Proximate Composition, Mineral Element Profile and Antioxidant Properties of the Edible Kenyan Mushroom, *Auricularia polytricha*

Samuel Nduva Mutuku, Ezekiel Kipkorir Lang’at, Eric Kihagendi Osoro*, Palmer Sivoko Imbenzi, Josiah Ouma Omolo

DO: 10.31254/jsir.2022.11302

Abstract

The indigenous Kenyan *Auricularia polytricha* is a known delicacy to the communities residing around Kakamega forest in Western Kenya. The objective of the present study was to carry out proximate analysis, determine selected mineral element levels and radical scavenging capacity of the fruiting bodies of *Auricularia polytricha*. Proximate analysis which included determination of total carbohydrates, crude protein, crude fibre, crude fat, ash and moisture contents was done according to the Association of Official Analytical Chemists (AOAC) methods. The minerals (Ca, Mg, Fe, Zn, Mn, Pd, Cd) in the dried mushroom sample were determined using an Atomic Absorption Spectrophotometer (AAS) while Na and K were determined by flame emission photometry. Phosphorus was estimated by spectrophotometric method. The antioxidant activity of the crude mushroom extracts was evaluated by measuring their scavenging capacity on the stable radical, DPPH (2,2'-Diphenyl-1-Perclyhydrazyl) using UV-Vi’s spectrophotometer at 517 nm. The mushroom was found to contain 64.53% total carbohydrates, 43.12% crude fibre, 11.67% crude proteins, 4.75% crude fat and 4.69% ash content on dry matter basis. The moisture content of the mushroom was found to be 80.33% of the fresh weight, which is typical of fresh foods and vegetables. A methanol extract of the mushroom exhibited antiradical activity against DPPH in a dose dependent manner with the highest radical scavenging capacity (40.84%) obtained at a concentration 500 µg/mL. For the mineral profile, the variations and concentrations of the essential and trace elements under study decreased in the order K>Na>Mg>Ca>Fe>P>Zn>Mn. The selected hazardous heavy metals Cd and Pb were not detected in the mushroom sample. Implications of the mineral concentrations on the nutritional value of the mushroom have been highlighted. In conclusion, the obtained results suggest that the mushroom, which has good amounts of the required proximate components, minerals and antiradical constituents, is a potentially healthy, safe and functional food.

Keywords: *Auricularia polytricha*, Mushrooms, Proximate, Anti-oxidant, Mineral Element.

INTRODUCTION

*Auricularia polytricha* is one of the edible mushrooms that belongs to the order Auriculariales, in the Auriculariaceae family. Auricularia spp are commonly referred to as the wood ear fungus, due to their morphological similarities with human ear [1]. *Auricularia polytricha* is widely distributed in tropical and temperate regions where it grows as a saprophyte on wood logs. It can also be easily cultivated in an effort to boost its production for medicinal and nutritional application [2]. The mushroom is reported to be highly valued in most countries for their numerous nutritional and medicinal properties stemming from them having low calorie content, richness in dietary fiber, proteins, minerals and biologically active polysaccharides [3]. Previous research has also reported the mushroom’s potential for application in anticancer, anti-diabetic, anti-oxidant and lowering cholesterol therapy [4-8].

*Auricularia polytricha*, along with some species of the same family have been reported in Kakamega forest of western Kenya. These species, famously known to the local communities as “matere”, are a known delicacy to these communities residing around Kakamega forest [9]. Many other Kenyan communities do not, however, consume these mushrooms for several reasons including, lack of information about them, non-availability and/or probably due to their rubbery-gelatinous nature with no distinctive taste. These limitations do not change the fact that Auricularia mushrooms are full of health benefits [10].
The chemical composition of these species is also likely to vary with different ecological systems [11], and thus, determining the nutritional composition of the indigenous Kenyan *Auricularia polytrichoides* would provide the most accurate information on its constitution. The objective of this study was to carry out proximate analysis, determine the mineral element levels and radical scavenging capacity of the edible Kenyan mushroom, *Auricularia polytrichoides*.

**MATERIALS AND METHODS**

**Sample Collection and preparation**

The fresh fruiting bodies of *Auricularia polytrichoides* were collected from Iscehno forest reserve of Kakamega forest. Kakamega forest reserves are located between longitudes of 34032°E and 34057°E and latitudes of 0007°30′N, 0010°15′S.

The collected mushroom sample (except the one set aside for moisture content analysis) was washed thoroughly under running tap water to remove soil and other particles. The sample was then air dried under shade and ground into powder.

**Proximate Analysis**

The collected mushroom sample was subjected to proximate analysis according to the Association of Official Analytical Chemists methods [12]. The analysis included determination of crude protein (Kjeldahl method), crude fat (Soxhlet method), ash (dry ashing method), crude fiber (Weende method), total carbohydrates (phenol-sulfuric method) and moisture content (thermogravimetric analysis). Except for the moisture content, all the other calculations were carried out on the dry weight basis of the mushrooms. The moisture content was determined on the fresh mushroom sample.

