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# CHEMICAL COMPOSITION AND NUTRITIONAL VALUE IN TURKEY SPECIES OF WILD GROWING EDIBLE MUSHROOMS: A REVIEW

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## ABSTRACT

Edible mushrooms having potential value in maintaining good health and boosting immune system of the human body. In addition economically and ecologically important. The nutritional analysis results showed the presence of moisture, dry matter, total carbohydrates, dietary fiber, crude fat, ash, and protein in edible species of mushrooms collected from Turkey. The aim of the review is to collect recent data published on chemical composition of edible mushroom species growing in Turkey. Chemical analysis results showed that mushrooms have a large amount of protein, but lipid concentration is very low and low calories. It has a high nutritional value almost twice that of any vegetable or fruit, also mushrooms have a good food for the consumer, which can virtually be compared with meat, eggs, and milk. These results suggest that mushrooms are very good nutrition source for mankind who looks for new and alternative food and nutrition source all the time it is an excellent food that can be used in a well-balanced diet for their low fat content. A balanced diet is the supporting treatment for the prevention of illness and especially against oxidative stress.

**KEYWORDS**: Edible mushrooms; basic composition; moisture; total carbohydrates, dietary fiber; crude fat; ash; protein.

## INTRODUCTION

Mushrooms along with other fungi are something special in the living world, being neither plant nor animal(Cheung, 2008), but had for long been classified as plants. It was only in 1969 that Whittaker reclassified these organisms into a separate kingdom, the Fungi

(Whittaker, 1969). Mushrooms are fleshy, the fruiting bodies of macrofungi. It produced above ground on soil or on its food source. They include edible, medicinal and poisonous species. However, originally most of the time, the word "mushroom" is used for the edible species of macrofungi. Edible mushrooms still treated as a garnish or delicacy and can be taken regularly as part of the human diet or be treated as healthy food or as functional food (Gebrelibanos, Megersa, & Taddesse, 2016).

Mushroom is most often applied to fungi (Basidiomycota, Agaricomycetes, order Boletales and family Boletaceae) that have stem (stipe), a cap (Pileus) and gills (Lamellae) on the other side of the cap(Chittaragi & Naika, 2014). The number of mushrooms on Earth is estimated at 140,000, yet maybe only 10% (approximately 14,000 named species (Wasser, 2002). Not far from 14,000 mushroom species, described according to the rules of mycological nomenclature, represent about 10% of the estimated number of species existing on Earth. More than 2000 species are safe for consumption, and almost 700 species are known to possess significant pharmacological properties (Kalač, 2016). Fungi are an exceptionally diverse group, central to the functioning of ecosystems. Fungi play a principal main role in recycling of energy and nutrients and influence plant community composition through symbiotic relationships (Dighton, 2016). The total number of correct names of species of myxomycetes, recognized as occurring in Turkey is 232 and the total number of correct names of macrofungi species is 2158, including 215 species of ascomycetes, and 1943 species of basidiomycetes proper. Eighty species were treated as doubtfoul, confused or erroneously recorded names or as illegitimate names and included in a list of excluded records, providing reasons for their exclusion(Sesli & Denchev, 2008). Mushroom, also known as mantar in Turkish, are so different from other plants in nature, These mushrooms, whose names differ from district to district, are consumed throughout the autumn season.

Turkey is rich in mushrooms diversity, as well as medicinal plant. Turkish people have a tradition of using a number of mushrooms for food, instead of the treatment of infectious diseases and various ailments(Akyuz, Onganer, ERECEVIT, & Kirbag, 2010).

Turkey has a wide range of mushrooms potential due to suitable ecological natural features and 2400 macrofungi taxa have been identified by various researchers. The fact that many species are edible, most of them are not known by local people as edible. likewise, mushrooms have an economically importance besides biological diversity (Allı & Şen, 2016). New research publications have reported the presence of bioactive metabolites, e.g. phenolic

compounds, terpenoids, polysaccharides, lectins, nucleotides, steroids, glycoproteins and their derivatives, glycoproteins, and polysaccharides. Chemical composition of mushroom species may be affected by several variables such as genetic structure, strains, maturation stage, environmental conditions, such as soil composition, as well as the specific part of the mushroom, postharvest, preservation method (dry or fresh procedures), and cooking process (Crisan & Sands, 1978; Manzi, Aguzzi, & Pizzoferrato, 2001; Manzi, Marconi, Aguzzi, & Pizzoferrato, 2004; Miles & Chang, 2004). In addition management techniques, handling conditions and preparation of the substrates (Onbaşılı, Çelik, Katırcıoğlu, & Narin, 2015)

