EDIBLE MUSHROOMS: AN ALTERNATIVE FOOD ITEM

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ABSTRACT

Nutrition is the main living reason for all of the societies of the world. Food supply should be both an economic and ecological subject. Health and nutrition involve balanced and sufficient functional food components. Sufficient daily calorie intake is the main problem of developing countries. The people cannot supply an adequate intake of essential food compounds such as proteins containing essential amino acids, vitamins, minerals and essential fatty acids. The developing countries need to provide essential food components for nutrition. Edible mushrooms have these essential compounds and functional substances for human health. Mushrooms also contain bioactive components including β-glucans and chitin. The amount of edible mushrooms produced in modern plants for public nutrition that need balanced foods has increased. The production plant can bring economical benefits to unemployed people in these countries. The nutritional value of mushrooms is reviewed together with biochemical aspects, mushroom production and economical aspects.

Key words: Nutrition; Health; People; Economy; Nutrients and functional compounds

INTRODUCTION

Nutrition is the most important subject for humankind. A balanced nutrition is particularly important from the point of taking in essential elements such as minerals, vitamins and high quality proteins. Nutritional levels in societies depend on various factors such as economic conditions, ecology, nutritional habits, traditions and education. Successful development of countries is achieved by advancing economic subjects including levels of agriculture, industry and education.

Nutritional values of foods play an important role in human health. The people have to provide a balance diet containing essential food compounds; amino acids, fatty acids, minerals and vitamins. A sufficient and balanced diet should also include taking in enough carbohydrate and energy supplies. Mushrooms can provide balancing diet compounds in sufficient quantities for human nutrition, and contain medicinal compounds. They are in rich in crude fiber and protein. In fact, mushrooms also contain low fat, low calories and good vitamins and many mushrooms possess multi-functional medicinal properties [1].

The total number of edible and medicinal fungi is over 2300 species [2]. Cultivated mushrooms have become popular, and over 200 genera of macrofungi are useful for the people in the world. Most of them are cultivated on lignocelluloses waste materials and contribute to their re-cycling. The common mushroom species produced in suitable ecological conditions are: *Agaricus* spp., *Lentinula edodes* (shiitake), *Pleurotus* spp. (oyster), *Volvariella volvacea* (straw), Lion's head or pom pom (*Hericium*), ear (*Auricularia*), *Ganoderma* (Reishi), *Grifola frondosa* (maitake), Winter (*Flammulina*), white jelly (*Tremella*), *Pholiota* (nameko), and shaggy mane (*Coprinus*). The most common ones produced are *Agaricus bisporus* (button) mushroom, *Lentinula edodes*, and *Pleurotus* species [2]. The nutritional and chemical composition, and physical properties of edible mushrooms have been studied by different authors [3-7]. It is well know that mushrooms have a rich chemical composition and functional properties for health.

The aim of this article is to evaluate the importance of the economical contribution of cultivated and wild edible mushrooms, as well as their nutritional importance as an alternative food item.

RESULTS AND DISCUSSION

Evaluation of the economic aspects of agricultural production and collecting of edible mushrooms. Agriculture plays a vital role, especially in developing and underdeveloped countries all over the world. The development of societies implies similar or the same recipes that include fostering pro-poor economical growth and favoring poor people in access to all the services and other factors that support poverty eradication and define an acceptable standard of living [8]. Income growth of societies is essential in order to reduce undernourishment due to some factors such as better public services and sanitation that also are crucial. Growth and modern agricultural practices must become important and essential especially in developing countries like Turkey.

Cultivated mushroom production can apply in closed areas without depending on climatic conditions. Projection studies have shown that demand for agricultural products will continue to grow more slowly. Several factors influence this situation. World population will grow at an average of 1.1 percent a year up to 2030, compared with 1.7 percent a year over the past years [1]. Soylu et al. [9] studied the economic aspects of edible mushrooms grown in Turkey. There are many edible wild mushroom species growing in various ecological conditions such as the Black Sea, Marmara and Eagan Sea regions. Cultivated edible mushrooms can also grow in similar regions of Turkey including west of the Mediterranean Sea.