The energy value of the mushroom was determined by the Atwater method which involves multiplying grams of protein, fats and carbohydrates by the factors, 4-9-4, respectively [13].

**Mineral element Analysis**

The mineral (Ca, Mg, Fe, Zn, Mn, Pd, Cd) in the dried mushroom sample were determined using an Atomic Absorption Spectrophotometer (AAS) [14]. The samples which were digested in a HNO₃/HCl acid mixture were passed through the AAS system using different lamps, and calibrated with related standards in different concentrations for different minerals under study. Phosphorus content of the dried mushroom samples was determined using molybdovanadate method [15]. Na and K were determined by flame emission photometry [16].

**DPPH Radical Scavenging Activity**

The DPPH assay was estimated according to the procedure reported by Imbenzi and co-workers (2014), with slight modification [17]. The scavenging activity was calculated using the formula:

\[
\text{Scavenging rate (\%) = } \frac{A_{\text{sample}} - A_{\text{blank}}}{A_{\text{blank}}} \times 100
\]

where \(A_{\text{sample}}\) is the absorbance at 517 nm, obtained for a DPPH solution prepared in methanol while \(A_{\text{blank}}\) is the absorbance of the test sample obtained at the same wavelength. The results were expressed as the IC₅₀ value. The IC₅₀ value was defined as an effective concentration of the extract that could scavenge 50% of the free radicals. All the determinations were performed in triplicates and averaged. The percentage scavenging activity of each of the sample dilutions was compared and ranked with reference to percentage scavenging rate of the standard (vitamin C) [18].

**Statistical Analysis**

All experiments were done in triplicates, and reported as mean values. The results were expressed as mean ± SE (standard error).

**RESULTS AND DISCUSSION**

**Proximate Composition**

The present study was carried out to evaluate the nutritional value, by determining the proximate composition, radical scavenging capacity and mineral levels composition of the indigenous Kenyan mushroom, *Auricularia polytrichoides*. The results of the proximate composition and calorific value of the studied sample are given in Table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sample A</th>
<th>Sample B</th>
<th>Sample C</th>
<th>Mean ±SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>79.43</td>
<td>80.30</td>
<td>81.40</td>
<td>80.33±0.61</td>
</tr>
<tr>
<td>Total Carbohydrates (%)</td>
<td>63.70</td>
<td>64.5</td>
<td>65.40</td>
<td>64.53±0.49</td>
</tr>
<tr>
<td>Crude Proteins (%)</td>
<td>10.85</td>
<td>11.38</td>
<td>12.78</td>
<td>11.67±0.58</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>5.00</td>
<td>4.50</td>
<td>4.75</td>
<td>4.75±0.14</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>4.29</td>
<td>4.58</td>
<td>5.22</td>
<td>4.69±0.28</td>
</tr>
<tr>
<td>Crude Fiber (%)</td>
<td>43.34</td>
<td>42.92</td>
<td>43.11</td>
<td>43.12±0.12</td>
</tr>
<tr>
<td>Energy value (Kcal/100g)</td>
<td>343.2</td>
<td>344.02</td>
<td>355.47</td>
<td>347.56±3.96</td>
</tr>
</tbody>
</table>

The moisture content of the mushroom was found to be 80.33% of the fresh weight which is typical of fresh foods and vegetables. This value is in agreement with the values reported in literature [19-21]. The high levels moisture content show that *Auricularia polytrichoides* is highly perishable and would therefore require proper preservation upon harvesting. Generally, high levels of moisture content make the mushroom susceptible to microbial growth and enzyme activity [22].

The total carbohydrates, crude proteins, crude fat and ash values obtained for *Auricularia polytrichoides* are also in agreement with values reported in literature [14-21]. The mushroom contains 64.53% total carbohydrates, 43.12% crude fiber, 11.67% crude proteins, 4.75% crude fat and 4.69% ash content. Carbohydrates, proteins and fats are macronutrients required by the body for growth, provision of energy and maintenance of other body functions. Proteins are needed for growth and body building while carbohydrates and fats mainly provide the energy needed to maintain body functions [23]. Consumption of excessive amounts of fats in a diet has, however, been acknowledged as a very important dietary factor aiding increased levels of cholesterol in the body [24]. *Auricularia polytrichoides* notably contains low fat of 4.75%, a diet which may be beneficial in helping maintain weight loss and lower the risk of coronary heart diseases and some forms of cancer.

The mushroom also contains high levels of crude fiber, ideal for improved digestive health, regular bowel movements and regulation of cholesterol and blood sugar levels. These roles played by the fiber-rich mushroom are likely to lower risk of metabolic disorders such as diabetes, cardiovascular diseases and bowel cancer [25]. The present study also recorded low levels of ash content (4.69%). Ash content provides insights into the amounts of the nutritionally important inorganic minerals present in the mushroom [26]. *Auricularia polytrichoides* mushroom can therefore be said to be nutritionally sound, rich in carbohydrates and fibers with low levels of fat, medium source of protein and calories.