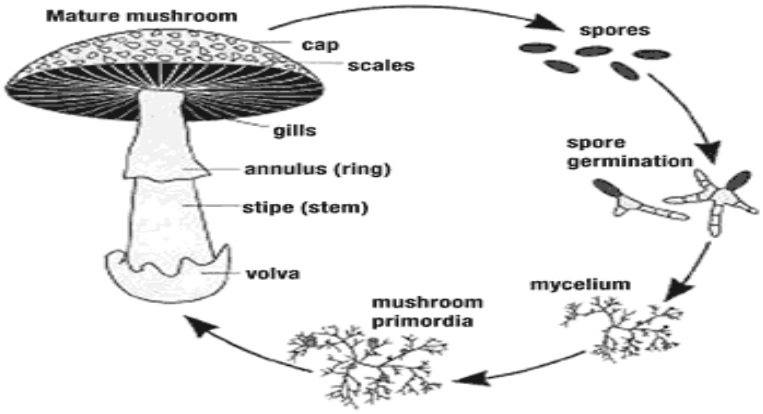
**1- Mycological terms**

A mushroom is the fleshy, spore-bearing fruiting body of a fungus. The fruiting body (carpophore, mycocarp) in higher fungi is found mostly above ground. A fruiting body grows from spacious underground mycelia (hyphae) by the process of fructifying. The lifetime of the bulk of fruiting bodies have a short lifetime only about 10-14 days (Kalač, 2009).

A mushroom or a fruit body has three main parts above the substratum, the cap, the gills and the stipe.

Generally, they can be divided into three types of fungi according to their ecology. Those growing on dead organic material are termed saprophytic fungi. Those living with their hosts by symbiosis to gain vital benefits from each other are called mutualistic symbiotic fungi (Miles & Chang, 2004).

Mycelia of ectomycorrhizal species grow within roots of plants, such as trees. Terrestrial saprobic species snatch nutrients mainly from organic compounds of the plant and animal debris (Kalač, 2009). The life cycle of a mushroom starts when spores germinate to form haploid mycelia (fig. 1).




Life cycle of mushroom (www.mushroomgrow.com)

**2- Some pictures of wild mushrooms**

**Lactarius deliciosus**

**Armillaria mellea**

**Infundibulicybe geotropa**

**Meripilus giganteus**

**Hydnum repandum**

**Sparassis crispa**

**Boletopsis leucomelaena**

**Hydnum repandum**

**Laetiporus sulphurous**


**Boletus edulis**


**Armillaria mellea**


**Macrolepiota procera**

**3 - The dry matter and moisture content of mushrooms**

Dry matter (DM) of mushrooms is very low and may range from 8% to 14% (Kalacˇ, 2012). Commonly, dry matter content of 100 g kg_1 has been used for calculations if the factual value is unknown.

The low content of dry matter versus high water content and water activity directly affects the texture and in the short shelf life of fruit bodies. (Prakash et al., 2015). Dried mushrooms are known for their hygroscopicity (Kalač, 2013). The nutrient content of mushrooms is also essentially determined by the ratio of dry matter to moisture content. (Prakash et al., 2015).

On an average, fresh mushrooms contain approximately 90% moisture and air-dried mushrooms 10-12%.(Chang & Hayes, 2013), and dry mushrooms contained about 90% dry matter and 10% moisture. Proximate composition of dry matter of several mushroom species is given in data published on table. The highest dry matter was 92.42 ± 1.4% DM in Sparassis crispa and Meripilus giganteus, whereas the lowest (86.7 %) in Laetiporus sulphurous.

The moisture content of fresh mushrooms is 70.00 - 93.31% depending upon the harvest time, species, and environmental conditions; that of dried mushrooms is 7.58% in Sparassis crispa to 13.30% in Laetiporus sulphurous. Water content is a quality factor of food products and is inversely related to its dry matter.

The texture, taste, appearance and stability of foods depends on the amount of water they contain. Dehydrated mushrooms usually have a really intense flavour.

