

**EVALUATION OF THE NUTRITIONAL COMPOSITION OF  
WILD EDIBLE MUSHROOM *AGARICUS LANIPES*  
(F.H. MØLLER & JUL. SCHÄFF.) HLAVÁČEK**

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*Key words:* Evaluation, Nutritional composition, Wild edible mushroom

**Abstract**

The present investigation was undertaken to evaluate the nutritional composition of the wild edible mushroom *Agaricus lanipes*. Results of the study showed that, based on dry weight, the moisture content of the samples of mature fruiting bodies of *A. lanipes* was 4.49%, while the contents of other components were, in order: total carbohydrate (52.32 g/100 g) > crude protein (30.14 g/100 g) > crude fibre (9.17 g/100 g) > ash (8.14 g/100 g) > crude fat (4.90 g/100 g). The metabolizable energy content of *A. lanipes* was also calculated and it was found as 374.18 kcal/100 g and 1583.29 kJ/100 g. The major elements found in the mushroom samples were K, P, Mg, Ca, and Na (20280.8, 6468.9, 927.5, 270.2 and 238.8 mg/kg, respectively), and trace elements were Fe, Zn, Cu, Mn, and Se (130.05, 68.21, 26.90, 38.13 and 5.11 mg/kg, respectively). This study suggests that *A. lanipes* may be used as healthy food with protein supplementing properties. To our knowledge, this is the first report on the nutritional composition of *A. lanipes*.

**Introduction**

The excellent taste of edible wild mushrooms and their texture profiles (Hiraide *et al.* 2010), nutritional characteristics (Barros *et al.* 2007), potential health benefits (Lee *et al.* 2009, Wasser 2010), economic value (Wang and Marcone 2011) and organoleptic characteristics (Maga 1981) mean that they are becoming increasingly popular in the developing world in both fresh and dried forms. Turkey is as rich in fungal biodiversity as it is in plant species, and for this reason many people go out to pick wild mushrooms when available. Therefore, it is important the levels of elements and basic compounds in the wild fungi which are gathered.

It is known that edible wild mushrooms are low in dry matter and fat but rich in water, protein, carbohydrate, chitin, fiber, and some vitamins (B1, B2, B12, C, D and E) and minerals (K, P, Fe, Zn, Se and Na) (Ouzouni *et al.* 2009, Reis *et al.* 2012, Wang *et al.* 2014). Also, edible fungi contain unsaturated fatty acids, tocopherols, ascorbic acid, carotenoids, polyketides, terpenes, steroids and such basic phenolic compounds as quercetin, catechin, *p*-coumaric acids, caffeic acid and gallic acid (Tsai *et al.* 2007, Reis *et al.* 2012, Wang *et al.* 2014). Polysaccharides, high molecular weight polysaccharides, low molecular weight protein bound polysaccharides, glycoproteins (lectins), triterpenoids, and immunomodulatory proteins have been isolated from certain edible fungi (Ikekawa 2001, Chang and Miles 2004).

The aim of the present study was to evaluate the nutritional composition of the wild edible mushroom *A. lanipes*.

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## Materials and Methods

Fruit bodies of *Agaricus lanipes* samples were collected in the forest around Gireniz Valley, located in the western part of Denizli province, Turkey in the course of field work in 2010 and 2013. Table 1 shows the species, family, habitat, edibility and gathering season of the mushrooms examined in the study. Identification and classification of macrofungi were carried out at the laboratory of the Mushroom Research and Application Center, Pamukkale University, Denizli, Turkey.

**Table 1. The family, habitat, edibility and time of collection of *A. lanipes*.**

Species	Family	Habitat	Edibility	Time
<i>Agaricus lanipes</i>	Agaricaceae	Associated with <i>Pinus</i> , usually on neutral and calcareous soils in forests	Good	Spring

Fresh mushrooms were randomly divided into three samples of 75 g and then dried in an oven at  $40 \pm 0.1^\circ\text{C}$  before analysis.

Proximate analysis of *A. lanipes*, including moisture, ash, crude fibre, crude fat, crude protein ( $\text{N} \times 4.38$ ), and total carbohydrate were determined in triplicate according to the Association of Official Analytical Chemists (AOAC 1995) procedures. Moisture content was examined by further heating of the dried samples at  $105^\circ\text{C}$  for 24 hrs, cooling in a desiccator, and weighing. Ash content of samples (%) was determined as the residue of incineration at  $525 \pm 25^\circ\text{C}$  in a muffle furnace (AOAC 1984). Crude fat content (%) was calculated according to AOAC (1984). Crude protein content (%) was measured by the Kjeldahl method.

