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Micronutrients Analysis of Fresh and Canned "*Agaricus Bisporus*" and "*Pleurotus Ostreatus*" Mushroom Sold in Alexandria Markets, Egypt

Doaa A. Shbeeb[1], Mohamed Fawzi Farahat[1,2,*], Hanaa Mohamed Ismail[1]

[1]Department of Nutrition, High Institute of Public Health, Alexandria University, Egypt
[2]Department of Community Health Sciences, College of Applied Medical Sciences, King Saud University, Kingdom of Saudi Arabia

Abstract

Edible mushrooms form very nourishing meals especially for invalids, for they are easily digestible. They are consumed not only for their innate flavor and taste, but also for their important nutritional value, therefore, we analyzed the micronutrient contents of fresh and canned *Agaricus bisporus* and *Pleurotus ostreatus* mushroom for their calcium, potassium and iron content. Fresh *Agaricus* was insignificantly higher in its calcium and iron contents (36.0 and 37.5 mg/100g; respectively) than *Pleurotus* (33.8 and 29.8 mg/100g) although the later was significantly higher in its potassium content (3890.4 mg/100g) versus 3102.9 in *Agaricus*. The micronutrient content of the canned *Agaricus* was higher than the canned cut *Pleurotus*. As these species of mushrooms are good sources of calcium, potassium, and iron, so they can be used as supplementary healthy foods for human nutrition.

Corresponding author: Mohamed Fawzi Farahat, Associate professor of community health Sciences, Department of Community Health Sciences, College of Applied Medical Sciences, King Saud University, Kingdom of Saudi Arabia. Email: mffarahat@ksu.edu.sa
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Introduction

Mushrooms are edible fungus those have been eaten since the time of the ancient Egyptians, and were regarded as plants of immortality [1]. Human have used mushroom collected in the wild as food and it is estimated that the first intentional cultivation of mushroom took place almost 1400 years ago [2]. Mushrooms are fleshly fungi, spore bearing fruiting bodies which are produced above ground on soil. They often refer to fruiting body of the gill fungi, which do not contain chlorophyll like green plants and as a result cannot manufacture food by their own. They are very nutritious products that can be generated from lignocellulosic waste materials. The bioconversion of agricultural wastes into a value added products is a good mean of their use [3]. Edible mushrooms are important sources of food. They form very nourishing meals especially for invalids, for they are easily digestible. They are consumed not only for their innate flavor and taste, but also for their important nutritional value [4, 5]. In Egypt, only a minute proportion of fruit bodies sold in the markets and they are always either *Pleurotus* or *Agaricus* mushroom [6]. Mushrooms constitute an integral part of the normal human diet and in recent times, the amounts of consumption have been raised greatly, which includes variety of species [7]. Compared with vegetables, mushrooms proved to be also a good source of many minerals [8]. The minerals of highest content are potassium, followed by phosphorous, calcium and magnesium [9,10]. Potassium is particularly abundant and accounts for nearly 45% of the total ash content [11]. Mushrooms provide small, but nutritionally important, amounts of iron with high bioavailability (up to 90% can be absorbed)[12]. The water content of mushrooms is high, usually approximately 90%. However, amount of water is greatly influenced by relative humidity and temperature during growth and storage [13]. The aim of the present study was to analyze the micronutrient contents of fresh and canned *Agaricus bisporus* and *Pleurotus ostreatus* mushroom sold in Alexandria markets, Egypt.

Materials and Methods

A total of 95 samples, 30 of each fresh *Agaricus* and *Pleurotus* mushrooms were purchased from various markets in Alexandria in addition to 35 of canned samples (30 samples from *Agaricus* obtained from different commercial brands of different countries of origin in addition to five samples from *Pleurotus* obtained from the only available commercial brand). Only five samples were collected from the canned *Pleurotus* since only one commercial brand was available in the market.

Determination of ash Content

It was carried out according to AOAC (2003)[14] where two grams of the dried samples were weighed into porcelain crucible and ignited in a muffle furnace at 550 ^{0}C until white ash was obtained. The crucible was transferred to a desiccator and left to cool and weighed. This process was repeated until two successive constant weights were obtained and the ash percentage was calculated using the following equation:

Ash % = (B-C)/A X 100

Where

B = Weight of the crucible and sample before ashing

C= Weight of the crucible and sample after ashing.