**4 - Protein**

Protein is an important constituent of dry matter of mushrooms (Alofe, Odeyemi, & Oke, 1996; Wani, Bodha, & Wani, 2010).

The nutritional value of mushrooms is directly related to their protein content. According to a report published by the Food and Agriculture Organization (Joint, 1991). The protein quality is however lower than that from animal sources like fish, or eggs (Pathak, Yadav, & Gaur, 2000).

In 100 g of dried mushrooms contain proteins of 10.80% DM in Armillaria mellea to 83.40% DM in Sparassis crispa, whereas that of fresh mushrooms is 2.67% Lactarius piperatus in to 50.10% in Craterellus cornucopioides, as compared to 7.3% in rice, 13.2% in wheat, 39.1% in soybean, and 25.2% in milk(Miles & Chang, 2004). Protein content of mushrooms depends on the composition of the species of mushrooms, size of pileus, and harvest time (Bano & Rajarathnam, 1982). Protein determination could represent a problem since different conversion factors have been used calculated on the base of nitrogen content. The protein conversion factor used. Kalač (2009) due to the presence of of digestible protein is different.

Verma, Singh, & Bilgrami, (1987) record that mushrooms are very useful for vegetarian because they contain some essential amino acids which are found in animal proteins. Mushroom proteins are reported to contain all the essential amino acids, some non-essential amino acids and amides (Chang and Miles 1989). Proteins consist of over 20 amino acids in variable amounts. Humans can convert some of these amino acids into others but nine of them are considered as essential amino acids (lysine, methionine, tryptophan, threonine, valine, leucine, isoleucine, histidine, and phenylalanine) (Ferreira, Morales, & Barros, 2016).

Crisan and Sands proposed in 1978 the use of a nutritional index calculated as follows: Nutritional Index = (EAA Index percentage protein) /100

**5 - Crude fat**

In mushrooms, Contents of total lipids (crude fat) are very low as compared to proteins and carbohydrates.(Kalač, 2009) The fats present in mushroom fruiting bodies are dominated by unsaturated fatty acids. (Wani et al., 2010). Fatty acids are the basic components of most lipids. Fatty acid analysis of the mushrooms showed that the unsaturated fatty acids higher than the saturated (Yilmaz, Türkekul, Bulut, & Sahin, 2013).

Data published for certain species collected in Turkey on (Table). Crude fat content of mushrooms is usually low, The reported content of Crude fat range between and ranging 0.68% in Meripilus giganteus, Sparassis crispa to 5.85% DM in Laetiporus sulphurous. On fresh weight basis, the fat content between 0.18% to 10.58% in Lactarius piperatus, Lycoperdon perlatum respectively.

Lipids play a fundamental role in the human body; they act as hormones or as their precursors, helping the digestion process, and constitute a source of metabolic energy(Burtis, Ashwood, & Bruns, 2008; Ferreira et al., 2016).

**6 – Carbohydrates**

Nutritionally, it is important to differentiate between available carbohydrates that include monosaccharides, disaccharides, trisaccharides, starch, and some maltooligosaccharides and dietary fiber that includes nonstarch polysaccharides such as cellulose, hemicellulose, pectins, gums, mucilages, β-glucans, oligosaccharides, and chitin (EFSA 2010).

The carbohydrate content of mushrooms found the bulk of fruiting bodies accounting for 50 to 65% on dry weight basis. (Kalač 2013). The total dietary fiber (TDF) is the sum of intrinsic nondigestible carbohydrates, soluble and insoluble fractions. Ayaz et al., (2011) reported the carbohydrate contents of 8 selected mushrooms from Turkey ranged from 42.50% DM in Lactarius piperatus to 67.65% DM in Lactarius quietus. Recently total carbohydrate contents of 3 fresh mushrooms were studied by (Caglarlrmak, Unal, & Otles, 2002) and found the highest value in Boletus edulis (9.23%) and the lowest in Lactarius piperatus (6.50%). According to (Colak, Faiz, & Sesli, 2009) found highest the in fresh Armillaria mellea (70%) and lowest in fresh Craterellus cornucopioides (34%). Manikandan (2011) reported that total carbohydrate content varies from 26-82% on dry weight basis in different mushrooms.