The total carbohydrates content were calculated by subtraction:

Total carbohydrates =  $100 - (\text{g moisture} + \text{g protein} + \text{g fat} + \text{g ash})$ .

Total energy was calculated according to the following equation:

Energy (kcal) =  $4 \times (\text{g protein} + \text{g carbohydrate}) + 9 (\text{g fat})$  and,

Energy (kJ) =  $17 \times (\text{g protein} + \text{g carbohydrate}) + 37 (\text{g fat})$  (Manzi *et al.* 2004).

The collected mushroom samples were cleaned, cut up and dried at  $105^\circ\text{C}$  for 24 hrs. The dried samples were then reduced to small homogeneous pieces using a blender, and kept in clean polyethylene bottles until analysis. A 2 g quantity of mushroom sample was taken, 25 ml of  $\text{HNO}_3$  was added, and after heating for 30 minutes, it was left to cool. Later, 15 ml of  $\text{HClO}_4$  was added, and the solution was boiled in a magnetic heater until it became colorless. After cooling, the solutions were filtered through filter paper and made up to 50 ml with distilled water (Rosa *et al.* 2012). A blank digest was performed in the same way.

Analyses for the elements calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), phosphorus (P), iron (Fe), zinc (Zn), copper (Cu), manganese (Mn) and selenium (Se) in aliquot of the ash solution were performed with inductively coupled plasma optical emission spectrometry (ICP-OES). Phosphorus (P) was determined by molybdenum blue spectrophotometry. The concentrations of all the minerals were expressed as mg/100 g dry weight of the mushroom sample.

## Results and Discussion

Table 2 shows the chemical compound and energy values obtained from the fungus *A. lanipes*. The moisture content of the mature fruiting body samples was 4.49%. In previous studies, a moisture content of between 5.9 and 9.7% of dry weight has been determined for *A. bisporus*,

while *A. bitorquis* has been found to have a dry weight moisture content of 12.1% (Sadiq *et al.* 2008, Akyüz and Kırbağ 2010). In addition, it is known that the moisture content of fungi is affected by the time of harvest and by such environmental conditions as moisture and temperature values in the growth and maturation period (Crisan and Sands 1978). Based on dry weight, contents of other components were, in order, total carbohydrate (52.32 g/100 g) > crude protein (30.14 g/100 g) > crude fibre (9.17 g/100 g) > ash (8.14 g/100 g) > crude fat (4.90 g/100 g). Studies which have been carried out have reported ash contents of 3.5 - 13.3 g/100 g (Barros *et al.* 2007a, Zhu *et al.* 2007, Yin and Zhou 2008, Kalač 2013), crude fiber contents of 5.1 - 40.0 g/100 g (Yin and Zhou 2008, Zhang and Chen 2011), total carbohydrate contents of 12.8 - 71.0 g/100 g (Ouzouni and Riganakos 2007, Zhou and Yin 2008, Kalač 2009), crude fat contents of 0.4 - 6.7 g/100 g (Barros *et al.* 2008, Yin and Zhou 2008), and crude protein contents of 12.0 - 62.8 g/100 g (Heleno *et al.* 2009, Kalač 2009, Zhang and Chen 2011). The energy contribution of the *A. lanipes* sample was 374.18 kcal/100 g (1583.29 kJ/100 g). Data obtained are in agreement with those stated by different authors who reported mushrooms as high in total carbohydrate and crude protein as well as low in ash, crude fibre, crude fat and energy value (Kalač 2009, Wang *et al.* 2014).

**Table 2. Moisture content (g/100 g), proximate composition (mg/100 g) and energetic value (kcal/100 g and kJ/100 g) of *A. lanipes* fruiting bodies.\***

Moisture	Ash	Crude fibre	Crude fat	Crude protein	Total carbohydrate	Energy (kcal)	Energy (kJ)
4.49 ± 0.13	8.14 ± 0.12	9.17 ± 0.10	4.90 ± 0.02	30.14 ± 0.72	52.32 ± 0.90	374.18 ± 1.89	1583.29 ± 4.2

\*Results are on dry weight basis. Each value is the mean of three replicate determinations ± standard deviation.

