconds until a pink color persisted (Oibiokpa *et al.*, 2017) [20]. The following formula was used to calculate the oxalate content:

Calculation

$$Oxalate \text{ mg/100g} = \frac{T \times Vme\ (DF) \times 105}{Me \times mf} \quad (9)$$

Where; T = titer of $KMnO_4$ (mg/100g) (ml), Vme = volume-mass equivalent in which (1 cm3 of 0.05M KMnO4 solution is equivalent to 0.00225g anhydrous oxalic acid) Df = dilution factor = (Vt/A =75/25 =3) and Vt is the total volume of filtrate (75ml) and A is the aliquot used for titration (25ml) i. e 75 ml divide by 25ml =3 ME = the molar equivalent of $KMNO_4$ in oxalic acid ($KMNO_4$ redox reaction is 50) and Mf = mass of the flour sample used.

Determination of cyanide

About (0.5g) of the sample was measured and placed in a

100ml conical flask with 50ml of distilled water, this was boiled for about 30minutes in a boiling water and filtered using filter paper, the filtrate was used for the test. Three (3) test tubes were carefully arranged in a test tube rake and labeled as test, standard and blank, 1ml of sample (filtrate) was added to the labeled test tube, 1ml of standard KCN was added to the standard test tube and 1ml of distilled water was added to the blank test tube. 4ml of alkaline picrate was added to each of the labeled test tube and the contents were mixed for 5 minutes. This was allowed to cool and the absorbance was measured at 490nm (Karaye *et al.*, 2020) [14].

Calculation

$$Cyanide = \frac{\text{Absorbance of Sample}}{\text{Absorbance of standard}} \text{ x concentation standard} \quad 10$$

Determination of nitrate

Exactly 0.1g of each powder sample was added to a 100ml conical flask, where 10ml distilled water was added, and the flask was brought to a boil for 30 minutes before filtering with filter paper. The samples were mixed and allowed to cool before measuring absorbance at 410nm (Zainab *et al.*, 2021) [30].

Calculation

$$Nitrate\ content = \frac{\text{Absorbance of Sample}}{\text{Absorbance of standard}} \text{ x conc. standard} \quad 11$$

Data analysis

Data collected were subjected to a one-way analysis of variance where significant differences were observed between treatments. The means were separated using the Duncan Multiple Range Test (DMRT).

Results

The results of the various tests conducted during the study are presented. The mushrooms collected were identified as: *Coprinus* sp, *Lycoperdon* sp, *Bovista* sp, *Chlorophyllum rachodes*, *Agaricus compestris*, *Podaxis* sp, *Chlorophyllum brunneum Termitomyces* sp, *Volvariella* sp and *Auricularia* sp

Proximate Composition

The result of the proximate analyses obtained for macrofungi is presented in Table 1. From the results; the moisture content ranged from 26.67±2.89 in *Termitomyces* sp which recorded the highest value, followed by *Auricularia* sp with 22.30±0.30, *Volvariella* sp with18.83±0.76, *Agaricus compestris* with 17.17±13.57, *Podaxis* sp 16.67±7.64, *Chlorophyllum rachodes* with 10.50±12.56, *Chlorophyllum brunneum* with 6.67±2.89, *Coprinus* sp with 2.00±0.50, *Bovista* sp with 1.83±0.76 and lowest was observed with *Lycoperdon* sp which had the lowest moisture content of 1.67 %.

Ash content was highest in *Chlorophyllum brunneum* with 4.50±4.77, followed by *Volvariella* sp with 3.23±0.49, *Podaxis* sp with 3.00±0.50, *Coprinus* sp with 2.83±0.76, *Termitomyces* sp with 2.67±0.56, *Auricularia* sp with 2.60±0.20, *Bovista* sp with 2.33±0.29, *Agaricus compestris* and *Chlorophyllum rachodes* has 1.83±0.58 each while the lowest was in *Lycoperdon* sp with 1.33%.

Lipid was found to be highest in *Termitomyces* sp and *Auricularia* sp with 3.83±0.76, followed by *Chlorophyllum brunneum* and *Volvariella* sp with 3.50±0.10 each, *Coprinus* sp with 3.17±1.04, *Lycoperdon* sp which 3.00±0.50, *Agaricus compestris* with 2.33±0.76, *Bovista* sp with 1.33±0.76, *Podaxis* sp with 1.00% and the lowest was in *Chlorophyllum rachodes* with 0.83±0.29.

Fibre content was seen to be highest in *Chlorophyllum rachodes* at 43.17±0.58, followed by *Lycoperdon* sp with 34.33±5.25, *Auricularia* sp with 27.63±0.31, *Bovista* sp with 26.00±6.50, *Chlorophyllum brunneum* with 22.83±0.76, *Volvariella* sp with 20.27±0.21, *Podaxis* sp and *Coprinus* sp with 20.17±0.76 each, *Agaricus compestris* 16.67±3.62 and lowest in *Termitomyces* sp with 11.18±0.76%.