Commercial mushroom production began at the end of the 1970's. In 1973, 1983, 2008 and 2010, the quantity of cultivated mushroom produced in Turkey was 80 tonnes, 1,400 tonnes, 26,526 tonnes, and 45,000 tonnes, respectively [5, 9, 10]. Cultivated mushroom species have been produced for 34 years since 1970 [2, 11, 13] when mushroom production has contributed to the Turkish economy. The Mushroom Research Department investigates mushroom biology and science, and agriculture in the "Yalova Atatürk Horticulture Research Institute", which works by depending on the Agricultural Ministry in Turkey and reports on the amount of mushroom production, the export and import of mushrooms, and the marketing of mushroom [13].

As seen from Table 1, mushroom imports to Turkey fell during 1996 to 2001. In 1999, Turkey exported 17,920 tonnes of mushroom but this figure fell to 3,370 tonnes in 2001 [13]. Soylu et al. [9] reported mushrooms are wild edible mushrooms while 10% of them are *Morchella* sp. Turkey has at least 2,388 wild mushroom species [14]. The other mushroom species exported from Turkey are: *Terfezia bouderi*, (Chatin) & Tone, *Boletus edulis* and other *Boletus* species, *Leccinium scabrum*, *Lactarius* spp., *Tricholama calignotum*, *T. analtolicum*, *T. matsutake*, *Cantharellus* sp., *Craterellus cornocopioides* and *Amanita caesarea.* The total value of exported mushroom is US$28.5 million, while the total value of imported mushrooms is US$1.6 million [9].

Agriculture is the key factor for the development of the countries. Mushroom production is economically important since data have shown that mushrooms can contribute to the economy in terms of nutritional value.

Table 1: Mushroom import and export figures for Turkey (tonnes)

Year	1996	1997	1998	1999	2000	2001
Imports	350	1,020	10	10	0	60
Exports	5,450	6,290	5,580	17,920	3,370	3,730

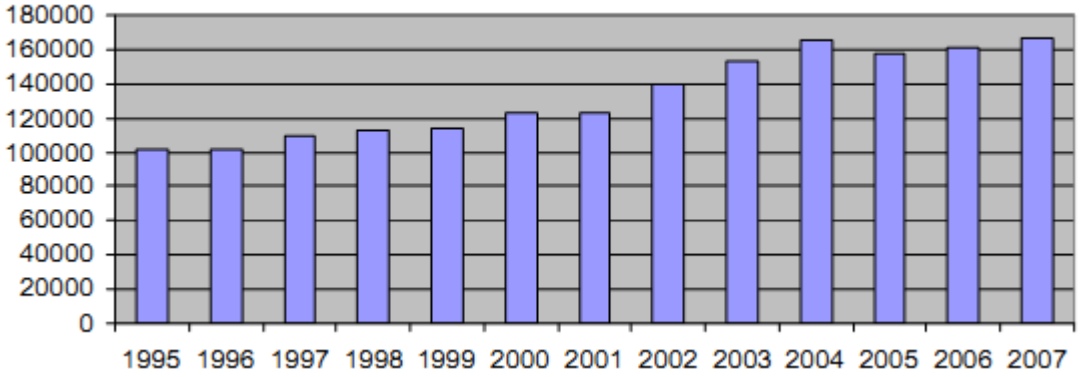

Figure 1: Total production of cultivated edible mushrooms (tons).
Data from Reference [15].

As seen from Figure 1, highest edible mushroom production occurred in 2004 and 2007 (over 160 000 tonnes) and similar amounts were produced between 2003 and 2007.