Five major elements (K, P, Ca, Na and Mg) and five trace elements (Fe, Zn, Cu, Mn and Se) were determined in *A. lanipes*. Element concentrations of *A. lanipes* are presented in Tables 3 and 4. According to the results of the study, the most abundant major elements in the mushroom samples were, in order, potassium (20280.8 mg/kg) and phosphorus (6468.9 mg/kg). After these, magnesium, calcium and sodium (927.5, 270.2 and 238.8 mg/kg, respectively) came. Potassium and phosphorus are the two most abundant elements in the fruiting bodies of fungi (Okoro and Achuba 2012, Falandysz and Borovička 2013) with contents reported to vary from 16.320 - 41.000 mg/kg for potassium and 4820 - 10.000 mg/kg for phosphorus (Bakken and Olsen 1990, Kalač 2009, Liu *et al.* 2012). The most abundant elements in fungi after potassium and phosphorus are generally calcium, sodium and magnesium (Wang *et al.* 2014). Previous studies have reported calcium contents of 76 - 2004 mg/kg, sodium contents of 100 - 1645 mg/kg, and magnesium contents of 520 - 1800 mg/kg (Li and Wang 2006, Kalač 2009, Mallikarjuna *et al.* 2013). The values relating to the content of major elements in our study are similar to the data reported in the literature.

It is necessary to know the levels of trace elements in mushrooms before using them because of their important physiological effects on human health. According to the results of the study, the most abundant trace elements found in the mushroom samples were, in order, iron (130.05 mg/kg) and zinc (68.21 mg/kg), followed by manganese, copper and selenium (38.13, 26.90 and 5.11 mg/kg, respectively) (Table 4). Trace elements are the components or activators of various enzymes found in fungi (Chang and Miles 2004). Iron is a component of catalase as well as of cytochrome enzymes, and previous studies have reported finding an iron content in fungi of 50 -

300 mg/kg (Chang and Miles 2004, Kalač 2009). Zinc is particularly important for the normal functions of the immune system, and at the same time is an activator for many enzymes such as alcohol dehydrogenase (Chang and Miles 2004, Kalač and Svaboda 2000), and studies which have been carried out report values of 25 - 200 mg/kg (Kalač 2009, Wang *et al.* 2014).

**Table 3. Major element concentrations of *A. lanipes* (mg/kg)\*.**

Potassium	Phosphorus	Calcium	Sodium	Magnesium
20280.8 ± 18.7	6468.9 ± 14.5	270.2 ± 8.4	238.8 ± 7.0	927.5 ± 1.0

\*Results are on dry weight basis. Each value is the mean of three replicate determinations ± standard deviation.

Copper is a part of many enzymes catalyzing oxidation-reduction reactions, and is necessary for collagen synthesis and ion transport. Various researchers have reported the copper content of fungi to vary between 0 and 100 mg/kg (Kalač 2009, Wang *et al.* 2014). Manganese plays a role in the activation of a large number of enzymes including in the tricarboxylic acid cycle and nucleic acid synthesis (Chang and Miles 2004). Manganese content has been reported to vary from 9 to 83 mg/kg (Liu *et al.* 2010, Liu *et al.* 2012).

Selenium has been reported to be effective in the struggle against cancer (Lipinski 2005). Selenium deficiency has been reported to upset cells and the immune system and thus to increase sensitivity to cancer and infections (Wang *et al.* 2014). The selenium content of fungi has been reported to vary between 2 and 20 mg/kg (Kalač 2012). The trace element values found in the present study were similar to data reported in the literature. In addition, the levels of both major and trace elements in fungi were found to be below the limits recommended by the FAO/WHO for weekly consumption (FAO/WHO 2001).

**Table 4. Trace element concentrations of *A. lanipes* (mg/kg)\*.**

Iron	Zinc	Copper	Manganese	Selenium
130.05 ± 1.00	68.21 ± 0.04	26.90 ± 0.13	38.13 ± 0.27	5.11 ± 0.02

\*Results are on dry weight basis. Each value is the mean of three replicate determinations ± standard deviation.

As a result of the study, samples of the fruiting bodies of *A. lanipes* were found to have a moisture content of 4.49% based on dry weight, and the contents of other components were, in order, total carbohydrate (52.32 g/100 g) > crude protein (30.14 g/100 g) > crude fibre (9.17 g/100 g) > ash (8.14 g/100 g) > crude fat (4.90 g/100 g). The major elements found in the fungal samples were, in order, potassium (20280.8 mg/kg), phosphorus (6468.9 mg/kg), and magnesium, calcium and sodium (927.5, 270.2 and 238.8 mg/kg, respectively), while the trace elements found were, in order, iron (130.05 mg/kg), zinc (68.21 mg/kg), and manganese, copper and selenium (38.13, 26.90 and 5.11 mg/kg, respectively).

This study suggests that *A. lanipes* may be used as healthy food with protein supplementing properties. To our knowledge, this is the first report on the nutritional composition of *A. lanipes*. The *A. lanipes* mushroom can be used as a healthy food.

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