A= Weight of the sample

Determination of Minerals Contents

Mineral contents in mushroom samples were determined after ashing the samples at 550 oC in a muffle furnace. After complete ignition, the contents were transferred into a flask and 100 ml hydrochloric acid (diluted 1:3) then heated for 3 – 5 minutes and filtered and the residues on the filter paper was washed several times by distilled water and used for determining calcium, potassium and iron. Calcium (Ca) and potassium (K) were determined using flame photometer (Jenway model PEP7 Serial No.2422). Iron (Fe) was estimated using Atomic absorption Spectrophotometry Perkin-Elmer, Model 2380 according to the method described in AOAC,1990[15].

Statistical Analysis

Data was analyzed statistically using SPSS version 11.5 computer software. The cut off point for statistical significance was P value <0.05 and all tests were two-sided. Data were tabulated and presented in the form of arithmetic mean and standard deviation. Mann-Whitney test was used to compare the mean chemical composition between fresh and/or canned

Agaricus and *Pleurotus* as well as between their two forms[16].

Results

The present study revealed that fresh *Agaricus* mushroom was insignificantly higher in its calcium and iron contents than *Pleurotus* mushroom although the later was significantly higher in its potassium content (3890.4 and 3102.9 mg/100g in case of *Pleurotus* and *Agaricus*; respectively). Canned *Agaricus* were higher in their micronutrient contents than the canned cut *Pleurotus*. Moreover, the variations were significant in case of calcium contents. Also, the variations in iron contents between whole *Agaricus* and cut *Pleurotus* were significant. The whole canned *Agaricus* was higher in its micronutrient contents than the cut canned *Agaricus* and both forms were higher in their contents than the fresh type. Although, there were significant variations in the calcium contents between fresh *Agaricus* and canned *Agaricus* as well as between both forms of canned *Agaricus* and whole fresh *Agaricus*, the variations were insignificant in case potassium. Also, there were significant variations in the iron content between fresh and canned *Agaricus* as well as between whole fresh *Agaricus* and whole canned *Agaricus*. Whole fresh *Pleurotus* had insignificantly lower calcium content than canned cut *Pleurotus* (33.8 and 47.1 mg/100g; respectively), it had significantly higher potassium content (3890.4 and 3174.5mg/100g; respectively). Fresh whole and canned cut *Pleurotus* had more or less similar iron contents (29.8 and 29.3 mg/100g; respectively) as shown in table 1.

Table 2 illustrates that the French whole and cut canned *Agaricus* are higher in their microelements contents than the corresponding Chinese forms and the differences were statistically significant in case of iron and potassium contents in case of the cut forms. Unfortunately, the Egyptian cut *Pleurotus* was with the lowest calcium and iron contents when compared with both forms of the Chinese and French *Agaricus*. Also, there were statistically significant differences in its calcium contents when compared with the both forms, in its iron contents with cut and whole *Agaricus* and finally in its potassium contents when compared with the French whole *Agaricus*.

Discussion

There are many minerals that are essential for a normal healthy body. Mushrooms like all living organisms have a good mix of minerals, and their fruiting bodies are characterized by high levels of assimilable mineral constituents[17]. The fructifications of mushrooms are characterized by a high level of well mineral constituents, whose level depends, among other things, on the species, age of the mushrooms, the diameter of the pilei and the substratum[18]. Mushroom fruiting bodies provide considerable amounts of absorbable mineral ingredients[19].

From the mineral analysis reported in this study, it seems that the two mushrooms can provide a useful

Table 1. Micronutrients content (mean ±SD) of different types and forms fresh *Pleurotus* and *Agaricus* mushroom

Types	Species	Form	NO. of samples	Ca.	Fe.	K.
				(mg/100g dry wt)		
Fresh	*Pleurotus*	Whole	30	33.8 ± 11.0	29.8 ± 8.1	3890.4 ± 1391.9^{a}
	Agaricus	Whole	30	36.0 ± 12.1^{abc}	37.5 ± 16.4^{ab}	3102.9 ± 2309.8
Canned	*Pleurotus*	Cut	5	47.1 ± 22.4 ^{de}	29.3 ± 8.5 ^{c}	3174.5 ± 1241.0^{a}
	Agaricus	Cut	15	293.7 ± 125.5^{ad}	48.5 ± 28.5	3539.6 ± 2987.2
		Whole	15	376.9 ± 92.8^{be}	72.0 ± 46.7^{ac}	3566.7 ± 2183.7
		ALL	30	335.3±116.4^{c}	60.3 ±39.8^{b}	3553.2 ± 2570.9

