THE ASSESSMENT OF THE PROXIMATE COMPOSITION, MINERAL COMPOSITION AND NUTRITIVE VALUE OF TWO EDIBLE MUSHROOM GENERA

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Abstract

The present study was carried out in an attempt to assess the proximate composition, mineral composition and nutritive value of two edible mushrooms namely: (*Agaricus bisporus*) and (*Pleurotus ostreatus*). The gross chemical composition of the two mushrooms genera showed that mushrooms (*Agaricus bisporus*) and (*Pleurotus ostreatus*) were rich sources of proteins and fibers (48.30%, 52.27%), (26.33%, 21.46%) on dry weight basis; respectively. While moisture content, fat, ash and carbohydrates were relatively low (5.8%, 9.6%), (0.96%, 0.86%), (10.93%, 9.85%) and (13.48%, 15.56%); respectively. (*Agaricus bisporus*) and (*Pleurotus ostreatus*) contained (46.75, 158.20), (4.80, 11.05), (24.30, 11.05), (37.50, 44.65), (0.10, 0.10), (2.10, 1.60), (0.10, 0.35) and (0.15, 0.09) mg/100 g samples of Fe, Mn, Cu, Zn, Na, K, Ca and Mg; respectively.

The data revealed that mushrooms are considered as a rich source of essential amino acids especially leucine, lysine, phenylalanine, threonine, tryptophan and valine in both (*Agaricus bisporus*) and (*Pleurotus ostreatus*) mushrooms recording (1.86, 1.82), (1.88, 1.42), (1.56, 1.50), (1.36, 1.38), (1.43, 0.87) and (1.62, 1.52); respectively. The protein efficiency ratio (PER) of (*Agaricus bisporus*) mushroom recorded slight increase than (*Pleurotus ostreatus*) mushroom, while the Biological Value (BV) had almost the same value for both genera.

The data revealed that the lipid extracted from (*Agaricus bisporus*) and (*Pleurotus ostreatus*) contained more amounts of the unsaturated than the saturated fatty acids.

Key-Words:

Agaricus bisporus, *Pleurotus ostreatus*, gross chemical composition, mineral composition, amino acid and fatty acids.

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Introduction:

From ancient times, people had been interested in mushroom. Food of Gods was what the Romans called mushroom. The Greek regarded mushrooms as providing strength for warriors in battles. The Pharaohs prized mushroom as a delicacy food. Certain of mushroom varieties had been welcomed as food and some as inebriants, but others had been shunned and feared because of their known or suspected poisonous nature. So far about 25 species of more than 2000 edible fungi are widely accepted for human consumption, but only few of them are commercially cultivated with technical advances (**Chang and Miles 1982)**. Edible mushrooms had been widely utilized as a human foods for centuries and had been appreciated for texture and flavor as well as some medicinal and tonic attributes (**Manzi *et al*., 2001)**. However, the awarness of mushrooms as a healthy food and as an important source of biological active substances with medicinal value had only recently emerged **(Cheung 1999)**. Mushrooms are considered as healthy food because they are low in calories and fat but rich in proteins and dietary fibers **(Manzi *et al.,* 1999)**. In the 17th century their culture was in artificial conditions started in France. The first species obtained in this way was (*Agaricus bisporus*) **(Grzybowski 1978)**.

Egypt started the cultivation of mushroom in the eighties and increased interest in Egypt took place due to its many benefits **(Madbouli and El-Husseini 1996)**.

Fungus mushroom was famous since ancient Egyptians. Mushroom was called kings food. The fungus get their diet from papers and decaying organic materials. Breading and multiplication of such fungi could be performed by providing appropriate food environment both in the laboratory or a house (**Madbouli and El-Husseini 1996**). In Asia, especially in Japan, the cultivation of various mushroom species had been known for centuries and they were commonly used in traditional Japanese cooking **(Miles and Chang 1997, Shah *et al*. 1997)**.

In nature many thousands of species of mushrooms are located varying in form, color, size, strength and appearance and the nature of growth, taste with very tasty flavor. Most of such types have delicious flavor, however a few percentage of them are toxic kinds such as *Agaricus* compestris, (*Pleurotus ostreatus*), *Lentinus Edodes*, *Flammulina Velutipes*, *Ganoderma Lucidium* and *Agaricus Blazei*. (**Hussain *et al.* 2006**) and

Lelley (1982), reported that (*Pleurotus ostreatus*), the second most important edible mushroom in Europe, is a fast-growing, lignin-degrading fungus (**Platt *et al*., 1984**), which can therefore be grown for fruiting-body production on lignocellulosic waste such as cotton straw **(Platt *et al*., 1982)**.

Gosh *et al.* (1991) reported that the proximate composition of mushrooms (*Agaricus bisporus*) per 100 g fresh weight was 92.5% moisture and nitrogen 0.34%.

According to **Ahmed (1995)** the proximate composition of mushroom (*Agaricus bisporus*) and (*Pleurotus ostreatus*) were 88– 90%, 80%, moisture, 24 – 35%, 20% crude protein, 2 – 8%, 1.8% crude fat, 44 – 54%, 60% carbohydrates, 8 – 10%, 8% crude fiber, 8 – 12%, 7.5% ash and 350, 350 caloric value; respectively. While the proximate composition of mushroom g/100 g fresh weight were 90% moisture, 3.5% protein, 0.3% fat, 4.5% carbohydrates and 1.0% mineral. The proximate composition in fresh and dry weight mushroom (*Agricus bisporus*) and (*Pleurotus ostreatus*) were moisture (89%, 90%), (10%, 10%) protein (34%, 32%), (28%, 28%) fat (4%, 3%), (4%, 2.5%), carbohydrates (60%, 65%), (52%, 65%) fiber (10%, 8%), (7%, 8%) ash (12%, 7%), (6%, 7%) and caloric value (350, 350), (350, 360); respectively **(Madbouli and El Husseini 1996)**.