Table 1: Proximate composition of wild macro fungi from Gwandu emirate Kebbi state (%)

Sample	Moisture	Ash	Lipid	Fiber	Protein	CHO	Energy value
Coprinus sp	2.00±0.50^{dd}	2.83±0.76^{ab}	3.17±1.04^{ab}	20.17±0.76^{de}	15.55±0.13^{e}	38.54±5.24^{ab}	244.85±12.68^{bb}
Lycoperdon sp	1.67±0.29^{dd}	1.33±0.29^{bb}	3.00±0.50^{ab}	34.33±5.25^{b}	18.73±0.09^{d}	29.03±5.78^{bc}	218.04±27.42^{bb}
Bovista sp	1.83±0.76^{dd}	2.33±0.29^{ab}	1.33±0.76^{cd}	26.00±6.50^{cc}	25.87±0.22^{b}	29.05±6.88^{bc}	231.79±23.23^{bb}
C. rochades	10.50±12.56^{cd}	1.83±0.58^{ab}	0.83±0.29^{dd}	43.17±0.58^{a}	13.30±0.18^{h}	18.31±7.79^{cc}	133.95±32.48^{c}
A. compestris	17.17±13.57^{bc}	1.83±0.58^{ab}	2.33±0.76^{cc}	16.67±3.62^{ee}	14.29±0.09^{g}	43.66±5.91^{aa}	254.01±20.53^{bb}
Podaxis sp	16.67±7.64^{bc}	3.00±0.50^{ab}	1.00±0.50^{dd}	20.17±0.76^{de}	10.27±0.10^{i}	48.74±8.08^{aa}	245.05±28.19^{bb}
C. brunneum	6.67±2.89^{cd}	4.50±4.77^{aa}	3.50±1.00^{ab}	22.83±0.76^{cd}	24.07±0.09^{b}	48.13±9.08^{aa}	320.27±43.85^{a}
Termitomyces sp	26.67±2.89^{aa}	2.67±0.56^{ab}	3.83±0.76^{aa}	11.18±0.76^{f}	27.68±0.05^{a}	18.49±5.46^{cc}	249.17±37.93^{bb}
Volvaruella sp	18.83±0.76^{ab}	3.23±0.49^{ab}	3.50±0.10^{ab}	20.27±0.21^{de}	15.27±0.15^{f}	39.30±0.95^{ab}	249.53±2.64^{bb}
Auricularia sp	22.30±0.30^{ab}	2.60±0.20^{ab}	3.83±0.15^{aa}	27.63±0.31^{cc}	14.43±0.12^{g}	30.20±2.72^{bb}	212.63±8.59^{bb}

Values are expressed as means ± SEM (Standard error of means). Means having different superscripted alphabet(s) along columns are significantly different at $P < 0.05$

Termitomyces sp 1 recorded the highest protein content of 27.68±0.05 followed by *Bovista* sp with 25.87±0.22, *Chlorophyllum brunneum* 24.07±0.09, *Lycoperdon* sp with 18.73±0.09, *Coprinus* sp with 15.55±0.13, *Volvariella* sp 15.27±0.15, *Auricularia* sp 14.43±0.12, *Agaricus compestris* with 14.29±0.09, *Chlorophyllum rachodes* with 13.30±0.18 and the lowest was seen in *Podaxis* sp which gave the lowest with 10.27±0.10 %.

The highest calculated Carbohydrate was 48.74±8.08 in *Podaxis* sp followed by *Chlorophyllum brunneum* with

48.13±9.08, *Agaricus compestris* with 43.66±5.91, *Volvariella* sp with 39.30±0.95, *Coprinus* sp with 38.54±5.24, *Auricularia* sp with 30.20±2.72 *Bovista* sp with 29.05±6.88, *Lycoperdon* sp 29.03±5.78, *Termitomyces* sp with 18.49±5.46 and the lowest was 18.31±7.79 in *Chlorophyllum rachodes.*

The highest energy was in *Chlorophyllum brunneum* with 320.27±43.85 followed by *Agaricus compestris* 254.01±20.53, *Volvariella* sp with 249.53±2.64, *Termitomyces* sp with 249.17±37.93, *Podaxis* sp 245.05±28.19, *Coprinus* sp with 244.85±12.68, *Bovista* sp with 231.79±23.23, *Lycoperdon* sp with 218.04±27.42, *Auricularia* sp with 212.63±8.59 and the lowest was *Chlorophyllum rachodes* with 133.95±32.4.