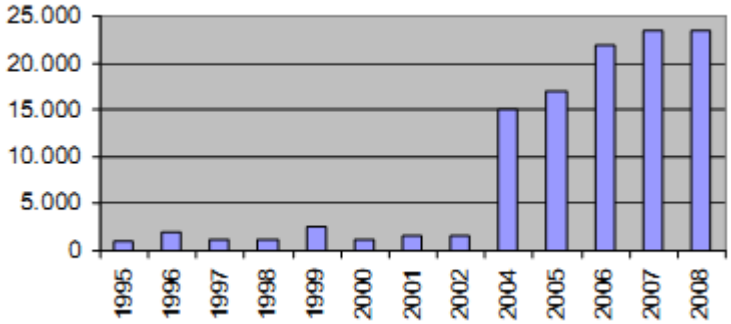

Figure 2: Production of cultivated edible mushroom in Turkey (tons)
Data from Reference [15].

Edible mushroom production in Turkey increased after 2002 and the increasing trend was strong between the 2004 and 2008 years (Figure 2).

The significance of mushroom nutrients for a balanced diet and health. Economic levels of societies affect their nutritional levels. The daily protein consumption for individuals is approximately 83 g per person and provided from sources of plant origin in Turkey. In the developed countries, 100 g protein intake per day is provided from animal sources. Nutrition develops parallel with public economical conditions [16]. Mushrooms should be a good alternative foodstuff with an especially balanced healthy nutrition for the person who has a low income.

The FAO reports mentioned that undernourishment is a characteristic feature of poverty and a direct violation of a universally recognized human right. Plenty of negative effects on human beings are seen in cases of undernourishment. This situation causes illness in people who are susceptible. Undernourished pregnant and nursing babies are born underweight, and so meet life with a nutritional handicap that may affect their health structure throughout their lives. Besides, undernourishment could also affect brain development and human productivity, which may be an obstacle to the learning performance. If energy and protein intakes are inadequate for the work requirements, muscle mass and labor productivity decline Deficiency of essential micronutrients cause some specific illnesses and reduce working capacity [17].

The main essential substances are shown in Table 2. Vitamins are considered to be micronutrients, as the human body requires only small amounts at any given time. The class of compounds called vitamins is a group of organic compounds. A good nutritious and well-balanced diet cannot replace by mere vitamin supplements (Table 2). While essential to life, the vitamins themselves do not provide any energy to the body. Vitamins are just one essential component of the human diet and the body requires many other substances besides vitamins for a full and adequate nutritional status. These include carbon-based compounds like carbohydrates, lipids, and essential fatty acids such as linoleic acid. The generally recommended daily protein intake for an average adult based on body size is 0.8 g per kilogram of body weight. High quality protein sources must contain essential amino acids (Table 2) and all essential trace minerals are necessary for a healthy diet. The health of the human body is not sustainable by vitamins alone and all other vital nutrients, such as minerals: Ca, P, Na, K, Cl, Mg, Mn that are produced N, S, Fe, Cu, I, Zn, F, Cr, Se, Mo, Si are acquired primarily from the food consumed by a person [17].

Mushrooms contain most of the essential elements (Table 2). Mushrooms can provide the balanced nutrition that comprises essential nutrients. There are data about nutritive values for both edible wild and cultivated mushrooms [18]. The data explained that studies dealing with the data related to the amount of vitamin C (L-ascorbic acid), B1 (thiamine), B2 (riboflavin), folic acid, B6 (pyridoxine), niacin, like *Cantharellus subalbidus*, (White chanterelle), *C. cibaruis*, *Craterellus cornucopiodes* (Black chanterelle), grown in Turkey (Table 3.). In this research, the species were fulfilling the required standards of recommended daily intake of folic acid, pyridoxine, and niacin. On the other hand, they fall short of the required amount of daily intake of protein and vitamin C. The folic acid, pyridoxine, and niacin contents of white, black and yellow chanterelle (mg/100g, wet basis), are as follows: (82.83; 1.83 and 96.3), (0.62, 0.86 and 0.91), and (3.75, 3.34 and 6.42), respectively. The Ca, Na, K, P, Mg and Zn contents of these species have been studied. The important positive cations are Na, K, Ca and Mg in the body. Na plays a significant role in providing intracellular balance of blood. Black chanterelles exhibited the highest quantity of Na, 461.53 (mg/kg) wet basis (wb). White and yellow chanterelle contained 19.50 and 26.89 mg/100g. wb respectively (Table 3) [17].