Cells with similar superscripts in the same column are significant (P <0.05)

Table 2. Micronutrient content (mean ± SD) of different forms of canned *Pleurotus* and *Agaricus* mushroom according to their country of Origin

Species	Form	Country of origin	NO. of samples	Ca.	Fe.	K.
				(mg/100g dry wt)		
Pleurotus	Cut	Egypt	5	47.1 ± 22.4^{bcde}	29.3 ± 8.5^{bc}	3174.5 ± 1241.0^{b}
Agaricus	Cut	China	10	252.0 ± 123.3^{ab}	35.4 ± 20.1	3275.8 ± 3574.8
		France	5	377.1 ± 88.7^{ac}	74.9 ± 25.1^{b}	4067.3 ± 1398.3
	Whole	China	10	363.6 ± 108.7^{d}	43.4 ± 18.5^{a}	2409.7 ± 1520.3^{a}
		France	5	403.4 ± 47.2^{e}	129.1 ± 26.1^{ac}	5880.6 ± 1203.9^{ab}

Cells with similar superscripts in the same column are significant ($P < 0.05$)

source of potassium, iron and calcium. Potassium was the most predominate mineral in the two studied species ranging from 3890.4% mg/100g in fresh *Pleurotus ostreatus* to 3102.9% in fresh *Agaricus bisporus* with significant difference between them (table 1). These contents are equivalent to 413.1 and 407.2 mg/100g on the wet weight basis respectively. They provide about hence recommendation daily intake for potassium at 4700 mg per day for men and women, recommendation daily intake for iron 8 mg per day for men ages 19-50 years and postmenopausal women, for females ages 19-50 years is significantly higher at 18 mg per day and recommendation daily intake for calcium for both men and women, ages 19-50 years 1000 mg per day, the recommendations are higher for men and women 9-18 years old 1300 mg per day [20]. A Previous study reported that potassium alone constituted 45 percent of the total ash content of mushroom [21].

Regarding the minerals content of mushrooms, revealed that the calcium content of the two mushroom species were more similar about 33.8 and 36.0 mg/100g dry weight for fresh *Pleurotus ostreatus* and *Agaricus bisporus* respectively with insignificant difference between them. Potassium was the dominate minerals in all tested mushrooms, 3102.9 and 3890.4 mg/100g dry weight for fresh *Agaricus bisporus* and *Pleurotus ostreatus* with significant difference between them. Also the present study showed the iron content of the two present studies were 29.8 and 37.5 mg/100g dry weight for fresh *Pleurotus ostreatus* and *Agaricus bisporus*, in succession with significant difference between them.

Another study reported that, potassium, calcium, iron contents were 224.7, 25.8, 31.0 mg/100g and 203.9 30.7, 39.4 mg/100g in fresh *Pleurotus ostreatus* and *Agaricus bisporus* respectively [22]. Previous study declared that, fresh *Pleurotus ostreatus* contained 3793.0, 33.0, 15.2 mg/100g for potassium, calcium and iron respectively and 28-30,000 mg/kg, 71.0 and 8.8 mg/100g for fresh *Agaricus bisporus* [23].

The present study revealed that, the calcium contents of canned *Agaricus bisporus* were about ten time higher than the fresh types (335.3 and 36 mg/100g, respectively) with significant difference between them, this high contents in canned mushroom may be attributed to the dipping mushrooms in $CaCl_2$ solution to produce firmer texture and caps opened slower [24].

Also, iron content of canned *Agaricus bisporus* was about two times higher than the fresh type with significant difference between them, also their potassium content was approximately similar but without significant difference between them.

Other study reported that, the calcium, potassium and iron canned *Agaricus bisporus* were 87.0, 2855.0 and 7.2 mg/100g dry weight contents

respectively [24]. There was a higher content of most minerals in the cap than in the stem of the mushroom except iron and calcium, which were more abundant in the stem [21].

Conclusion

Micronutrients analysis of canned and fresh *Agaricus* and *Pleurotus* revealed that these species of mushrooms are good sources of calcium, potassium, and iron, so they can be used as supplementary healthy foods for human nutrition.

Conflicts of Interest

The authors declare no conflict of interest.

Author Contributions

All authors have made full contribution to data acquisition, interpretation of results, drafting and revising the final manuscript. All authors read and approved the final manuscript.

Study Limitations

Limited number of canned *Pleurotus ostreatus* samples were collected and analyzed because this variety is sold in Egypt only in fresh form.

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