Anti-nutritional analysis

Result for anti-nutritional shown in Table 2 revealed that *Chlorophyllum brunneum* contain the highest amount of nitrate with 25.000±0.85; followed by *Coprinus* sp with 24.410±0.41, *Lycoperdon* sp with 20.477±5.73, *Bovista* sp with 18.103±0.29, *Volvariella* sp with 15.510±2.73, *Podaxis* sp 14.927±0.55, *Agaricus compestris* with 12.863±0.47, *Termitomyces* sp w ith 12.757±3.51, *Auricularia* sp with 12.090±0.87 and *Chlorophyllum rachodes* had the lowest with 8.530±1.03.

In Bovista sp the highest amount of nitrate was 4.3653±0.49 followed by *Volvariella* sp with 3.1487±0.29, *Podaxis* sp with 2.9567±0.73, *Chlorophyllum brunneum* with 2.8120±0.88, *Chlorophyllum rachodes* with 2.6753±1.06, *Agaricus compestris* with 2.5343±0.73.

Table 2: Result of the anti-nutritional parameters of Wildmacro from Gwandu emirate Kebbi state (Mg/100g)

Sample	Nitrate	Phytate	Oxalate	Cyanide
Coprinus sp	24.410±0.41^{ab}	1.9710±0.88^{bc}	0.02483±0.01^{ab}	2.248±0.00^{cc}
Lycoperdon sp	20.477±5.73^{bc}	1.9710±0.65^{bc}	0.03600±0.01^{ab}	1.375±0.29^{dd}
Bovista sp	18.103±0.29^{cd}	4.3653±0.49^{a}	0.04050±0.01^{ab}	3.657±0.52^{b}
C. rachodes	8.530±0.41^{ff}	2.6753±1.06^{bc}	0.02700±0.005^{ab}	1.588±0.05^{cd}
A, compestris	12.863±0.47^{ee}	2.5343±0.73^{bc}	0.03600±0.005^{ab}	2.187±0.21^{cc}
Podaxis sp	14.927±0.55^{de}	2.9567±0.73^{bb}	0.01800±0.01^{bb}	5.543±0.32^{a}
C. brunneum	25.000±0.85^{aa}	2.8120±0.88^{bb}	0.04200±0.01^{ab}	3.179±0.61^{bc}
Termitomyces sp	12.757±3.51^{ee}	2.3933±0.49^{bc}	0.03153±0.005^{ab}	2.886±0.68^{bc}
Volvariella sp	15.510±2.73^{de}	3.1487±0.29^{bb}	0.10970±0.14^{aa}	1.134±0.04^{dd}
Auricularia sp	12.090±0.87^{ee}	1.4017±0.22^{cc}	0.04633±0.01^{ab}	1.348±0.34^{dd}

Values are expressed as means ± SEM (Standard error of means). Means having different superscripted alphabet(s) along columns are significantly different at P < 0.05

Termitomyces sp contain 2.3933±0.49 of nitrate, *Coprinus* sp with 1.9710±0.88, *Lycoperdon* sp with 1.9710±0.65 and the lowest was in *Auricularia* sp with 1.4017±0.22.

Oxalate ranges from *Volvariella* sp with 0.10970±0.14 followed by *Auricularia* sp with 0.04633±0.01, *Chlorophyllum brunneum* with 0.04200±0.01, *Bovista* sp with 0.04050±0.01, *Agaricus compestris* with 0.03600±0.005, *Lycoperdon* sp with 0.03600±0.01, *Termitomyces* sp with 0.03153±0.005, *Chlorophyllum rachodes* at 0.02700±0.005, *Coprinus* sp with 0.02483±0.01and the lowest was recorded for *Podaxis* sp with 0.01800±0.01.

Cyanide was recorded to be highest in *Podaxis* sp with 5.543±0.32 followed by *Bovista* sp with 3.657±0.52, *Chlorophyllum brunneum* with 3.179±0.61, *Termitomyces* sp with 2.886±0.68, *Coprinus* sp with 2.248±0.00, *Agaricus compestris* with 2.187±0.21, *Chlorophyllum rachodes* 1.588±0.05, *Lycoperdon* sp with 1.375±0.29, *Auricularia* sp with 1.348±0.34 and the lowest was in *Volvariella* sp with 1.134±0.04.

3. Discussion

The findings of the proximate study of the ten edible mushroom species revealed that the mushrooms are abundant in proximate contents. The highest moisture content (Dw) was 26.67±2.89 for *Termitomyces* sp and the lowest was 1.67±0.29 for *Lycoperdon* sp. This result agrees with the finding of Adebiyi and Yakubu (2016) [1] and Ijioma Blessing *et al.* (2015) [11] who stated that edible mushrooms are high in nutritional composition. Moisture content in this study, when compared to those reported by Okon *et al.* (2015) [21], was low but high in those reported by Manjunathan and Kaviyarasan (2011) [18]. The high moisture content in the mushroom in this work indicates that fresh mushrooms cannot be kept for a long period of time, as high-water activity encourage microbial activities as suggested by Gbolagade *et al.* (2006) [8].