Table 2: Main essential nutrients of mushrooms [17]

Essential amino acids	Leucine, lysine, isoleucine, valine, methionine, phenylalanine, threonine, tryptophan
Essential fatty acids	Polyunsaturated fatty acids, fatty acids (PUFA), linoleic acid, α-linoleic acid, omega 3 , omega 6, omega 9
Water soluble and fat soluble vitamins	Thiamine, riboflavin, pyridoxine, cyanocobalamin, pantothenic acid, niacin, folic acid, vitamin C. Fat soluble vitamins; A (retinoic acid), D (kolekalsiferol), E (tocopherol) and K (phylloquinone).
Essential minerals	Ca, P, Na, K, Cl, Mg, Mn, S, Fe, Cu, I, Zn, F, Cr, Se, Mo, Si

Derived from Reference [17]

The Eagan, Marmara and Black Sea regions of Turkey have the suitable ecological conditions. The nutritional values of edible wild mushrooms collected from the Black Sea Region of Turkey, i.e. *Cantharellus cibarıus,* (Yellow mushroom), *Lactarius piperatus* and *Boletus edulis*, were established by Çağlarırmak et al. [3]. *Boletus edulis* contains the highest protein value 7.39 %, while *L. piperatus* contains 2.67 %. The protein content of *B. edulis* is superior among the vegetables.

Table 3: Protein and vitamin contents of *Cantharellaceus* species [18]

Nutrient	*Cantharellus subalbidus* (White Chanterelle)	*Craterellus cornucopioides* (Siyah Chanterelle)	*Cantharellus cibarius* (Sarı Chanterelle)
Protein	0.24 ± 0.01	0.76 ± 0.00	0.33 ± 0.04
Vitamin C	1.64 ± 0.06	1.89 ± 0.04	1.96 ± 0.04
Folic acid	82.83 ± 1.11	17.83 ± 0.81	96.83 ± 2.47
Thiamine	0.12 ± 0.017	0.11 ± 0.04	0.12 ± 0.00
Riboflavin	0.21 ± 0.01	0.06 ± 0.01	0.11 ± 0.00
Pyridoxine	0.62 ± 0.01	0.86 ± 0.01	0.90 ± 0.01
Niacin	3.75 ± 0.13	3.34 ± 0.32	6.42 ± 0.31

Protein values expressed as % (wet weight), N x 4.38; Vitamin values expressed as mg/100g (wet weight)

Mushrooms are a well-balanced foodstuff when compared with other vegetables. Çağlarırmak [19] investigated proximate compositions, B group vitamins, minerals and volatiles of *L. edodes*, and *Pleurotus* species. In the research, the chemical composition and texture were examined according to four flush terms of *L. edodes. Pleurotus* species harvested only one flush term.

Mushroom can contribute to the human nutrition protein quality and containability of some essential amino acids. Reported mean protein values of *L. edodes*, *P. ostreatus* and *P. sajor-caju* were 2.61%, 1.76% and 0.92 % wb. Vitamin C contents of *P. ostreatu*s and *P. sajor caju* were 3.38 and 16.01 (mg/100 g wb). *Pleurotus sajor caju* can contribute to human nutrition from the point of vitamin C level. The folic acid, thiamin, riboflavin and niacin contents of these studied mushrooms found good levels for contributing to nutrition. Zn, Fe, P, Ca, Mg, K and Na quantities were determined according to flush terms. Zn, P, Mg contents of investigated exotic mushroom was high quantities [19]. In Turkey, quantity of consumption shiitake is very low since its price is very high according to approximate budget of people. Shiitake has medicinal importance [4].

Agaricus bisporus is produced in the highest quantity in Turkey. In some studies, the reported amount of total cultivated mushroom is 40,000-50,000 tonnes [20]. In rural areas, the public collects wild edible mushrooms that contribute to their economy and nutritional level.

