Identification and evaluation of proximate and antinutritional profile of some underutilized mushrooms in Yauri Local Government Area, Kebbi State, Nigeria

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Received 8 Sep 2022; Accepted 24 Oct 2022; Published 5 Nov 2022

Abstract

This study was carried out to study the nutritional and antinutritional values of underutilized mushroom in Kebbi State, Nigeria. A total of 5 samples were collected during rainy season from the month of June to October in different locations of Yauri local Government Area. Fresh and fully matured species was uprooted using scalpel or knife. Photographs were taken to aid in further morphological study for the purpose of identification The samples were preserved using formaldehyde, Oven-dry at 60ºc to avoid spoiling or decay. Analysis of Proximate and antinutrient parameters was carried out using AOAC (Association of Official Analytical Chemist) recommended techniques. Five species were identified as *Daldinia concentrica, Tremetes versicolor, Ganoderma applanatum, Ganoderma tsugae and Pleurotus tuberigium le* in this study. Nutritional analysis showed that, *Tremetes versicolor* (7.513±0.015) had highest moisture while *Daldinia concentrica* (4.507±0.021) had lowest. Ash was seen to be high in *Pleurotus tuberigium* (29.013±0.015). *Ganoderma applanatum* (2.513±0.015) had highest lipid while *Daldinia concentrica* (1.000±0.020) had lowest. *Ganoderma tsugae* (40.510±0.010) had highest fiber while *Pleurotus tuberigium* (19.510±0.010) had the lowest. *Ganoderma applanatum* (28.520±0.010) is seen to have the highest Protein while *Ganoderma tsugae (*20.827±0.015) had lowest. *Tremetes versicolor* (31.560±0.053) was seen to have highest carbohydrates *Pleurotus tuberigium* (23.040±0.052) had lowest. Anti-nutrients analysis showed that, *Pleurotus tuberigium* (103.333±0.225) is seen with highest Nitrate while *Tremetes versicolor* (88.333±0.136) had lowest. *Pleurotus tuberigium*. (103.054±0.933) is seen to have highest Tannin while *Ganoderma applanatum* (92.939±0.118) had lowest. *Tremetes versicolor* (116.862±17.249) is seen to have highest Cyanide while *Ganoderma tsugae* (109.568±0.238) had lowest. *Ganoderma applanatum* (5.491±0.845) is seen to have highest Phytate while *Ganoderma tsugae* (3.238±0.244) had lowest. *Ganoderma applanatum* (0.0192±0.0.0258) is seen to have highest Oxalate while *Daldinia concentrica* and *Ganoderma tsugae* (0.0046±0.0007). The level of anti-nutrients in identified mushrooms are high and make them unavailable for consumption in this study and are therefore poisonous for human and animals. Due to the shortage of information related to mushrooms in the study area, further studies should be carryout in order to know the nutritional and antinutritional profile of mushrooms within the study area.

Keywords: mushroom, proximatel and anti-nutritional

Introduction

The term mushroom describes the reproductive structure of fruiting body of a fungus (Berch *et al.,* 2007) [8]. A mushroom is a fruiting body of Macro-fungus that is produced above ground and is large enough to be seen with the naked eye and to be picked up by a bare hand (Kumar, 2015; Wani *et al.,* Royce, 1997) [22]. Mushrooms belong to the kingdom of fungi, a group very distinctive from plants, animals and bacteria (Berch *et al.,* 2007) [8] Generally, mushrooms possess four functionalities, including nutritional values, tasty properties, physiological effects and cultural characteristics (Beluhan and Ranogajec, 2011) [9]. Wild growing mushrooms are known as a delicacy in many countries, due to high proteins and trace minerals content (Kalac 2012; Murugkar and Subbulakshmi, 2005) [19].

There are several evidences in history which shows that mushrooms have been consumed by mankind since a long back in the form of food or medicine. The ancient civilizations of Greek, Romans, Egyptians, Japanese, Chinese and Mexicans prized mushrooms for their medicinal properties and consumed them as dietary supplement or medicinal food (Agrawal and Dhanasekaran, 2019) [1]. According to Greeks, mushrooms are the source of strength for soldiers in battle, whereas Romans believed them as "god's food" and Chinese consider them as a health food or medicine of life (Bashir *et al.,* 2014) [7].

