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Proximate and minerals composition of *Agaricus subsaharianus* L.A.Parra, Hama and De Kesel and *Macrocybe lobayensis* (Heim) Peg. and Lodge two wild edible mushrooms used in Niger

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Abstract

Mushrooms are widely consumed because of their nutritional virtues. The objective of this study was to determine the proximate and mineral composition of *Macrocybe lobayensis and Agaricus subsaharianus* two wild edible mushrooms used in Niger. The proximate and mineral composition were determined on dry weight basis using standard method. The results of proximate analysis showed that the moisture content was in the range of 9.08 and 10.03%, that of ash in the range of 10.46 and 08.48%. They are rich in protein (20.66 and 28.09%) and carbohydrates (57.55 and 54.42%), poor in fat (2.45 and 3.28%). In addition, their consumption would provide energy between 267.99 and 342.36 kcal/100g. For the chemical characterization of the ash, the results showed sodium contents ranging from 69.67mg/100g to 72.09mg/100, Calcium 35.67mg/100g to 39.18mg/100g, Iron 6.25mg/100g to 6.43mg/100g, Potassium 330.45mg/100g to 439.67mg/100g, Magnesium 41.83mg/100g to 365.61mg/100g, Copper 2.41mg/100g to 2.70mg/100g, Zinc 3.02mg/100g to 3,05mg/100g and Phosphorus 1298.35mg/100g to 1792.17mg/100g. These nutrients varied widely among the mushrooms species. According to the result *A. subsaharianus and M. lobayensis* can be good sources of protein for the rural populations in Niger who face nutritional diseases.

Keywords: Proximate; Minerals; Edible mushrooms; Niger

1. Introduction

For hundreds of years, mushrooms have been used by humans for their nutritional and medicinal properties. [1,2,3]. Edible mushrooms are considered among the indispensable elements of diets due to their rich nutritional contents, as well as being delicious enough to be consumed by many people [4]. Moreover, Asians (Chinese, Thai, Vietnamese and Japanese) recognize the importance of mushrooms to enhance vital energy, to increase intellectual capacity and to promote longevity [5]. In fact, they are appreciated not only for texture and flavor but also for their chemical and nutritional characteristics [6,7]. They are rich in protein (19 to 35%) and reportedly contain twice the protein content of onions (1.4%), cabbage (1.4%), potatoes (1.6%) and four to six times that of oranges (1.0%) and apples (0.3%) [8,9]. They actively participate in the vitamin needs of the body, especially in vitamin group B: thiamine (B1), riboflavin (B2), niacin (B3) and pantothenic acid (B5). Mushrooms are also the only non-animal food source that contains vitamin D and hence they are the only natural vitamin D ingredients for vegetarians [10]. These vitamins are beneficial for the skin, muscles, metabolism and the functioning of the immune, digestive and nervous systems. Mushrooms also contain essential minerals, particularly selenium, iron, copper, calcium, zinc and potassium, which play an important role in immune function and in the reproduction of antioxidants to reduce free radicals [11]. In Africa, mushrooms are of great interest because of their diversity and their use by rural populations. About 300 species of food importance fungi have

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been reported in Africa south of Sahara, including about 60 species for the West African region [12,13]. Indeed, these mushrooms species are used by populations as a palliative source of food during lean periods when several thousand people are victims of hunger, malnutrition and nutritional diseases. In Niger, the work of Hama et *al*. [14,15] identified two edible mushrooms, *A. subsaharianus* and *M. lobayensis* are consumed by the Gourmantchés and Mossis living on the banks of the Niger River. Nevertheless, the mushroom species have not been studied in depth to evaluate their nutritional potential.

The objective of this study was to determine the proximate and mineral composition of *M. lobayensis and A. subsaharianus* two wild edible mushrooms used in Niger.

2. Material and methods

2.1. Fungal Materials

The specimens (photo 1 and photo 2) were collected during the rainy season, from July to September 2018 at Torodi, a city located about 55 km from the capital Niamey. The identification of the specimens was carried out at the Mycology Laboratory of the Ecole Normale Supérieur de Niamey on the basis of macroscopic characters but also with the help of books and articles dealing with the taxonomy of fungi of tropical Africa. After identification, the specimens were photographed and dried at 45-50°C for 24 hours and packed in 'Minigrip' type plastic bags for further analysis [16,17].

Figure 1 *Agaricus subsaharianus* L.A.Parra, Hama and De Kesel

Figure 2 *Macrocybe lobayensis* (Heim) Peg. and Lodge

2.2. Proximate composition

The chemical composition of moisture, protein, ash, lipid and carbohydrate in the samples was analyzed using the standard AOAC method. Protein contents were determined according to the KJEDHAL method [18], ash contents were obtained by dry mineralization of the samples at 550°C for about 6 hours [19]. The moisture content was evaluated on the samples by oven drying at 103°C for 12 hours [20]. Fat was extracted with soxhlet by hexane percolation for 6 hours

[21]. Total carbohydrates were estimated by the difference: 100 − (% moisture + % crude protein + % crude fat + % ash content) . The energy value was calculated according to the following equation: Energy (kcal) = ((%) protein x 4) + (% carbohydrate x 4) + (% fat x 9) [22].