However, **Mattila *et al.* (2001) and (2002)** reported that the proximate composition of mushrooms (*Agaricus bisporus*) g per 100 g fresh weight was 92.0% and 92.3% moisture, 0.64% and 0.78% ash, 0.35% and 0.33% fat and 2.40% and 1.50% crude fiber. On the other hand **Kurtzman (2005)** stated that the proximate composition of mushrooms, g per 100 g weight was 89.7% moisture, 0.82% ash, 3.90% protein, 0.20% fat and 0.38% crude fiber. However, **Saiqa *et al*. (2008)** reported that (*Agaricus bisporus*) was low in moisture content (5.9±0.12) and ash contents (11.01±0.26), the crude protein content was (16.40±0.01) in (*Agaricus bisporus*).

Sivrikaya *et al.,* (2002) stated that the protein contents of both species were comparable to average proteins present in mushroom (17.5%). Crude lipids was (26.21±0.17); respectively. The reported average crude lipid in edible mushrooms was (29%); while there was a significant difference in carbohydrates in (*Agaricus bisporus*) (56.47±0.21) and the energy value of (*Agaricus bisporus*) was (499.52±9.32); respectively. However, moisture, carbohydrates, crude fiber, ash, fat and crude protein

content of (*pleratus ostreatus*) mushroom were 92.44, 57.63, 13.07, 8.85, 2.33 and 31.19 on dry weight basis; respectively. While in (*Agricus bisporus*) such values were 87.39, 50.79, 15.02, 9.13, 2.44 and 37.64; respectively **(Hassan 2002 and Medany 2004)**.

The chemical composition of edible mushrooms 100 g of fresh mushrooms contained 5.3 – 14.8 g dry matter, 1.5 – 6.7 g of carbohydrates, 1.5 – 3.0 g of protein and 0.3 – 0.4 g of fat **(Bernas *et al*. 2006)** and that the Oyster mushroom fruit bodies were 50.0% carbohydrate, 24.5% total protein, 5.0% lipids, 3.0% fiber, 6.0% ash, 90.0% moisture and energy value (Kcal/100 g dry weight) was 320; respectively **(Daba *et al*. 2008)**.

The proximate mineral composition of mushrooms (*Agaricus bisporus*) mg per 100 g fresh weight was 371.5% K, 9.3% Ca, 0.25% Fe and 71.3% P **(Bakowski and Michalik 1986)**. However, that in mushroom (*Pleurotus ostreatus*) and (*Agaricus bisporus*) mg/100g dry matter were calcium 29, 87, phosphorous 380, 328, iron 5, 44, sodium 72, 44 and potassium 450, 1700; respectively (**Madbouli and El Husseini 1996)**. The proximate mineral composition of mushrooms (*Agaricus bisporus*) mg per 100 g fresh weight was 1.0%, 3.20% Na , 296.0%, 346.0% K, 0.1%, 1.9% Ca, 0.43%, 0.37% Fe and 111.0%, 98.0% P **(Mattila *et al.* 2001 and 2002)**. The mineral composition mg / 100 gm dry matter in mushroom (*Pleurotus ostreatus*) and (*Agaricus bisporus*) were potassium 197.8, 189.6, sodium 117.6, 108.9, calcium 29.9, 32.9, iron 34.9, 36.3 and cupper 3.9, 6.6; respectively **(Hassan 2002 and Medany 2004)**. Also **(Bernas *et al*. 2006)** reported that mushrooms are a high valued source of mineral constituents, particularly potassium, phosphorus and magnesium and vitamins of the B group chiefly vitamins B_2 and also vitamin D.

Bakowski and Michalik (1986) reported that the ratio of essential amino acids in mushroom (*Agaricus bisporus*) were isoleucine 0.583, leucine 0.552, lysine 0.875, phenylalanine 0.598, tyrosine 0.529, threonine 0.878, valine 0.630, methionine 1.471; respectively. **Yitzhak and Ephraim (1986)** reported that the amino acid composition of fruiting bodies of (*Pleurotus ostreatus*) were aspartic acid 17.9, threonine 8.5, serine 9.7, glutamic acid 21.7, proline 6.0, glycine 9.0, alanine 12.8, cysteine 2.8, valine 10.7, methionine 4.6, isoleucine 6.6, leucine 12.2, tyrosine 6.0, phenylalanine 7.2, histidine 15.0, lysine 9.7 and arginine 12.1; respectively.

Ahmed (1995) reported that the essential amino acids g/100g crude protein in mushrooms (*Pleurotus ostreatus*) and (*Agaricus bisporus*) were

isoleucine 4.5, 5.2, leucine 7.5,7.5, lysine 9.1, 9.9, phenylalanine 4.2, 3.5, threonine 5.5, 6.1, tryptophan 2, 1.1, valine 2.5, 6.9, histidine 2.7, 2.8, methionine 0.9, 3; respectively. **Madbouli and El Husseini (1996)** reported that the essential amino acids mg/100g in mushroom (*Agaricus bisporus*) and (*Pleurotus ostreatus*) were isoleucine 366, 267, leucine 580, 610, lysine 527, 287, phenylalanine 340, 233, threonine 366, 290, valine 420, 326, cystine 71, 29, methionine 126, 97 and tryptophan 143, 87; respectively and the unessential amino acids in mushroom (*Pleurotus ostreatus*) in dry matter were 4.08 aspartic acid, 3.15 serine, 9.94 glutamic acid, 3.06 proline, 1.54 glycine, 4.41 alanine and 2.66 argenine.