**7- Ash**

The amount of ash in wild mushrooms spanned from 4.61 and 13.7 g/100 g of dry matter according to what was recorded in lactarius deliciouss. and Pleurotus ostreatus, whereas 1.15, 10.26% in Boletus edulis, Craterellus cornucopioides respectively in fresh mushrooms.. Determining the ash content may be important for nutritional evaluation. The ash content is a measure of the overall amount of minerals present within a food, whereas the mineral content is a measure of the amount of specific inorganic components present within a food,

such as Ca, Na, K and C. Some minerals are essential to a healthy diet. High mineral contents are sometimes used to retard the growth of certain microorganisms. Major mineral content in mushrooms are K, P, Na, Ca, Mg and elements like Cu, Zn, Fe, Mo, Cd form minor constituents (Bano and Rajarathanum, 1982; Bano et al., 1981). K, P, Na and Mg constitute about 56 to 70% of the total ash content of the mushrooms (Li and Chang, 1982), while potassium alone forms 45% of the total ash**.** Mushrooms are capable of accumulating in their fruiting bodies large amounts of both macro- and" micro-elements that are essential to fungi and its consumers. Ash content of mushrooms depends on the composition of the substratum, size of pileus, harvest time and species of mushrooms, age and the diameter of the fruiting body (**Demirbas, 2001).**

Manzi et al (1999) reported that ash content of mushroom was around 6-10.5% of dry matter, this result was supported by Kalač (2009) who showed it to be about 5-12%. On other hand, Okechukwu, R., Okereke, J., Onyedineke, N., & Obi, R. (2011) showed a range of 3.20% - 25.10%. The principle constituents in the ash are potassium, phosphorus, magnesium, calcium, copper, iron, and zinc (Kalač, 2009; Guillamón et al., 2010).

**8-Energy**

The energy content of edible mushrooms is generally low, which allows them to be used in low-energy diets. Total energy values were calculated by multiplying the amounts of protein and carbohydrate by the factor of 4 kcal/g and lipid by the factor of 9 kcal/g.

## CONCLUSION

Proximate composition of mushrooms are comparable with the most common green leafy vegetables, legumes, whole grain cereals, meats and dairy products.

Mushrooms are very poor in lipid and very rich in protein, ash, carbohydrates, and minerals. if these mushrooms are encouraged to be consumed together with the common staple foods, especially of a poor man’s diet, stand a high chance of solving malnutrition in the above mentioned vulnerable groups of people. mushrooms could make quite a splash in medicine.