2.3. Mineral analyzes

Approximately 1g of finely ground dry matter from two samples was placed in silica crucibles and then incinerated in an oven at 600°C for 2 hours. The resulting ash was reworked with 1ml of distilled water and 3ml of 50% hydrochloric acid. This step is followed by the evaporation of these solvents on a hot plate at 40°C until complete drying. The residue is again taken up in 3 ml of hydrochloric acid 50% and a little distilled water, then filtered on filter paper in a flask of 100 ml, at the end the flask is supplemented to 100 ml with distilled water. These extracts will be used as stock solutions for the determination of mineral elements. The contents of Ca, Cu, Fe, Mg and Zn are determined by atomic absorption spectrophotometer, Na and K by emission spectrophotometer [23,24].

3. Results and discussion

3.1. Proximate composition

The result of chemical analysis of *A. subsaharianus* and *M. lobayensis* are presented in Table 1. The analysis of this result shows a moisture content between 09.08 and 10.03% of dry weight, that of ash varies between 10.46 and 08.48%. They are rich in protein (20.66-28.09%) and carbohydrates (50.02-57.55%), poor in lipid (0.95-1.28%). In addition, their consumption provides energy between 334.49and 342.36 kcal/100g.

Table 1 Proximate composition of *Agaricus subsaharianus* and *Macrocybe lobeyensis*

Mushrooms	Moisture (%)	Ashes (%)	Lipid (%)	Proteins (%)	Carbohydrate	Energy (kcal/100g)
Agaricus subsaharianus	09.08±0,21	10.46±0.30	2.45±0.18	28.09±1.94	50.02±2.63	334.49±19.38
Macrocybe lobayensis	10.03±0.33	08.48±0.32	3.28±0.15	20.66±1.24	57.55±2.04	342.36±14.47

The results of the proximate analysis of the two wild edible mushrooms revealed that the crude protein content varied from 18.71 to 28.09 %. The highest protein content was found for *A. subsaharianus* (28.09 %) and the lowest protein content was found in *M. lobayensis* (20.66%). Most mushrooms obtained from literature had their protein content ranging from 19 to 39 % on dry matter basis [25,26]. It has been reported that the protein contents of mushrooms are affected by a number of factors, namely the type of mushrooms, genetic structure, physical and chemical characteristics and environmental [27]. It has been demonstrated that increasing consumption of mushroom is good for preventing malnutrition, although mushrooms can be an alternative protein source instead of meat [28].

A. subsaharianus showed the lowest moisture content in this study (09.08 and 10.03%). Low moisture suggests that the mushrooms will be less susceptible to microbial contamination moisture, because the high water content favors the growth of microbes [29].

The highest fat content is recorded in *M. lobayensis* (3.28%g) and lowest content in *A. subsaharianus* (2.45g/100). The value in fat observed in this study compares favourably with values reported in *Volvariella volvacea* (2.27 %), *Psathyrella tuberculata* (1.78 %), *Agaricus bisporus* (2.21%) [30]. The low fat content improves blood cholesterol levels, decrease the risk of cardiovascular disease and promote weight loss [31].

For ash, the contents ranged from 08.48% (*M. lobayensis*) to 10.46% (*A. subsaharinus)*. The knowledge of the ash content is an indication of the mineral composition of the mushrooms that can be considered as potential mineral element sources [32]. The total carbohydrates contents range from 50.02 and 57.55% *M. lobayenis* showed the highest total carbohydrate contents (57.55%) and the lowest carbohydrates content was in obtained in *A. subsaharianus* (50.02%). This result could be compared with the carbohydrate content of edible mushrooms [33]. Carbohydrates are the most abundant constituents of mushrooms, which include sugars (monosaccharides,their derivatives and oligosaccharides) as well as both reserved and construction polysaccharides [34]. Mushooms contain digestible carbohydrates (such as glucose, glycogen, mannitol, and trehalose) as well as non-digestible carbohydrate (such as β-

glucan, chitin and mannans). Both of these carbohydrates forms constitute the total carbohy drates in mushroom fruiting bodies [35]. With high protein and carbohydrate contents, consumption of these mushrooms would provide energy between 267.99 and 342.36 kcal/100g. Other studies from literature reported that the high energy values of edible mushrooms ranging from 250 to 400 kcal/100g [36].

At the food and nutritional level, these mushrooms species can be good sources of protein for the Nigerien populations who face nutritional diseases.

3.2. Mineral composition

In this study, five mineral elements (P, K, Na, Mg and Ca) and three trace elements were determined. The results of the chemical characterization of the ashes are reported in Table 2. The analysis of these results show that sodium contents of vary from 69,67mg/100 to 72,09mg/100, Calcium 35,67mg/100 to 39,18 mg /100g, Iron 6,25 mg/100 to 6,43 mg/100g, Zinc 3.02mg/100g to 3.05mg/100g Potassium 330,45mg/100 to 365,67 mg/100g, Magnesium 41,83 mg/100 to 365,61 mg/100g, Copper 2,62 mg/100 to 2,70 mg/100 and Phosphorus 1298,35 mg/100g to 1788,48 mg/100g.