Mattila *et al*. (2002) reported that the values of essential amino acids in mushroom (*Agaricus bisporus*) and (*Pleurotus ostreatus*) were isoleucine 0.562, 0.506, leucine 0.466, 0.424, lysine 0.524, 0.478, phenylalanine 0.578, 0.600, tyrosine 1.736, 1.344 threonine 0.725, 0.693 valine 0.608, 0.563, cystine 0.821, 1.000, methionine 0.384, 0.407; respectively. **Hassan (2002) and Medany (2004)** reported that the essential amino acid values gm/100 gm protein in mushroom (*Pleurotus ostreatus*) and (*Agaricus bisporus*) were isoleucine 3.65, 3.82, leucine 3.48, 3.75, lysine 6.25, 6.09, phenylalanine 2.99, 3.75, tyrosine 1.8, 2.55, threonine 2.92, 2.87, valine 2.08, 1.43, cystine 0.88, 1.57, methionine 0.86, 0.92 and tryptophan 1.73, 1.87; respectively. **Kurtzman (2005)** showed that amino acids can be easily formed within the body but the essential amino acids are needed to build the proteins that make our bodies function.

The fatty acid composition of fruiting bodies of *Pleurotus ostreatus* on dry weight were palmitic acid 2.2, stearic acid 0.5, oleic acid 2.9, linoleic acid 10.3 and unsaturated and saturated fatty acid were 4.85; respectively **(Yitzhak and Ephraim 1986)**. However, that in mushrooms (*Agaricus bisporus*) and (*Pleurotus ostreatus*) were 0.86, 0.59% myristic acid, 11.75, 16.42% palmitic acid, 1.32, 1.42% palmotheolic acid, 5.36, 3.0% stearic acid, 3.57, 12.29% oleic acid and 69.22, 62.94% linolenic acid; respectively **(Ahmed 1995)**.

Hashimoto *et al*., (1999) and (2001) showed that Considerable experimental evidence suggested that one of the most important food components that helped reduce serum cholesterol was its polyunsaturated fatty acid content. The content of fats in mushrooms is low; however, they contain the unsaturated fatty acids which constitute over 70% of the total content of fatty acids. In 100 g fresh matter of (*Agaricus bisporus*) and

(*Pleurotus ostreatus*) the content of fatty compounds was 0.3 and 0.4 g (**Manzi *et a*l. 2001**) or in 100 g dry matter 2.0 and 1.8; respectively **(Shah *et al*. 1997)**. **Yilmaz *et al*. (2006)** showed that the unsaturated fatty acids were at higher concentrations than the saturated fatty acids in mushrooms.

Mushrooms are quite high in protein (19-35%, including all the essential amino acids) and low in fat. Mushrooms also contain relatively large amounts of carbohydrate and fiber, ranging from 51 to 88% and from 4 to 20% (dry weight); respectively, for the major cultivated species. In addition, mushrooms contain significant amounts of vitamins, namely thiamin, riboflavin, ascorbic acid, and vitamin D_2, as well as minerals. In addition to their nutritional value, some popular mushrooms in the Far East may also have a medicinal value; antitumor, antiviral, and hypolipidemic effects have been reported. **(Miles and Chang 1997 and Breene 1990)**.

Vetter (2003) showed that a comparison of chemical constituents of fresh and conserved samples of (*Agaricus biporus*) revealed the crude protein and crude fat contents were practically unchanged but a decrease in dry matter content and a remarkable decrease in ash content were found. The concentrations of some minerals (Cd, Mn, Zn) were unchanged, indicating that the solubility was not good or the soluble, free forms of the elements were not present in large amounts. Another group of elements (B, Cu, K, Mg, P, Se) showed a decrease to varying extents because the presence of the free forms of the elements was high.

Kurtzman (2005) reported that mushrooms contain many components that fit the definition of food supplements. One kind of mushroom may be richer in one of these materials, while another kind will be richer another. However, mushrooms are generally similar to each other in especial food values.

The aim of this investigation was to study the gross chemical composition, mineral composition, as well as amino acid composition and fatty acid composition of the two studied mushrooms genera, in order to clarify their nutritive value.

Materials and Methods:

Materials:

Source of Samples:

The two studied mushrooms genera namely: (*Pleurotus ostreatus*) and (*Agaricus bisporus*) were procured from Food Technology Institute and Metro local market Giza, Cairo; respectively in March 2008.

- 40 Kg mushrooms (*Agaricus bisporus*)
- 40 Kg mushrooms (*Pleurotus ostreatus*)

Preparation of Samples:

Two studied mushrooms genera were dried in a drying oven at 55 – 60^{o}C for 6 – 8 hours to complete drying, thereafter were milled and kept in polyethylene bags at 5^{o}C until required for analysis.

The mycelia were cleaned with a minimal amount of distilled water to remove the dust and solids. The rind (outer covering) of the mycelia were removed to avoid any contamination that might come from the compost and the plastic wrapping during cultivation, then air dried and were pulverized to pass through a mill. The milled mushroom powder were transferred to airtight plastic bags and stored at room temperature (**Moharram *et al*., 2008)**.

Methods:

(I) *Chemical Analysis*:

(a) *Determination of moisture, crude protein, crude fat, crude fiber and ash contents*:

Moisture, protein, fat, crude fiber, and ash were determined according to the methods described by **A.O.A.C. (1990)**.

(b) *Total carbohydrates:*

Total carbohydrates were calculated by difference according to **Howard and Leonard (1963)**.

100 – (crude protein + crude fat + crude fiber + ash)

(c) *Caloric value:*

The caloric value was calculated according to **Wilson *et al*. (1974) and Seleet (1990)**.