**Mineral element Composition**

The mineral composition of the mushroom reflects on its growth conditions. Mineral elements are a very important component of the nutritional value, which the human body requires in small quantities to be able to perform different functions. The results of the mineral element contents, the macro and microelements, of the mushroom sample are given in Table 2. The concentrations of the reported elements were determined on a dry weight basis.
A high potassium diet has been suggested to possess potential health benefits, and immune modulatory activity against DPPH even though it suppresses the toxicity limit of 400-1000 mg/kg set by WHO [34]. Magnesium which plays a pivotal role in energy production and nucleic acid synthesis, among other functions [35], recorded dry weight concentration of 1.26 × 104 mg/kg.

Iron performs numerous roles in the human body including biosynthesis of hemoglobin for oxygen transport, enzymatic processes, and immune response among other functions [36]. In the present study, the indigenous Kenyan Auricularia polytricha recorded 1933 mg/kg of iron, a value which by far exceeds the set limit of 15 mg/kg by WHO [34]. Previous studies estimate that up to 90% of the iron present in Auricularia polytricha is bioavailable and can be absorbed since mushrooms do not contain phytates, which reduce the body’s ability to absorb iron [37]. The mushroom is therefore a better source of iron than some vegetable sources which contain phytates.

Zinc is an important microelement for human metabolism which catalyzes a variety of different enzymes, aids protein folding and regulates gene expression [38]. In the present study, the concentration of zinc determined in the mushroom sample was 430 mg/kg, a value which is also higher than the permissible limit of 60 mg/kg set by WHO [34]. The hazardous heavy metals, cadmium and lead were not detected in the mushroom sample.

DPPH Radical Scavenging Activity

The methanol (MeOH) extract of Auricularia polytricha showed DPPH radical scavenging capacity in a dose-dependent manner with an IC50 of 548 µg/mL (Table 3).

Table 3: DPPH radical scavenging activity of Auricularia polytricha (MeOH extract) compared to that of the reference standard

<table>
<thead>
<tr>
<th>Concentration (µg/mL)</th>
<th>% Scavenging Activity</th>
<th>Vitamin C (reference standard)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MeOH extract (A. polytricha)</td>
<td>Means±SEM</td>
</tr>
<tr>
<td>500</td>
<td>40.84±0.78</td>
<td>97.95±0.09</td>
</tr>
<tr>
<td>250</td>
<td>32.09±1.56</td>
<td>97.36±0.09</td>
</tr>
<tr>
<td>125</td>
<td>23.19±1.61</td>
<td>97.05±0.09</td>
</tr>
<tr>
<td>62.5</td>
<td>13.72±1.44</td>
<td>92.4±0.22</td>
</tr>
<tr>
<td>31.25</td>
<td>7.66±0.37</td>
<td>89.65±0.60</td>
</tr>
<tr>
<td>15.625</td>
<td>3.00±0.19</td>
<td>87.47±0.60</td>
</tr>
<tr>
<td>7.813</td>
<td>1.66±0.23</td>
<td>84.94±0.41</td>
</tr>
<tr>
<td>3.906</td>
<td>0.83±0.23</td>
<td>82.71±0.42</td>
</tr>
<tr>
<td>IC50 (µg/mL)</td>
<td>548.32</td>
<td>0.30</td>
</tr>
</tbody>
</table>

The highest antiradical activity of the extract (40.84%) against DPPH noted for the extracts was obtained at a concentration of 500 µg/mL, while the lowest antiradical activity (0.83%) against DPPH was obtained at a concentration of 3.906 µg/mL (Table 3). The mushroom sample extract exhibited significant antiradical activity against DPPH even the though the values were lower than those posted by the standard (Figure 1 and Table 3). Antiradical scavenging activity is an indicator that the mushrooms could be a good source of antioxidants, compounds which are appreciated for their ability to slow down ageing and fight oxidative stress [39].
CONCLUSION
In the present study, the indigenous Kenyan *Auricularia polytrichra* mushrooms contain high carbohydrate and crude fiber contents, intermediate protein and calorific values and low-fat content. The high crude fiber and low fat contents make the mushroom beneficial in helping maintain weight loss, lower the risk of cardiovascular diseases, diabetes and bowel cancer. The mushroom also contained good number of mineral elements required in the human diet. The mushroom also exhibited antiradical activity against DPPH in a dose dependent manner with its methanol extract recording highest radical scavenging capacity (40.84%) at a concentration 500µg/mL. The essential minerals, Na, K, Ca, Mg and P were present in good amounts as there were trace elements such as Fe, Zn and Mn. Fe and Zn, were however found to be higher than the permissible limits of 15mg/kg and 60mg/kg set by WHO. The toxic elements, Cd and Pb were not detected and the mushroom can therefore be said to be safe for human consumption. In conclusion, the obtained results suggest that the mushroom, which has good amounts of the required proximate components, minerals and antiradical constituents, is a potentially healthy, safe and functional food.

Conflict of Interest
The authors of this study declare no conflict of interest.

Financial Support
This research was funded (Ref: NACOSTI/RCD/ST & I/7th CALL/PhD/141) by National Research Fund (NRF), Kenya.

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