Proximate composition of mushrooms mg/100g (% dry weight) in Turkey

| Species | Moistue | Ash | Protein | Fat | Carbohydrat | Dry matter | References |
|---|---|---|---|---|---|---|---|
| ***Lactarius deliciosus*** | 8.75 ±0.72 | 4.61 ±0.03 | 75.25 ±0.15 | 2.64 ±0.16 | | 89.96 ±0.24 | (Onbaşılı et al., 2015) |
| ***Armillaria mellea*** | 9.00[a] | 9.76 ±0.14 | 76.94 ± 0.6 | 1.20 ± 0.05 | | 91.00 ± 0.6 | (KALYONCU, ERGÖNÜL, YILDIZ, KALMIŞ, & SOLAK, 2010) |
| ***Infundibulicybe geotropa*** | 10.08[a] | 8.23 ± 1.1 | 75.28 ± 1.7 | 1.05 ± 0.04 | | 89.92 ± 0.3 | (KALYONCU et al., 2010) |
| ***Meripilus giganteus*** | 7.58a | 11.62 ± 0.4 | 75.56 ± 0.4 | 0.68 ± 0.08 | | 92.42 ± 1.4 | (KALYONCU et al., 2010) |
| ***Sparassis crispa*** | 7.58[a] | 11.62 ± 0.4 | 75.56 ± 0.4 | 0.68 ± 0.08 | | 92.42 ± 1.4 | (KALYONCU et al., 2010) |
| ***Sparassis crispa*** | 7.64[a] | 5.68 ±0.17 | 83.40 ± 0.94 | 0.95 ± 0.0 | | 92.36 ± 0.44 | (KALYONCU et al., 2010) |
| ***Boletopsis leucomelaena*** | 10.25 ±0.50 | 6.30 ±0.40 | 22.90 ±1.20 | 2.2 ±0.20 | 58.35 ±4.30 | 89.75[a] | (Ayaz et al., 2011) |
| ***Hydnum repandum*** | 10.65 ±0.65 | 9.20 ±0.50 | 19.70 ±1.50 | 4.30 ±0.10 | 56.10 ±3.00 | 89.35[a] | (Ayaz et al., 2011) |
| ***Laetiporus sulphureus*** | 13.30 ±0.80 | 4.00 ±0.10 | 11.90 ±1.60 | 5.85 ±0.15 | 64.9 ±06.20 | 86.70[a] | (Ayaz et al., 2011) |
| ***Boletus edulis,*** | 12.75 ±0.60 | 5.00 ±0.7 | 32.50 ±1.20 | 2.85 ±0.20 | 46.95 ±2.80 | 87.25[a] | (Ayaz et al., 2011) |
| ***Armillaria mellea*** | 13.05 ±0.50 | 9.00 ±0.50 | 10.80 ±1.30 | 3.40 ±0.30 | 46.95 ±2.80 | 86.95[a] | (Ayaz et al., 2011) |
| ***Macrolepiota procera*** | 9.80 ±0.30 | 6.80 ±0.10 | 26.35 ±1.50 | 2.40 ±0.20 | 54.7 ±02.80 | 90.20[a] | (Ayaz et al., 2011) |
| ***Lactarius piperatus*** | 13.25 ±0.80 | 6.55 ±0.05 | 16.85 ±1.80 | 5.80 ±0.20 | 42.5 0±.1.60 | 86.75 | (Ayaz et al., 2011) |
| ***Lactarius quietus*** | 10.55 ±0.60 | 6.96 ±0.06 | 12.55 ±1.20 | 2.30 ±0.10 | 67.65 ±6.50 | 89.45[a] | (Ayaz et al., 2011) |
| ***Pleurotus ostreatus*** | 10.3 ± 0.6a | 13.7 ± 0.6a | 27.8 ± 0.3a | 0.9 ± 0.1ab | | 89.7 ± 0.6a | **(KIRBAĞ & AKYÜZ, 2010)** |
| ***Cantharellus cibarius*** | 85.56 | 1.77 | 3.10 | 0.72 | 8.86 | 14.44[a] | (Caglarlrmak et al., 2002) |
| ***Lactarius piperatus*** | 89.94 | 0.81 | 2.67 | 0.18 | 6.50 | 10.06[a] | (Caglarlrmak et al., 2002) |
| ***Boletus edulis*** | 80.53 | 1.15 | 7.39 | 1.70 | 9.23 | 19.47[a] | (Caglarlrmak et al., 2002) |
| **Craterellus cornucopioides** | 89.65 ±5.00 | 10.26 ±0.80 | 50.10 ±2.90 | 5.89 ±0.01 | 34±7 | 10.35 | (Colak et al., 2009) |
| **Armillaria mellea** | 83.82 ±5.00 | 3.16 ±0.30 | 21.12 ±3.00 | 6.08 ±0.10 | 70±5 | 16.18 | (Colak et al., 2009) |
| **Hydnum repandum** | 93.31 ±5.00 | 11.38 ±0.07 | 34.14 ±3.00 | 8.80 ±0.20 | 55±5 | 6.69 | (Colak et al., 2009) |
| **Cantharellus cibarius** | 87.92 ±5.00 | 7.78 ±0.60 | 34.17 ±2.60 | 1.40 ±3.00 | 57±4 | 12.08 | (Colak et al., 2009) ] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Ramaria flava** | 93.31 ±5.00 | 3.05 ±0.06 | 35.55 ±2.10 | 5.20 ±0.20 | 65±7 | 6.69 | (Colak et al., 2009) ] |
| **Sarcodon imbricatus** | 89.20 ±5.00 | 6.71 ±0.04 | 27.45 ±2.10 | 8.85 ±0.30 | 57±5 | 10.80 | (Colak et al., 2009) ] |
| **Lycoperdon perlatum** | 70.00 ±4.00 | 2.00 ±0.40 | 44.93 ±3.00 | 10.58 ±0.30 | 42±6 | 30.00 | (Colak et al., 2009) ] |
| **Lactarius volemus.** | 87.57 ±4.00 | 2.91 ±0.05 | 25.21 ±2.00 | 3.98 ±0.20 | 64±4 | 12.43 | (Colak et al., 2009) ] |
| **Limit values** | | | | | | ] | ] |

The total carbohydrate was calculated as :

100% - (% moisture + % ash + % crude protein + % fat)

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