(d) *Determination of mineral contents:*

The samples were wet acid-digested using a nitric acid and perchloric acid mixture (HNO3 : HCLO4;2:1v/v). The amounts of iron, zinc, copper and manganese in the digested sample were determined using a GBC Atomic Absorption 906 A, as described **in A.O.A.C. (1990).** Sodium and potassium were determined by a flame photometer 410, calcium and magnesium were determined by titration with version 0.0156 N according to **Jackson (1967)**.

(e) *Determination of amino acids content of the two studied mushrooms genera:*

Sample of 50 – 100 mg of dried and defatted was weighed in the screw-capped tubes and 5 ml of HCl 6.0 N were added. The hydrolysis tubes were attached to a system, which allowed the connection of nitrogen and vacuum lines without disturbing the sample. The tubes were placed in an oven at 110 ^{o}C for 24 h. (**A.O.A.C., 1990**). The tubes were then opened and the content of each tube was then filtered and evaporated for dryness in a rotary evaporator. A suitable volume of sodium citrate buffer (pH 2.2) was added to each dried film of the hydrolyzed sample. After all soluble materials completely dissolved the sample was then filtered using a 0.2µm membrane filter, the samples was ready for analysis **Baxter (1996)**.

The system used for the analysis was High Performance Amino Acid Analyzer, Biochrom 20 (Auto sampler version) Pharmacia Biotch constructed at NCRRT. Data analysis of chromatogram was done by EZChrom^{TM} Chromatography Data System Tutorial and User's Guide-Version 6.7.

Tryptophan was determined by chromatography using UV-1601 PC, SHIMADZU, UV-VISBLE spectrophotometer (550 nm) according to the method described by **Sastry and Tummuru (1985):**

To estimate the tryptophan in the sample, we treat the sample by 4.2 mm sodium hydroxide, then add 100 mg of the sample to 0.6 ml of 4.2 N. sodium hydroxide and 0.4 ml octand plus 25 mg starch (to prevent oxidation). Mix the contents and empty the air from inside the tube and

close the tube by heat. Then put the tube in an oven at 110^{o} C for 22 hours and then open the tube and transfer its contents to a volumetric flask (5 ml) containing suitable the amount of 6 mm N. Hcl to Neutralize alkalineity and then compute the volume by solution then filtrate the contents and store it at -20^{o} c. equipment for analyzing amino acid by (High performance liquid chromatography (HPLC)).

(f) *Determination of Fatty acids methyl esters by gas liquid chromatography:*

The methyl esters of fatty acids were separated using a PYE Unicam Pro-GC gas liquid chromatography with a dual flame ionization and carried out on (3.0 m × 0.25 mm) SP-2310 column, packed with 55% cyanopropyl phenyl silicone dimensions. Column temperature: At first the temperature was 100^{o}C at the rate of 8^{o}C minute, and then isothermal for 10 minutes at 195^{o}C. The injector and detector temperature were 250^{o}C and 300^{o}C; respectively (**Rossell *et al.*, (1983)**).

Carrier gas: Nitrogen at the rate 30 ml/minute. Hydrogen flow rate 33 ml/minute and air flow rate 330 ml/minute.

The chart speed was 0.4 cm/minute. Peak identifications were established by comparing the retention times obtained with standard methyl esters. The areas under the chromatographic peak were measured with electronic integrator.

(II) *Computation of chemical score:*

The chemical score was defined according **to Bhanu *et al*. (1991)** as follows:

$$\text{Chemical score} = \frac{\text{mg of essential amino acid in 1 gm test protein}}{\text{mg of essential amino acid in 1 gm reference protein}} \times 100$$

(III) *Computation of A/E ratio:*

The relationship between the content of an individual essential amino acid in the food protein (A) and the total essential amino acids content (E) was calculated according to **FAO (1965)** as follows:

$$\text{A/E ratio} = \frac{\text{mg of the individual essential amino acids}}{\text{g of total essential amino acids}}$$

(IV) ***Computation of protein efficiency ratio (PER):***

Protein efficiency ratio was calculated using the equation mentioned by **Alsmeyer *et al.* (1974)** as follows:

$$\text{PER} = -0.684 + 0.456\ (\text{Leucine}) - 0.047\ (\text{Proline})\ (\text{g}/100\text{g protein})$$

(V) ***Computation of biological value (BV):***

Biological value of protein samples was calculated according to the equation of **Oser (1959)** as follows:

$$\text{BV} = 49.09 + 10.53\ (\text{PER})$$

(VI) ***Statistical Analysis:-***

Data were analyzed with T-test using SPSS Program Version 16.

Results and Discussion:

Gross chemical composition of the two studied mushrooms genera:

Mushrooms had been considered as a food supplement in various cultures and they are cultivated and eaten for their edibility and delicacy. They fall between the best vegetables and animal protein source. Mushrooms are considered as source of proteins, vitamins, fats, carbohydrates, amino acids and minerals **(Jiskani, 2001)**. The gross chemical composition of the two studied mushroom genera are presented in Table (1).

Table (1): Gross Chemical composition of the two studied Mushrooms genera* (on dry weight basis)*:-

Components %	Materials	
	Agaricus bisporus	*Pleurotus ostreatus*
Moisture	5.8	9.6
Crude protein	48.30	52.27
Crude fat	0.96	0.86
Crude fiber	26.33	21.46
Ash	10.93	9.85
Carbohydrates**	13.48	15.56

* Mean of three replicates.

** Carbohydrates were calculated by difference.

The data given in this table revealed that (*Agaricus bisporus*) recorded the lowest percentages on moisture, protein and carbohydrates were (5.8%), (48.30%) and (13.48%) and higher percentage on crude fat (0.96%), crude fiber (26.33%) and ash (10.93%) on dry weight basis. However, (*Pleurotus ostreatus*) had the highest content of moisture (9.6%), protein (52.27%) and carbohydrates (15.56%) while the lowest content were crude fat (0.86%), crude fiber (21.46%) and ash (9.85%) on dry weight basis.

