

MUSHROOM NUTRITION

The importance and potential of mushroom is well known in many spheres of human life as well as ecosystem functions. Mushroom science has the potential to solve many problems such as quality food demand, environmental pollutions, unemployment and certain ecological issues in an amicable manner to a significant extent. It produces enough quantity of quality food, which is of high biological value and suitable for all age groups from child to aged people. Many medicinal mushrooms are solution for many of the human health problems.

The edible mushrooms considered a healthy food in terms of nutrition they contain. Mushroom is considered to be a complete, health food and suitable for all age groups, child to aged people as it contains all nutrient element required for human in desired proportion. The nutritional value of mushroom is affected by numerous factors such as species, variety, stage of development and environmental conditions. Mushrooms are rich in protein, dietary fiber, vitamins and minerals. The major proportion of carbohydrate is occupied by dietary and fermentable fibers and it do not contain starch with insignificant proportion of sugars.

Nutritive values of different mushrooms (dry weight basis g/100g)

Mushroom	Carbohydrate	Fibre	Protein	Fat	Ash	Energy (kcal)
<i>Agaricus bisporous</i>	46.17	20.90	33.48	3.10	5.70	499
<i>Pleurotus sajor-caju</i>	63.40	48.60	19.23	2.70	6.32	412
<i>Lentinula edodes</i>	47.60	28.80	32.93	3.73	5.20	387
<i>Pleurotus ostreatus</i>	57.60	8.70	30.40	2.20	9.80	265
<i>Vovarella volvaceae</i>	54.80	5.50	37.50	2.60	1.10	305
<i>Calocybe indica</i>	64.26	3.40	17.69	4.10	7.43	391
<i>Flammulina velutipes</i>	73.10	3.70	17.60	1.90	7.40	378
<i>Auricularia auricular</i>	82.80	19.80	4.20	8.30	4.70	351

Courtesy: Stamets, 2005 (*A.bisporous*, *P. sajor-caju*, *Lentinula edodes*), FAO, 1972 (*Pleurotus ostreatus*, *V. volvaceae*), Doshi and Sharma, 1995 (*Calocybe indica*), Crison and Sand, 1978 (*Flammulina velutipes* and *Auricularia spp*).

Proximal composition of some edible mushrooms (dry basis).

Species	Protein	Fat	Ash	Carbohydrates	Energy
	%	%	%	%	kcal/kg
<i>Agaricus bisporus</i>	14.1	2.2	9.7	74.0	325
<i>Lentinus edodes</i>	4.5	1.73	6.7	87.1	772
<i>Pleurotus ostreatus</i>	7.0	1.4	5.7	85.9	416
<i>Pleurotus eryngii</i>	11.0	1.5	6.2	81.4	421
<i>Pleurotus sajor-caju</i>	37.4	1.0	6.3	55.3	
<i>Pleurotus giganteus</i>	17.7	4.3	—	78.0	364
<i>Agaricus blazei</i>	31.3	1.8	7.5	59.4	379
<i>Lentinus edodes</i>	12.8	1.0	4.3	81.9	388

Adapted from Carneiro et al. 2013; Kalač 2013; Phan et al. 2012; Reis et al. 2012.

Protein - Most mushrooms have a high protein content, usually around 20-30% by dry weight. This can be useful for vegetarians or anyone looking to increase the protein content in their diet.

Essential amino acid composition (g per 100 g of protein) of proteins of mushroom



Arginine	6.7
Histidine	2.1
Lysine	5.0
Tryptophan	0.9
Phenylalanine	2.0
Methionine	1.2
Threonine	4.2
Leucine	4.4
Isoleucine	5.8
Valine	4.6
As proposed by Rose (1937).	

Edible mushrooms contain rich proteins that are composed of threonine and valine but deficient in sulphur containing amino acids (methionine and cysteine). The low lipid level with no cholesterol and higher proportion of polyunsaturated fatty acids is further advantage. The ergosterol present in mushrooms is the precursor for Vitamin D synthesis in human body. Nutritive values of different mushroom are given in Table 1.

Polysaccharides - Complex carbohydrates that stimulate the immune system. Average amount of Carbohydrates 50g

Polysaccharides are the best known and most potent mushroom derived substances with antitumor and immunomodulating properties. Data on mushroom polysaccharides have been collected from hundreds of different species of higher basidiomycetes; some specific carbohydrates with these properties have been quantified in different mushrooms: rhamnose, xylose, fucose, arabinose, fructose, glucose, mannose, mannitol, sucrose, maltose, and trehalose

Composition of sugars of some edible mushrooms (dry weight).

Species	Fructose	Mannitol	Sucrose	Trehalose	Total sugars
	(g/100 g fresh weight)				
<i>Agaricus bisporus</i>	0.03	5.6	nd	0.16	5.79
<i>Lentinus edodes</i>	0.69	10.01	nd	3.38	14.03
<i>Pleurotus ostreatus</i>	0.01	0.54	nd	4.42	4.97
<i>Pleurotus eryngii</i>	0.03	0.60	0.03	8.01	8.67
<i>Agaricus blazei</i>	0.27	60.89	nd	5.74	66.91
<i>Lentinus edodes</i>	nd	23.3	nd	13.22	38.31

Adapted from Carneiro et al. 2013; Kalač 2013; Phan et al. 2012; Reis et al. 2012.