Macro fungi, a term that describes mushrooms morels and puffballs, are very important dietary supplement in many developed and developing countries of the world. In some part of Nigeria today, edible mushrooms are utilized not only for medicinal purposes but they serve as food and vegetable (Keta *et al.,* 2020) [21]. Many species of wild mushrooms are widely consumed as a delicacy in different part of the world. The consumption and other utilization of the wild mushrooms are increasing because of their high nutritional, organoleptic and pharmacological values and remediation uses. Apart from valued aroma, flavour and fragrant smell. Mushrooms are nutritionally desirable due to their low energy value, fibre content and high antioxidant capacity (Kalac, 2009) [20].

The taste, size, fragrant smell and abundance of their fruiting bodies are very important factors to consider when selecting

mushrooms as potential source food (Dı´ez and Alvarez, 2001) [14]. Several factors determine the nutritional and chemical constituents of mushrooms which include species, geographical location, growth substrate, environmental factors, growth stage at harvest and part of the mushroom. Although information on the chemical composition of many edible mushrooms has been expanded dynamically during the last decade, the data can hardly be generalized because of large number of consumed species and great variability in chemical composition within individual even of the same species (Sudheep and Sridhar, 2014) [25].

Mushroom resource exploration and exploitation in Africa faces a great challenge due to lack of infrastructure and technical supports from national and international agencies, insufficient 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) [23]. African nations are not often listed among the largest producers and exporters of edible mushrooms and mushroom products (Chang and Miles, 1991; Flegg, 1992) [11]. The aim of this study was to identify and evaluate the proximate and antinutritional profile of some edible mushrooms in Yauri Local Government Area, Kebbi State, Nigeria.

Materials and methods collection of edible mushrooms

The fully matured mushroom species were collected from different parts of Ngaski Local Government Area, Kebbi State. 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 Plant Science and Biotechnology Laboratory, Kebbi State University of Science and Technology, Aliero 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 was 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) [32]. The colour of the powdery print (spore print) was used for identification. Mushrooms guide and identifier was also used for identification of mushrooms.

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 was viewed progressively under the objective lens. The identification of the species was done according to the above systematical criteria obtained from macroscopic and microscopic examination.

Proximate analysis

Proximate composition of moisture, ash, protein, fat, crude fibre and carbohydrate of Mushroom samples will be determine using the method of Association of Official Analytical Chemist (AOAC, 2016) [5].

Determination of fat (lipids)

This was done by soxhlet extraction method. 250ml clean flask was dried in an Oven at 105-110^0c for about 30 minutes. One gram (1g) of the dried sample were weighed accurately in to a labeled thimble then corresponding labeled cooled boiling flask was weigh. The boiling flask was filled about 100 ml of petroleum ether (Boiling point 40-60^0c). Extraction thimble was plugged lightly with cotton wool while the soxhlet extractor apparatus was assembled and refluxed for about 3 hours. The thimble was removed with care and petroleum ether to be collected on the top container of the set up and set up into flask for re-use. When the flask is free of petroleum ether, it was removed and dry at 105-105^0c for 1 hour. The flask was transferred from the Oven into a desiccator and allow to cooled and then weigh. The weight obtain was used to calculate the percentage of fat (Alabi *et al.,* 2005) [2].

Determination of moisture content

A crucible was thoroughly washed and dry in the oven at 100 °C for 30 minutes and allowed to cool inside desiccator. After cooling, it was weigh and the weight was recorded as (W_1). One gram (1g) of the sample were poured into crucible and weighed, the weight was recorded as (W_2). Then, the sample plus the crucible were placed in an oven at 100°C for 2 hours, cool in a desiccator and weigh for 30 minutes. The process was repeated until a constant weight is obtained as (W_3). The values obtained was used to calculate the percentage of moisture content (Alabi *et al.,* 2005) [2].

Determination of crude fibre

One gram (1g) of the sample was hydrolyzed in a beaker with petroleum ether after which it was reflux for 30 minutes with 200 ml of a solution containing 1.25% H_2SO_4 per 100ml of solution. The solution was filtered through filter paper. After filtration, the sample was washed in the boiled water until the sample is no longer acidic. The residue was then transferred through filter crucible and dried at 100°c for 2hours. The percentage crude fibre was calculated from the weight after drying and the weight of the sample (Christiana and Marcel, 2008) [12].

Determination of ash content

One gram (1g) of the sample was weigh into a previously ignited and weighed crucible. The crucible and content were ignited in a preheated muffle furnace at 650°C for 2 hours. The crucible was cooled in a desiccator to a constant weight, weigh and percentage ash content was calculated (Christiana and Marcel, 2008) [12].

Determination of protein

This was done by Kjeldah method which remains the most popular method of protein determination.