With respect to ash content of the two studied mushrooms genera data in the same table revealed that (*Agaricus bisporus*) had the highest amount of ash (10.93%), while the (*Pleurotus ostreatus*) had the lowest content of ash (9.85%) on dry weight basis.

Besides, Table (3) outlined the mean caloric value of the two studied mushrooms genera.

Table (2) outlined the statistical analysis of the gross chemical composition of the two studied mushrooms genera. The data given in table (2) recorded that only moisture content was high significant, while crude protein, crude fat and crude fiber contents were recorded significant. On the other hand both ash and total carbohydrates contents recorded non significant in the two studied mushrooms genera.

Table (2): Statistical analysis of Gross chemical composition of the two studied mushrooms genera:-

Components %	*Agaricus bisporus*	*Pleurotus ostreatus*	T. test	Level of significance
Moisture	5.32±0.423	9.24±0.32	-12.831	**
Crude protein	48.30±1.00	52.27±2.00	-3.075	*
Crude fat	0.960±0.03	0.86±0.05	2.97	*
Crude fiber	26.33±2.00	21.46±1.00	3.77	*
Ash	10.93±1.00	9.85±0.2	1.834	n.s
Carbohydrates	13.48±1.00	15.56±1.00	-2.547	n.s

Table (3): Statistical analysis of the caloric value of the two studied mushrooms genera*:-

Component %	Mushrooms	
	Agaricus bisporus	*Pleurotus ostreatus*
Caloric value (K. cal)***	255.76	279.06

* calculated on dry weight basis.

Results given in Table (3) showed that (*Pleurotus ostreatus*) had the highest caloric value (279.06 K.cal), while (*Agaricus bisporus*) recorded the lowest caloric value (255.76 K.cal) on dry weight basis.

Table (3): Statistical analysis of the caloric value of the two studied mushrooms genera (on dry weight basis):-

Agaricus bisporus	*Pleurotus ostreatus*	T. test	Level of significance
255.76±5.0	279.06±10.00	-3.61	*

Table (3) outlined the statistical analysis of the caloric value of the two studied mushrooms genera. The data given in Table (3) recorded that the caloric value contents was significant in the two studied mushrooms genera.

(a) *Mositure*:

The data presented in Table (1) indicated that the moisture content of (*Agaricus bisporus*) and (*Pleurotus ostreatus*) were (5.8%) and (9.6%). such values were rather low than that reported by **(Madbouli and El Husseini**

1996), who reported that moisture values were (10%) and (10%); respectively in the same two genera.

Gosh *et al.* (1991), Mattila *et al.* (2001), Yang *et al.* (2001), Hassan (2002), Medany (2004) and Bernas *et al.* (2006) noted that the moisture content in (*Agaricus bisporus*) ranged from (88.6%) to (92.5%) g per 100g fresh weight.

Data given in Table (1) indicated that the moisture content recorded as sound increase in (*Pleurotus ostreatus*) compared with that of (*Agaricus bisporus*).

(b) *Protein:*

The results outlined in Table (1) showed that the crude protein content of (*Pleurotus ostreatus*) mushroom recorded removable increase than that in (*Agaricus bisporus*) mushroom on dry weight basis.

However, **Ahmed (1995), Madbouli and El Husseini (1996), Hassan (2002) and Medany (2004)** reported that the protein content in (*Agaricus bisporus*) and (*Pleurotus ostreatus*) ranged from (24.0%) to (37.64%).

Daba *et al.*, (2008) reported that the chemical composition of (*Pleurotus ostreatus*) mushroom fruit bodies produced in rice straw, contained high content of moisture, while the composition of mushroom mycelia cultivated on liquid medium indicated high moisture per cent as well and high crude total protein content as well.

(c) *Crude fat:*

Data presented in Table (1) proved that the crude fat content of (*Agaricus bisporus*) was (0.96%). This value rather agrees with **Food and Agriculture Organization (1972)** values.

The data also showed a slight decrease in fat content between (*Pleurotus ostreatus*) and (*Agaricus bisporus*) mushrooms recording (0.86%) to (0.96%); respectively.

Vedder (1978), Madbouli and El Husseini (1996) and Yang et al. (2001) noted that the fat content in (*Agaricus bisporus*) and (*Pleurotus ostreatus*) ranged from (0.25%) to (3.0%).

Yitzhak and Ephraim (1986) reported that the higher protein and the lower lipid contents in mushrooms could stem from either differences in fungal strain or growth conditions and substrates.

(d) *Crude fiber:*

The data given in Table (1) indicated a high percentage of crude fiber content of (*Agaricus bisporus*) (26.33%). While the lowest percentage of crude fiber of (*Pleurotus ostreatus*) was (21.46%).

Generally, the percentage of fibers ranged from (13.07%) to (15.02%) in (*Agaricus bisporus*) as reported by in **Chang (1972), Hassan (2002) and Medany (2004)**, while in (*Pleurotus ostreatus*) it ranged from (7.0%) to (13.07%) in agreement with **Madbouli and El Husseini (1996), Hassan (2002) and Medany (2004).**

The data also showed an increase in crude fiber content between (*Pleurotus ostreatus*) and (*Agaricus bisporus*) mushrooms recording (21.46%) to (26.33%); respectively.

Sueli et al., (2002) reported that lower fiber contents were due to lignin and cellulose degradation by the mushroom. This degradation would increase the digestibility of this residue and also had a considerable protein content, due to the presence of mycelium.