Fiber - Helps lower cholesterol and is important for the digestive system.

Dietary fiber fractions, β -glucans, and free sugars in huitlacoche (dry basis).

Component	Units
Dietary fiber	% total content
Total dietary fiber	39–60
Soluble dietary fiber	9–29
Insoluble dietary fiber	22–51
β -glucans	20–120
Total free sugars	56–267
Glucose	53–231
Fructose	19–138
Galactose	0.2–3.5
Arabinose	0.2–3.3
Mannose	0–1.8
Xylose	0–2

Adapted from Valdez-Morales et al. (2010).

Mushrooms are full of micronutrients. They are a good source of copper, niacin (vitamin B3), pantothenic acid (vitamin B5), potassium, phosphorus, and iron. B vitamins assist in the release of energy from carbohydrate, protein, and fat.

Niacin and other important B vitamins - As certain B vitamins are found in animal tissue but not plants, this can be another good supplement for vegetarians.

Vitamin D - Essential for the absorption of calcium.

In addition to these, mushroom is an excellent source of vitamins especially C and B (Folic acid, Thiamine, Riboflavine and Niacin).

Selenium - An antioxidant that helps neutralize free radicals, thus preventing cell damage and reducing the risk of cancer and other diseases. Mushrooms contain more selenium than any other form of produce.

Potassium - An extremely important mineral that regulates blood pressure and keeps cells functioning properly. A large portobello mushroom is said to have more potassium than a banana.

Minerals viz., potassium, sodium and phosphorus are higher in mushroom fruit bodies besides other essential minerals (Cu, Zn, Mg) in traces but it is deficient in iron and calcium in general. Above all, growth promoting substances viz., enzymes, alkaloids, sterols, antioxidant and other undefined organic complexes also present in mushrooms

Copper - Aids in helping the body absorb oxygen and create red blood cells.

Other important minerals - Such as phosphorus,

Low levels of fat, calories, and sodium

No cholesterol

Yet the nutritional value of mushrooms can be measured in more ways than just strictly dietary. Further health benefits are gained from:

Fatty acids content of some edible mushrooms.

Species	Fatty acid (g/100 g fresh weight)				
	Palmitic (C16:0)	Stearic (C18:0)	Oleic (C18:1)	Linoleic (C18:2)	Linolenic (C18:3)
<i>Agaricus bisporus</i>	11.9	3.1	1.1	77.7	0.1
<i>Lentinus edodes</i>	10.3	1.6	2.3	81.1	0.1
<i>Pleurotus ostreatus</i>	11.2	1.6	12.3	68.9	0.1
<i>Pleurotus eryngii</i>	12.8	1.7	12.3	68.8	0.1
<i>Agaricus blazei</i>	11.38	2.8	1.85	72.42	nd
<i>Lentinus edodes</i>	11.78	1.09	3.28	78.59	0.59

Adapted from Carneiro et al. 2013; Reis et al. 2012.

Enzyme inhibiting activity - Mushrooms can inhibit the production of certain enzymes such as aromatase, which the body uses to make estrogen. This could reduce the risk of breast cancer.

Triterpenes - Steroid-like molecules that inhibit histamine release and have anti-inflammatory properties. Not all types of mushrooms have the same levels of vitamins, minerals, and medicinal properties. Do a little research if you have special health needs or goals. Of course, don't forget to take taste into account!

Phenolic compounds of huitlacoche from creole Mexican maize.

Phenolic compound	$\mu\text{g/g}$ huitlacoche (dry basis)
Gallic acid	2.4–2.6
Ferulic acid	514.1–544.2
Caffeic acid	26.3–27.4
<i>p</i> -Coumaric acid	10.2–10.6
<i>o</i> -Coumaric acid	4.4–4.8
Rutin	6.2–6.4
Catechin	11.0–11.7
Quercetin	42.4–45.2
Total phenols	636.8–667.4

Adapted from Valdez-Morales et al. (2010).

Several mushroom species have been pointed out as sources of bioactive compounds, in addition to their important nutritional value. The inclusion of whole mushrooms into the diet may have efficacy as potential dietary supplements.

The production of mushrooms and the extraction of bioactive metabolites is a key feature for the development of efficient biotechnological methods to obtain these metabolites. It has been shown by a wide range of studies that mushrooms contain components with outstanding properties to prevent or treat different type of diseases.

Powder formulations of some species have revealed the presence of essential nutrients. They present a low fat content and can be used in low-calorie diets, just like the mushrooms fruiting bodies. Some formulations could be used as antioxidants to prevent oxidative stress and thus ageing. Future studies into the mechanisms of action of mushroom extracts will help us to further delineate the interesting roles and properties of various mushroom phytochemicals in the prevention and treatment of some degenerative diseases.

In view of the current situation, the research of bioactive components in edible wild and cultivated mushrooms is yet deficient. There are numerous potential characteristics and old and novel properties, provided by mushrooms with nutraceutical and health benefits, which deserve further investigations.