Protein digestion

One gram (1g) of sample was weighed into a Kjeldah flask. 5g of anhydrous sodium sulphate was added. This was followed up with the addition of 1g of copper sulphate and 1 tablet of Kjeldah catalyst. Into the mixture, 25 ml of concentrated sulphuric acid and 5 glass beads were introduced. In the fume cupboard, heating was done gently at first and then increased in heat with occasional shaking till solution assumes a green colour. The black particle showing at the tip and neck of the flask was cooled and wash with the distilled water. Reheating was done gently at first until the green colour disappeared and then allowed to cool. After the cooling, the digest was transferred with several washings into a 250 ml volumetric flask and filled to the mark with distilled water. Distillation was done using distillation apparatus (Alabi *et al.,* 2005) [2].

Determination of carbohydrate

The total carbohydrate content of the sample was obtained from the relation; percentage carbohydrate = 100% - (moisture + ash + fat + crude fibre + protein) % (Christiana and Marcel, 2008) [12].

Anti-nutritional factors

Determination of tannins

This was determined by Folin denis colometric method. One gram (1g) of the sample was placed inside a volumetric flask and 50ml of distilled water was added inside the volumetric flask. The mixture was shaken for 30 minutes at room temperature and was filtered to obtain the extract. A standard tannic acid solution was prepared, 2ml of the standard solution and equal volume of distilled water was dispensed into a separate 50ml volumetric flasks, and this served as a standard and reagent blank respectively. Then 2ml of each of the sample extracts was put in their respective labeled flask. The content of each flask was mixed with 35ml distilled water and 1ml of the Folin Denis reagent was added to each. This was followed by 2.5ml of saturated Na_2CO_3 solution. The contents in the flask was diluted to the 50ml mark with distilled water and incubated for 90 minutes at room temperature. Their absorbance was measured at 760nm in a spectrophotometer with the reagent blank at zero (Nwosu, 2013). The tannin content was calculated as:

$$\% \, Tannin = \frac{100}{W} \times \frac{au}{as} \times \frac{C \times Vt}{Va}$$

Where, W = weight of sample
au = absorbance of test sample
as = absorbance of standard tanning solution
C = Concentration of standard tannin Solution
Vt = Total volume of extract
Va = Volume of extract analyzed

This was carried out by the methods described by A.O.A.C. (1990) [6]. Two (2.0g) of the sample was weighed into a test tube. Ten (10) ml of distilled water was added and extracted with 2ml of 0.2M HCl (aq). About 0.5ml of the extract was pipetted into a test tube fitted with glass stopper. Then, 1ml of the solution was added in the tube and covered with stopper. The tube was heated in a boiling water bath for 30 min and the tube was closed tight with a stopper for the first 15min. Then the test tube containing the solution was cooled in ice water for 15min and allowed to be cooled to room temperature. Then the content of the test tube was mixed very well and centrifuged for 30 min. one (1) ml of the supernatant was transferred into another test tube and about 1.5ml of the solution was added. The absorbance at 420nm against distilled water was measured (Awoyinka *et al*., 2016).

$$\% \text{ Phytate} = \frac{Au}{As} \times \frac{C}{W} \times \frac{100}{VA} \times VF$$

Where; Au = absorbance of test sample
As = Absorbance of standard solution
C = concentration of standard solution
W = Weight of sample used
Vf = Total volume of extract
Va = Volume of extrac

Results

Proximate composition of the identified mushrooms

The proximate composition of the identified sample is presented in Table 1. From the results, it can be seen that *Tremetes versicolor* had the highest moisture content (7.513±0.015), followed by *Ganoderma applanatum* (6.520±0.020), sample 6 (6.517±0.015), *Ganoderma tsugae* (6.513±0.015), *Ganoderma spp* (6.510±0.017), *Pleurotus turberigium* (5.010±0.010), *Agasricus spp* (4.517±0.015) and *Daldinia concentrica* (4.507±0.021) had the lowest. The highest in Ash was seen to be *Pleurotus turberigium* (29.013±0.015) followed by *Daldinia concentrica* (8.960±0.053), *Tremetes versicolor* and *Ganoderma spp* (8.517±0.015), *Ganoderma lucidum* (8.510±0.010), *Agasricus spp* (8.507±0.006), *Ganoderma tsugae* (6.010±0.010) and *Ganoderma applanatum* (4.510±0.010) had the lowest. The highest Lipid was seen in *Ganoderma spp* (2.520±0.017) followed by sample *Ganoderma lucidum* (2.517±0.015), *Ganoderma applanatum* (2.513±0.015), *Tremetes versicolor* (2.510±0.010), *Ganoderma tsugae* (1.510±0.010), *Pleurotus turberigium* (1.017±0.015), *Agasricus spp* (1.007±0.006) and *Daldinia concentrica* (1.000±0.020) had the lowest. The highest Fiber was seen in *Ganoderma tsugae* (40.510±0.010) *Daldinia concentrica* (33.503±0.025), *Ganoderma spp* (30.003±0.006), *Ganoderma lucidum* (27.520±0.020), *Ganoderma applanatum* (27.510±0.010), *Agasricus spp* (25.513±0.012), *Tremetes versicolor* (24.510±0.010) and *Pleurotus turberigium* (19.510±0.010) had the lowest. The highest protein was seen in *Ganoderma applanatum* (28.520±0.010) followed by *Daldinia concentrica*