Protein content ranged from 10.27±0.10 to 27.68±0.05% (dw). Generally, all the macro fungi contain a high amount of protein, but *Termitomyces* sp had the highest amount of protein. This result is comparable with the report of Jonathan *et al.* (2013) [12] who reported high protein in *Termitimyces* species. The authors went furthermore propose that, it was the reason why this specie is the most sorted macro fungi in Yoruba land due to its high protein content.

Macrofungi are highly valued for their good source of carbohydrates, carbohydrates vary from 18.31±7.79 to 48.74±8.08. Carbohydrate content is high when compared with the values reported by Adeduntan (2018), which range from 33.23% to 42.44%, The high carbohydrates content proves that macro fungi are highly nutritive and good for human consumption. This agrees with the work of (Jonathan *et al.*, 2012) [13].

The result shows that fiber content ranged from 11.18±0.76 to 43.17±0.58, fiber content was high when compared with the report of Tonga *et al.* (2021) [26]. The high fiber content in any food when digested helps the digestive system function properly and healthily because fiber aids in the passage of faces

from the body, preventing them from sitting in the bowel for too long, which can lead to diseases such as colon cancer, coronary heart disease, diabetes, obesity and a variety of digestive disorders as reported by Tonga *et al.* (2021) [26].

Generally, all fresh mushrooms do not contain fat (Yehia, 2012) [29]. The fat content ranges from 0.83±0.29 to 3.83±0.76 for *Termitomyces* sp and *Auricularia* sp respectively. These values are considered low when compared with the report of Gbolagade *et al.* (2006) [8]. The purpose of lipid in the body is for the storage of energy for the long term which acts as a substitute when the energy is used up. These macro fungi are low fat and the fat content consist of unsaturated fatty acids which are non-toxic to human as compared to saturated fatty acids in animal (Yehia, 2012) [29].

This study records low ash content in all the macro fungi, which ranges from 1.33±0.29 to 4.50±4.77 for *Lycoperdon* sp and *Chlorophyllum brunneum* respectively. Low ash content is an indication of its digestive ability and high rate of absorption to provide energy that is required for cellular and gastrointestinal functions. Low ash content has also been reported by Shamaki *et al.* (2012) [25].

Energy value is comparable with that reported by Okon *et al.* (2015) [21], an indication that all the macro fungi in this study contain a sufficient amount of energy to sustain the body system when consumed. This also agrees with (Okon *et al.*, 2015) [21].

Anti-nutritional factor has also been recorded in this study. Anti-nutritional factors interfere with the absorption of nutrients in the body. Nitrate ranges from 8.530±0.41 to 25.000±0.85, Phytate ranges from 1.4017±0.22 to 4.3653±0.49, Oxalate ranges from 0.01800±0.01 to 0.04633±0.01 and Cyanide ranges from 1.134±0.04 to 5.543±0.32. Fortunately, when compared to other vegetables in Nigeria and the work of Zainab *et al.* (2021) [30], the levels of anti-nutrients in these samples such as oxalate, phytate, nitrates and cyanide, were found to be low. Phytic acid is a powerful chelator that forms protein and mineral-phytic acid complexes, reducing protein and mineral bioavailability (Oibiokpa *et al.*, 2017) [20]. Phytate has been linked to nutritional problems such as rickets in children and osteomalacia in adults (Sam, 2019) [24]. Oxalate tends to render calcium unavailable by binding to plasma calcium ions to form complexes. The insoluble calcium oxalate complex can form around soft tissues such as the kidney, resulting in kidney stones. This statement also agrees with the report of Igile *et al.* (2013) [10]. Excess cyanide in the body has been shown to inhibit cytochrome oxidase. This might end the ATP synthesis and inorganic phosphate release to body tissues and as a result, the body loses energy which might lead to death. A high HCN level has been linked to cerebral injury and tiredness in men and animals. Cyanide content in these macrofungi was lower than the lethal dose which is between 50 – 60 mg/ kg body weight and therefore can serve as food and may not be detrimental to health (Oibiokpa *et al.*, 2017) [20].

4. Conclusion

The result of nutritional and anti-nutritional analyses of the identified mushrooms collected in Gwandu Emirate of Kebbi State, were shown to contain both nutritional and anti-nutritional components. The nutritional components: Moisture, ash, protein, carbohydrate, fibre, and lipids were high in the mushrooms and are good for human consumption and development. The anti-nutritional components; cyanide, oxalate, nitrate, and phytate, however, were low and their amounts fall within the permissible range for human consumption. The findings from the research, therefore, suggests that the wild macrofungi collected from Gwandu Emirate in Kebbi State, Northwestern Nigeria contain a wild range of nutrients necessary for human growth and development, hence their consumption is therefore, encouraged.

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