(e) *Ash content:*

The ash content in (*Pleurotus ostreatus*) and (*Agaricus bisporus*) recorded (9.85%) and (10.93%) on dry weight basis which coincides with **Hassan (2002) and Medany (2004)**, who reported (9.13%) ash content in (*Agaricus bisporus*). On the other hand the findings of ash reported by **Madbouli and El Husseini (1996)** was (7.0%) and (12.0%) in fresh weight mushrooms (*Pleurotus ostreatus*) and (*Agaricus bisporus*), while the ash content on (*Agaricus bisporus*) reported by other authors, namely: **Chang (1972), Food and Agriculture Organization (1972) and Yang *et al.* (2001)** ranged from (0.82%) to (0.9%) in fresh weight mushrooms.

(f) *Total carbohydrates:*

The data given in Table (1) indicated that a slight decrease in total carbohydrates between (*Agaricus bisporus*) and (*Pleurotus ostreatus*) was recorded (13.48%) to (15.56%); respectively.

Ahmed (1995) and Madbouli and El Husseini (1996) found the total carbohydrates in fresh weight mushrooms (*Agaricus bisporus*) and (*Pleurotus ostreatus*) ranged from (54.0%) to (65.0%), while **Vedder (1978)** reported a lower carbohydrates content (4.5%) in fresh weight mushrooms.

On the other hand, the caloric value of (*Agaricus bisporus*) and (*Pleurotus ostreatus*) in the present study Table (3) were (255.76 cal./100 g) and (279.06 cal./100 g), while **Madbouli and El Husseini (1996)** reported higher caloric values (350, 360 cal./100 g) on dry weight for mushrooms (*Agaricus bisporus*) and (*Pleurotus ostreatus*).

Guil *et al*., (1998) and Ozcan and Akgul (1998) reported that these differences might be due to the growth conditions, genetic factors, geographical variations and analytical procedures.

Mineral contents:

The data concerning mineral contents of (*Agaricus bisporus*) and (*Pleurotus ostreatus*) mushrooms are given in Table (4). (*Agaricus bisporus*) was relatively high in iron, copper, zinc, potassium and magnesium and relatively low in manganese, sodium and calcium, while in (*Pleurotus ostreatus*) was relatively high in iron, zinc and potassium, and relatively low in manganese, copper, sodium, calcium and magnesium.

Table (4): Mineral contents of the two studied mushrooms genera* mg/100g (on dry weight basis):-

Type of mushrooms	Minerals							
	Fe	Mn	Cu	Zn	Na	K	Ca	Mg
Agaricus bisporus	46.75	4.80	24.30	37.50	0.10	2.10	0.10	0.15
Pleurotus ostreatus	158.20	11.05	11.05	44.65	0.10	1.60	0.35	0.09

* Mean of three replicates

(*Agaricus bisporus*) contained 46.75, 4.80, 24.30, 37.50, 0.10, 2.10, 0.10 and 0.15 mg/100 g of iron manganese, copper, zinc, sodium, potassium, calcium and magnesium; respectively.

(*Pleurotus ostreatus*) contained 158.20, 11.05, 11.05, 44.65, 0.10, 1.60, 0.35 and 0.09 mg/100 g of iron manganese, copper, zinc, sodium, potassium, calcium and magnesium; respectively.

Results obtained by **Kurtzman (1991)** showed that sodium was generally low in mushroom but potassium and iron were high. Such values were in agreement with that of the present study.

Such variations were due to the different mineral composition of the substrates used for the cultivation (**Sturion and Oetterer 1995**).

Table (5): Statistical analysis of Mineral contents of the two studied mushrooms genera (on dry weight basis):-

Components %	*Agaricus bisporus*	*Pleurotus ostreatus*	T. test	Level of significance
Fe	46.75±1.00	158.20±8.00	-23.94	**
Mn	4.80±0.10	11.05±1.80	-10.77	**
Cu	24.30±2.0	11.05±1.00	10.26	**
Zn	37.5±2.00	44.65±2.00	-4.378	**
Na	0.0949±0.004	0.998±0.001	-2.122	n.s
K	2.0995±0.0004	1.6001±0.0001	2.0075	**
Ca	0.10000±0.0006	0.351±0.001	-433.96	**
Mg	0.1500±0.010	0.363±0.47	-0.779	n.s

Table (5) outlined the statistical analysis of the mineral contents value of the two studied mushrooms genera. The data given in Table (5) recorded that iron, manganese, copper, zinc, potassium and calcium contents were high significant. While sodium and magnesium contents were recorded non significant in the two studied mushrooms genera.

Amino acid composition of the two studied mushrooms genera:

The data revealed that a (18) amino acids were detected among them eight, represented the essentials amino acids. They were in alphabetical arrangement: Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan and Valine. However, another (10) amino acids known as non essentials amino acids, were detected, i.e., Alanine, Arginine, Aspartic acid, Cystine, Glutamic acid, Glycine, Histidine, Proline, Serine and Tyrosine.

The data given in Table (6) of (*Agaricus bisporus*) and (*Pleurotus ostreatus*) indicated that the highest essential amino acid was Lysine (1.88 mg/g) in (*Agaricus bisporus*) in agreement with **Campen (1972), (1973),**

Martinez and Torres et al. (1981), while the highest essential amino acid in (*Pleurotus ostreatus*) was Leucine (1.82 mg/g).