(27.370±0.208), *Tremetes versicolor* (25.387±0.006), *Ganoderma lucidum* (23.417±0.021), *Ganoderma spp* (23.347±0.021), *Pleurotus turberigium* (22.410±0.010), *Agasricus spp* (21.003±0.006) and *Ganoderma tsugae* (20.827±0.015) had the lowest. The highest Carbohydrate was seen in *Agasricus spp* (39.450±0.044), followed by *Tremetes versicolor* (31.560±0.053), *Ganoderma lucidum* (31.520±0.070), *Ganoderma applanatum* (30.427±0.038), *Ganoderma spp* (29.100±0.026), *Daldinia concentrica* (24.660±0.193), *Ganoderma tsugae* (24.630±0.040) and *Pleurotus turberigium* (23.040±0.052) had the lowest.

Table 1: Proximate composition of the identified mushrooms

Sample	Moisture	Ash	Lipid	Fiber	Protein	Carbohydrates
Daldinia concentrica	4.507±0.021	8.960±0.053	1.000±0.020	33.503±0.025	27.370±0.208	24.660±0.193
Tremetes versicolor	7.513±0.015	8.517±0.015	2.510±0.010	24.510±0.010	25.387±0.006	31.560±0.053
Ganoderma applanatum	6.520±0.020	5.010±0.010	2.513±0.015	27.510±0.010	28.520±0.010	30.427±0.038
Ganoderma tsugae	6.513±0.015	6.010±0.010	1.510±0.010	40.510±0.010	20.827±0.015	24.630±0.040
Pleurotus tuberigium	5.010±0.010	29.013±0.015	1.017±0.015	19.510±0.010	22.410±0.010	23.040±0.052

Antinutritional composition of the identified Mushrooms

The antinutritional composition of identified sample is presented in Table 2. From the results, it can be seen that *Pleurotus turberigium* (103.333±0.225) had highest Nitrate followed by *Daldinia concentrica* (101.339±0268), *Ganoderma tsugae* (93.363±0.136), *Ganoderma applanatum* (89.613±0.272) and *Tremetes versicolor* (88.333±0.136) had the lowest. The highest Tannins was seen in *Pleurotus turberigium* (103.054±0.933^{a}) followed by *Daldinia concentrica* (112.792±0.156^{bc}), *Ganoderma tsugae* (100.407±0.407), *Tremetes versicolor* (98.302±0.117) and *Ganoderma applanatum* (92.939±0.118^{d}) had the lowest. The highest Cyanide was seen in *Tremetes versicolor* (116.862±17.249^{a}) followed by *Ganoderma applanatum* (113.780±0.119^{b}), *Pleurotus turberigium* (112.844±0.119^{bc}) *Daldinia concentrica* (112.792±0.156^{bc}) and *Ganoderma tsugae* (112.792±0.156^{bc}), had the lowest. (112.792±0.156). The highest Phytate was seen in *Ganoderma applanatum* (5.491±0.845) followed by *Daldinia concentrica* (5.069±0.845), *Tremetes versicolor* (5.069±0.423), *Agasricus spp* (5.069±0.424), *Tremetes versicolor* (5.069±0.423), *Pleurotus turberigium* (4.224±0.422) and *Ganoderma tsugae* (3.238±0.244) had the lowest. The highest Oxalate was seen in *Ganoderma applanatum* (0.0192±0.0.0258) followed by *Pleurotus turberigium* (0.0105±0.0012),*Tremetes versicolor* (0.0054±0.0009), *Ganoderma spp* (0.0055±0,0008), *Tremetes versicolor* (0.0054±0.0009), *Ganoderma lucidum* (0.0047±0.0008), *Daldinia concentrica and Ganoderma tsugae* (0.0046±0.0007) had the lowest.