A balanced and sufficient diet is a problem for low-income people. Wheat products are consumed in large quantities. Bread consumption is almost 450 g per day, per person. People provide 44 % of their energy and work capability and 48 % of their protein requirement. These ratios are high especially in rural areas.

The main nutritional problems are the deficiency of growing and developing because of malnutrition, night blindness, anemia, tooth problems and obesity [21]. Mushrooms contain B group vitamins and vitamin D, essential minerals and high amounts of protein. The individual mushroom quantity is between the 0.4-0.5 kg annually that is very less amount when comparing with the EU countries (2.5 kg) [20]. *Agaricus biporus* (brown) mushroom is the one of the common produced mushroom. Its detailed chemical composition and volatiles were determined in the three flush terms [5]. The mean contents of Zn, Fe, P, Mg and Na in both two harvests. (mg/kg wb) were (8.15-7.07), (7.40-7.96), (1180.93-1038.69), (88.05-76.29), (213.29-238.82), (265.0-250.89) and (534.2-554.80), respectively.

In terms of vitamin C, folic acid, thiamin, riboflavin and niacin, the mean contents (mg/kg wb) were 6.75-3.97, 0.09-0.08), 0.085-0.09, 0.27-0.29) and 3.62-2.94, respectively [4].

Agaricus biporus (white) is produced in the highest quantity among the other produced cultivated mushrooms in Turkey. The applying some of food treatments for preservation to mushroom are gained economical benefits and long shelf life. Mushroom canning is one of the common ways of preservation techniques. The nutritive values of canned mushrooms changed due to blanching and sterilization process [22]. When dehydrated mushrooms, the nutrients concentrated and preserved well. Dried mushrooms can add to other foods for enrichment [23].

Edible mushrooms also have very important health benefits. *Agaricus bisporus* (white) mushroom research has suggested that it has anticarcinogenic effects for breast and prostate cancer. White mushrooms have been found to restrain the activity of aromatase, an enzyme involved in estrogen production, and 5-alpha-reductase, an enzyme that converts testosterone to DHT. Extracts can reduce cell proliferation as well as tumor size [24, 25].

Shiitake mushroom contains lentinan, β-glucan which stimulation of the immune system and can fight the against AIDS and exhibits antitumor activity. Mushrooms have anticarcinogenic effects such as they contain β-glucans, selenium, or ether medicinal compounds. They have cardiovascular protective effects e.g. Na /K ratio high K and low Na ratio opposite of lots of plant sources. *Pleurotus* species contain bioactive compounds that can affect vein system and body [24, 25].

CONCLUSIONS

Cultivated mushroom production is an independent agriculture action since it can be carried out in closed areas for 12 months in the year. Edible wild mushrooms can contribute to the economy but collecting of these mushrooms must be done in suitable conditions without causing any hazard to nature.

In southern Turkey, Korkuteli town of Antalya is a pilot region for mushroom production. The daily mushroom production is 70 tonnes and can be enough for 60-70% of mushroom production in Turkey and 15 different cities are producing cultivated mushrooms. In that town, 40% of the population earn money from mushroom production. Mushrooms are called "white gold" in the town, and there are 1,500 mushroom producing plants. Many are small plants but some can apply modern mushroom technology processes [26].

Biochemical compositions of mushrooms may be similar to meat and contain B complex vitamins, minerals and protein, and also special volatiles [4, 5, 7]. Mushrooms are consumed in Turkey especially because of their taste (similarity to meat) and nutritional value. However, medicinal importance is not common tradition in the Anatolia. According to the Turkish Statistical Institute (TUIK), the economic contribution of cultivated mushrooms is 90-100 million Turkish Lira. The Mediterranean, Middle Anatolia, Eagan and Marmara, and Black Sea regions can produce the cultivated mushrooms, but in eastern and southeastern Turkey, production is low and less common [15].

Regular development and improvement of modern mushroom plants can help to develop the economy of countries and contribute to nutrition and health. Well-nourished individuals can become more productive and better use their mental and physical potentials for their personal development and that of their country.

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