Table (6): Amino acid composition of the two studied mushrooms genera mg/g (on dry weight bases):-

Amino acids		Conc. mg/g	
		Agaricus bisporus	*Pleurotus ostreatus*
Essentials A. A.	Isoleucine	0.98	1.04
	Leucine	1.86	1.82
	Lysine	1.88	1.42
	Methionine	0.0	0.0
	Phenylalanine	1.56	1.50
	Threonine	1.36	1.38
	Tryptophan	1.43	0.87
	Valine	1.62	1.52
	Arginine	1.96	2.28
	Histidine	1.04	0.96
	Total Essentials A. A.	13.69	12.79
Non Essentials A. A.	Alanine	2.1	2.0
	Aspartic Acid	2.44	2.36
	Cystine	0.0	0.0
	Glutamic Acid	4.12	4.68
	Glycine	1.22	1.18
	Proline	1.9	1.9
	Serine	1.42	1.40
	Tyrosine	1.38	1.44
	Total Non Essentials	31.72	32.06
	E. A. A. / Non E. A. A.	0.43	0.40
	Total A. A.	45.41	44.85

Total amino acid ranged from 12.79 to 13.69 mg/g protein in (*Pleurotus ostreatus*) and (*Agaricus bisporus*); respectively.

In general, glutamic acid recorded the highest values 4.12, 4.68 mg/g protein in (*Agaricus bisporus*) and (*Pleurotus ostreatus*); respectively.

Total non-essential amino acids ranged from 31.72 to 32.06 mg/g protein (*Agaricus bisporus*) and (*Pleurotus ostreatus*); respectively.

However, **Yitzhak and Ephraim (1986)** reported that threonine and cysteine values were higher than that reported by **Hassan (2002) and Medany (2004)** in (*Agaricus bisporus*) and (*Pleurotus ostreatus*).

Mattila *et al.* (2002) reported that the essential amino acids in mushrooms (*Agaricus bisporus*) and (*Pleurotus ostreatus*) were rather close to the present study. Their values were isoleucine 0.56, 0.51, leucine 0.47, 0.42, lysine 0.52, 0.48, phenylalanine 0.58, 0.60, tyrosine 1.74, 1.34 threonine 0.73, 0.69 valine 0.61, 0.56, cystine 0.82, 1.00, methionine 0.38, 0.41; respectively.

A/E ratio:

A/E ratio indicated the relationship between the content of an individual essential amino acids in the food protein (A) and the total essential amino acids content (E).

High A/E ratio arginine in (*Agaricus bisporus*) and (*Pleurotus ostreatus*) were recorded (1.96) and (2.28).

Whereas, the lowest A/E ratio was recorded for isoleucine in (*Agaricus bisporus*) and tryptophan in (*Pleurotus ostreatus*).

Table (7): Computation of A/E ratio of the two studied mushroom (*Agaricus bisporus*), (*Pleurotus ostreatus*):-

Amino Acids	Type of mushrooms	
	Agaricus bisporus	***Pleurotus ostreatus***
Isoleucine	0.07	0.08
Leucine	0.14	0.14
Lysine	0.14	0.11
Methionine	0.0	0.0
Phenylalanine	0.11	0.12
Threonine	0.10	0.11
Tryptophan	0.10	0.07
Valine	0.12	0.12
Arginine	0.14	0.18
Histidine	0.08	0.08

The relationship between an essential amino acids leucine and non essential amino acids proline (g/100g protein), defined protein efficiency ratio of food. Data given in table (8) showed that high protein efficiency

ratio (PER) in the two studied mushrooms (*Agaricus bisporus*) and (*Pleurotus ostreatus*) were 0.08 and 0.06.

Table (8): Computation of protein efficiency ratio (PER) of the two studied mushroom (*Agaricus bisporus*), *Pleurotus ostreatus*):-

Type of mushrooms	PER
Agaricus bisporus	0.08
Pleurotus ostreatus	0.06

***Biological value of protein in the two studied mushroom (Agaricus bisporus), (Pleurotus ostreatus)*:**

Biological value (BV) of protein samples defined protein efficiency of food. Generally high (BV) of protein given in Table (9) recording (49.93, 49.72) in *Agaricus bisporus*) and (*Pleurotus ostreatus*).

Table (9): Computation of biological value of protein (BV) of the two studied mushroom (*Agaricus bisporus*), (*Pleurotus ostreatus*):-

Type of mushrooms	BV
Agaricus bisporus	49.93
Pleurotus ostreatus	49.72

***Chemical score and limiting amino acids*:**

Chemical score and limiting amino acids of the two studied mushrooms is in shown in Table (10).

Data presented in Table (10) showed that the chemical score indicated that methionine was the first limiting amino acid in (*Agaricus bisporus*) and (*Pleurotus ostreatus*), when whole egg was used as the reference protein.

The first limiting amino acid was methionine in the two studied mushrooms when casein was used as the reference protein.

The second limiting amino acid was tryptophan in the two studied mushrooms when whole egg and casein were used as the reference protein.

According to **Davidson *et al.* (1975)** chemical score is one of the most convenient parameters in determining the protein quality.

Table (10): Chemical score and limiting amino acids of the two studied mushroom (*Agaricus bisporus*), (*Pleurotus ostreatus*):-

Essential amino acid	Whole egg	Casein	Chemical score			
			Mushrooms			
	mg(E.A.A.)/g protein		*Agaricus bisporus*		*Pleurotus ostreatus*	
			D/E* 100	D/C*100	D/E* 100	D/C*100
Isoleucine	56	52	17.5	18.85	18.57	20.00
Leucine	83	96	22.41	19.38	21.93	18.96
Lysine	63	69	29.84	27.25	22.54	20.58
Methionine	32	16	0.0	0.0	0.0	0.0
Phenylalanine	51	35	30.59	44.57	29.41	42.86
Threonine	51	46	26.67	29.57	27.06	30
Tryptophan	18	17	79.44	84.12	48.33	51.18
Valine	76	60	21.32	27	20	25.33
First limiting amino acid			Isoleucine	Isoleucine	Isoleucine	Leucine
Second limiting amino acid			Valine	Leucine	Valine	Isoleucine

D = amino acid of mushrooms E = Amino acid of whole egg C = amino acid of casein.