Table 2: Antinutritional composition of the identified Mushrooms

Sample	Nitrate	Tannins	Cyanide	Phytate	Oxalate
Daldinia concentrica	101.339±0268^{b}	102.783±0.311^{a}	112.792±0.156^{bc}	5.069±0.845	0.0046±0.0007
Tremetes versicolor	88.333±0.136^{e}	98.302±0.117^{c}	116.862±17.249^{a}	5.069±0.423	0.0054±0.0009
Ganoderma applanatum	89.613±0.272^{d}	92.939±0.118^{d}	113.780±0.119^{b}	5.491±0.845	0.0192±0.0.0258
Ganoderma tsugae	93.363±0.136^{c}	100.407±0.407^{b}	109.568±0.238^{c}	3.238±0.244	0.0046±0.0007
Pleurotus tuberigium	103.333±0.225^{a}	103.054±0.933^{a}	112.844±0.119^{bc}	4.224±0.422	0.0105±0.0012

Discussion

In this study a total of five (5) mushrooms were identified as *Daldinia concentrica, Tremetes versicolor*, *Ganoderma applanatum*, *Ganoderma tsugae*, and *Pleurotus tuberigium.* The occurrence of some of these species has been reported by several workers, including *T. versicolor* and *P. tuberigium* (Harkonen *et al.,* 1995) [18], *Ganoderma tsugae* (Buyck, 1994) [10], *Daldinia concentrica* and *G. applanatum (*Oei, 2003) [28].

The relatively high carbohydrate contents recorded in *Tremetes versicolor* and *Ganoderma applanatum* 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) [24] on their study on mycoproteins, which shares much of its value with mushrooms, especially in their nutritional composition (Trinci, 1992) [31]. The high moisture content of some of the mushrooms obtained in this work is an indication that fresh mushrooms cannot be kept for a long time, as high-water activity enhances microbial growth (Aletor, 1995) [3]. The fat contents obtained, especially for *P. ostreatus* was higher than those reported by Crisan and Sands (1978) [13], Kalac (2009) [20] and Aletor (1995) [3]. 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) [17] for *Pleurotus tuberigium* and Ola and Oboh (2001) [29] for *Ganoderma tsugae,* 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) [13]. In this study, the high fiber content

obtained for *Ganoderma tsugae* compared favourably with those earlier reported by Obodai (1992) [26].

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) [30]. 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) [27].

Table 2 displays the amount of anti-nutrients present in some selected mushrooms in Yauri Local Government Area, Kebbi State. The Nitrate, Tannin, Cyanide, Phytate and Oxalate contents is seen to be high. Anti-nutrients, are known to have foamy properties and impact bitter taste at high concentration in foods (Duru *et al.,* 2012b) [15]; tannins complex with proteins in foods and make them unavailable for consumption (Amadi *et al.,* 2012; Duru *et al.,* 2012b) [4, 15]; tannic acid is also known to impact astringency in foods (Duru *et al.,* 2012b) [15]; alkaloids are known to impact bitter taste in foods and as well affect the nervous system with disruption or inappropriately augmenting electrochemical transmission in animals (Duru *et al*., 2012a; Fereidon, 2012; Fereidoon, 2014) [16]; Oxalates form insoluble complexes with calcium they hinder the body's ability to absorb nutrients in many different ways and are harmful to both humans and animals (Umar *et al.,* 2013).

Conclusion

It is concluded from the results of this study that some macro-fungi (mushrooms) found in Yauri Local Government Area, Kebbi State, Nigeria have good nutritional profile levels and important source of medicine for the people living in the area. However, the level of anti-nutrients in identified mushrooms are high and make them unavailable for consumption in this study and are therefore poisonous for human and animals.

Recommendation

Due to the shortage of information in related to mushrooms in the study area, further studies should be carryout in order to know the nutritional and antinutritional profile of mushrooms within the study area.

Acknowledgement

My sincere appreciation goes to the Almighty God who guide, protect and spare my life to this time. God bless Mrs Jonathan. I want to thank Abdulrahman Ahamad Na-Maihubbare for his selfless assistance and contributions in the course of the research. I want to also thank Mallam Abdulrahman Musa Tsoho the Laboratory Technician Department of Agriculture Kebbi State University of Science and Technology Aliero Nigeria for the assistance he rendered to me during the analysis of data of this research work.

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