Table 2 Mineral composition of *Agaricus subsaharianus* and *Macrocybe lobeyensis*

Mineral Element	**Values (mg/100g)**	
	Agaricus subsaharianus	*Macrocybe lobayensis*
Sodium	69.67±5.69	72.09±2.45
Calcium	39.18±2.64	35.67±3.51
Potassium	330.45±10.26	439.67±12.70
Magnesium	365.61±14.36	41.83±2.74
Copper	2.70±0.27	2.62±0.09
Zinc	3.02±0.13	3.05±0.14
Iron	6.43±0.81	6.25±0.65
Phosphorus	1792.17±46.06	1298.35±24.70

Minerals are essential for the growth, development, maintenance and repair of the body [37]. According serval studies, zinc is one of the most important mineral of our body needs. It is essential for many biological functions in the human body. Vital for more than 300 of the enzymes, activating cell growth and division, stimulates the immune system, increases fertility and vision, stimulates taste and smell and improves appetite [38,39]. Zinc contents reported in this study varied from 1.85mg/100g to 3.05mg/100g. *M. lobayensis* (3.05mg/100g) and *A. subsahaianus* (3.02mg/100g) recorded similar values. These zinc contents are comparable to those in red meat (5.2 mg/100g), nuts (3mg/100g), onion (2.52mg/100g), poultry (1.5 mg/100g), eggs (1.3 mg/100g), dairy products (1,2 mg/100g), cereals (1 mg/100g), fish (0.8 mg/100g), sugars and preserves (0.6 mg/100g), canned and green vegetables (0.4 mg/100g), [40,41]. The reported literature range of zinc contents in mushrooms is between 2.98 and 15.8mg [42]. In Niger, zinc deficiency is also a public health problem [43]. Iron is an essential nutrient in the composition of red blood cells. It is found in erythrocytes in the form of hemoglobin whose main function is to transport oxygen from the lungs to the tissues [44]. The lowest and the highest level of iron present in the studied mushrooms were 6.25 mg/100g and 6.43 mg/100. *A. subsaharinus* (6.45mg/100g) and *M. lobayensis* (6.25mg/100g) recorded similar values. Nevertheless, the range of reported literature values varies between 1.46mg/100g-83.5mg/100g. [45]. The iron contents of these mushrooms are high when compared with those of green vegetables [46]. Sodium and Potassium are important in the maintenance of osmotic balance between cells and the interstitial fluid in animal systems. Potassium content (439.67 mg/100g and 365.67 mg/100g) in this study is higher amount than sodium (69.67mg/100 to72.09 mg/100). This suggests that these mushrooms would be excellent in lowering blood pressure, reducing the risk of osteoporosis and in maintaining bone health [47]. In addition, Potassium helps to maintain normal heart rhythm, fluid balance, muscle, and nerve function [48]. Copper is a trance element that is essential to cellular life and to the fixation of bones and iron. It also maintains the integrity of the myelin sheath of nerve fibers and consequently skin pigmentation [33]. Copper content in study varied from 2.62mg/100 to 2.70 mg/100. Copper deficiency causes general fatigue, bone and skin disorders and hair loss. Copper levels in mushrooms reported in literature are 0.47–5.1 mg/100g [49]. The recommended daily intake of copper is 2mg/day. However, this is adequate for all age groups except for pregnant and lactating mothers who require

1mg/100g of copper [50]. Magnesium level in this study, varied from 41.83 mg/100g to 365.61 mg/100g. Magnesium is a cofactor in more than 300 enzymatic reactions. It is also an essential component of bone, cartilage and the crustacean exoskeleton [51]. The reported literature ranges magnesium contents in mushrooms from 60mg/100g to 250mg/100g [52]. Phosphorous is an important component of phospholipids, nucleic acids and many key enzymes which play important role in energy and cell metabolism. It is also required for bones and teeth. Phosphorous is the most abundant nutrient reported in this study [53]. The level of Phosphorous in this study varied from 1298.35 mg/100g to 1792.17mg/100g. The calcium content of the mushrooms in this study varied from 35.67mg /100g to 39.18 mg /100g. Calcium is necessary for sustaining strong bones, muscular contraction and relaxation, blood clotting and absorption of vitamins B12[54]. Generally, variations in the mineral proportions of mushrooms vary according to the species, age, diameter of fruiting bodies and the type of substratum [55,56].

4. Conclusion

Proximate and mineral composition of *A. subsaharianus* and *M. lobayensis*, two edible mushrooms species in Niger, were determined. The results showed that both species are energetic foods, rich in proteins and carbohydrates, and low in lipids. They are also rich in mineral elements. These mushroom species can be good sources of protein for rural populations in Niger who are facing nutritional diseases.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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