Fatty acids composition of total lipids of the two studied mushrooms genera:

The data presented in Table (11) revealed that the fatty acids composition of total extracted of the two studied mushrooms genera.

The results detected from gas chromatographic analysis of the methyl ester of saturated and unsaturated fatty acids were: Caproic, Caprylic, Capric, Lauric, Myristic, Pentadecanoic, Palmitic, Stearic, Oleic and Linoleic.

The lipid extracted from (*Agaricus bisporus*) and (*Pleurotus ostreatus*) contained more amounts of unsaturated fatty acids than the saturated one.

Mushrooms genera had least values of the relative percentage of saturated two unsaturated fatty acids in Table (11), there were ranged from (0.31 to 0.52); respectively in both studied genera.

Table (11): Fatty acids composition of total lipids of the two studied mushrooms genera:-

Fatty acids	Mushrooms	
	Agaricus bisporus	*Pleurotus ostreatus*
Caproic (C6)	4.17	N. D.
Caprylic (C8)	2.51	1.56
Capric (C10)	1.11	N. D.
Lauric (C12)	2.16	N. D.
Myristic (C14)	0.89	0.61
Pentadecanoic (C15)	N. D.	2.36
Palmitic (C16)	17.66	16.14
Stearic (C18)	5.42	2.89
Oleic (C18:1)	32.68	20.96
Linoleic (C18:2)	33.40	54.99
Total	100	99.51
Unknown fatty acids	--	0.49
Total saturated (S)	0.55	0.22
Total unsaturated (U)	1.06	0.72
S / U Ratio	0.52	0.31

N.D. = Not detected. S = saturated fatty acids. U = unsaturated fatty acids.

Total saturated fatty acids in (*Pleurotus ostreatus*) and (*Agaricus bisporus*) were ranged from 0.22% to 0.55%; respectively. While, the total unsaturated fatty acids in (*Pleurotus ostreatus*) and (*Agaricus bisporus*) were ranged from 0.72% to 1.06%; respectively. Results were in agreement with those given by **Ahmed (1995)**.

Conclusion:

In conclusion, the present study revealed that the two studied mushrooms genera were rich sources of proteins and fibers as well as iron, zinc, copper and manganese.

On the other hand both studied mushroom genera were as well considered as a rich source of essential amino acids, especially leucine, lysine, phenylalanine, threonine, tryptophan and valine.

The protein efficiency ratio (PER) of (*Agaricus bisporus*) mushroom recorded slight increase than (*Pleurotus ostreatus*) mushroom, while the Biological value (BV) had almost the same value for both genera.

The data revealed that the lipid extracted from (*Agaricus bisporus*) and (*Pleurotus ostreatus*) contained more amounts of the unsaturated than the saturated fatty acids.

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تقدير التركيب الكيميائي العام والعناصر المعدنية والقيمة الغذائية لصنفين صالحين للتغذية من عيش الغراب

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تناول البحث تقدير التركيب الكيميائي العام لنوعين من عيش الغراب الصالحة للتغذية (الأجاريكس والمحاري) ولقد أظهرت النتائج ثراء عيش الغراب بنوعيه في كل من البروتين الخام والألياف إذ بلغت نسبتهما (٤٨,٣٠٪، ٥٢,٢٧٪)، (٢٦,٣٣٪، ٢١,٤٦٪) على التوالي على أساس الوزن الجاف بينما كانت نسبة الرطوبة والدهن الخام والكربوهيدرات الكلية منخفضة نسبياً (٥,٨٪، ٩,٦٪)، (٠,٩٦٪، ٠,٨٦٪)، (١٠,٩٣٪، ٩,٨٥٪)، (١٣,٤٨٪، ١٥,٥٦٪) في السلالتين المدروستين على التوالي.

كما أوضحت النتائج أن عيش الغراب بنوعيه (الأجاريكس والمحاري) احتوي على العديد من العناصر المعدنية مثل الحديد والمنجنيز والنحاس والزنك والصوديوم والبوتاسيوم والكالسيوم والماغنسيوم بنسب (٤٦,٧٥، ١٥٨,٢٠)، (٤,٨٠، ١١,٠٥)، (٢٤,٣٠، ١١,٠٥)، (٣٧,٥٠، ٤٤,٦٥)، (٠,١٠، ٠,١٠)، (٢,١٠،١,٦٠)، (٠,١٠، ٠,٣٥)، (٠,١٥، ٠,٠٩) ملليجرام لكل ١٠٠ جرام عينة على التوالي.

أوضحت النتائج أن عيش الغراب بنوعيه يعتبر غنياً بالأحماض الأمينية الأساسية الليوسين والليسين والفينيل الانين والثريونين والتربتوفان والفالين بنسب وصلت (١,٨٦، ١,٨٢)، (١,٨٨، ١,٤٢)، (١,٥٦، ١,٥٠)، (١,٣٦، ١,٣٨)،(١,٤٣، ٠,٨٧)، (١,٦٢، ١,٥٢).

ولقد أوضحت النتائج ما طرأ على كل من معدل كفاءة البروتين (PER) والقيمة البيولوجية (BV) لعيش الغراب بنوعيه من تحسن ملحوظ، كما أوضحت النتائج أيضاً ارتفاع محتوى عيش الغراب بنوعيه (الأجاريكس والمحاري) من الأحماض الدهنية غير المشبعة.

الكلمات المفتاحية:

عيش غراب أجاريكس ـ عيش غراب محاري ـ التركيب الكيميائي العام ـ العناصر المعدنية ـ الأحماض الأمينية ـ الأحماض الدهنية.

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