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For millennia, human beings have valued mushrooms as an edible and medicinal resource. The archaeological record reveals edible species associated with people living 13,000 years ago in Chile, but it is in China where the eating of wild fungi is first reliably noted, several hundred years before the birth of Christ. Edible fungi were collected from forests in ancient Greek and Roman times and highly valued, though more by high-ranking people than by peasants. Caesar’s mushroom (*Amanita caesarea*) is a reminder of an ancient tradition that still exists in many parts of Italy, embracing a diversity of edible species dominated today by truffles (*Tuber* spp.) and *porcini* (*Boletus edulis*). Early civilizations, by trial and error built up a practical knowledge of those suitable to eat and those to be avoided, e.g., poisonous or even psychotrophic. In many parts of the world, especially Europe, wild mushrooms are regularly collected and used directly as a main source of food or added to soups, stews and teas. Mushrooms are considered to be a good source of digestible proteins with protein content above most vegetables and somewhat less than most meats and milk. Protein content can vary from 10-40% on dry weight basis. Mushrooms contain all the essential amino acids, but can be limiting in the sulphur containing amino acids, cysteine and methionine (Chang, 1991). Fresh mushrooms contain 3-21% fibre on a dry weight basis. Thus, a considerable proportion of the carbohydrate of mushrooms consists of dietary fibres which cannot be easily digested by humans and which function essentially as dietary fibre hence, making the calorific value of most mushrooms very low. Historically, hot-water-soluble fractions (decoctions and essences) from medicinal mushrooms, i.e., mostly polysaccharides, were used as medicine in the Far East, where knowledge and practice of mushroom use primarily originated (Hobbs, 1995). Mushrooms such as *Ganoderma lucidum* (Reishi), *Lentinus edodes* (Shiitake), *Inonotus obliquus* (Chaga) and many others have been collected and used for hundreds of years in Korea, China, Japan and Eastern Russia. Those practice still form the basis of modern scientific studies of fungal medicinal activities, especially in the field of stomach, prostate and lung cancers.

China features prominently in the early and later historical record of wild edible mushrooms. The Chinese have for centuries valued many species, not only for nutrition and taste but also for their healing properties. These values and traditions are as strong
today as they were centuries ago and are confirmed by the huge range of wild fungi collected from forests and fields and marketed widely. China is also the leading exporter of cultivated mushrooms. It is less well known that countries such as Mexico and Turkey, and major areas of central and southern Africa, also have a long and notable tradition of wild edible mushrooms. The use of wild edible mushrooms is both extensive and intensive, though patterns of use do vary.

Wild edible mushrooms add flavor to bland staple foods but they are also valuable foods in their own right. Not all wild edible mushrooms have such high protein content but they are of comparable nutritional value to many vegetables. In addition to making substantial contributions to the diets of poor people in developing countries, they are an important source of income. Wild edible mushrooms are sold in many local markets and commercial harvesting has provided new sources of income for many rural people. The demand for specialist wild mushrooms from Europe and Japan continues to earn significant amounts for countries such as Bhutan, the Democratic People’s Republic of Korea and Pakistan.

Wild mushrooms also have medicinal properties, some of which are found in edible species (Table 1). They comprise a vast and yet largely untapped source of powerful new pharmaceutical products. A number of bioactive molecules, including antitumor substance, have been identified in many mushroom species. In particular, they represent an unlimited source of polysaccharides— the most potent mushroom derived substances with anti tumor and immunostimulating properties (Mizuno, 1996; Wasser and Weis, 1999; Ooi and Liu, 200). Wild mushrooms therefore contribute towards diet, income and human health. Many species also play a vital ecological role through the symbiotic relationships known as mycorrhizas that they form with trees. Truffles, morels and other valuable wild edible mushrooms depend on trees for their growth and cannot be cultivated artificially. The mycorrhizas enable trees to grow in nutrient-poor soils.

The number of the mushrooms on earth is estimated at 140,000; of which may be only 10% are known. Meanwhile, of those 14,000 species that we know today, about 50% are considered to possess varying degrees of edibility, more than 2,000 are safe, about 7000 species are known to possess significant pharmacological properties (Chung, 1999; Wasser and Weis, 1999; Reshetnikov et al, 2001), thus, making clear that mushrooms represent major source of powerful new pharmaceutical products. According to FAO
Discussion

Several authors have described the taxonomy of mushrooms from various regions of the world but an analysis reveals that 60% of the newly described fungi are from tropics including mushrooms and up to 55% of the mushroom species have proved to be undescribed (Hawkesworth, 2001). Almost all the main taxonomic mushroom groups have been investigated for biologically active polysaccharides and most of them possess such substances. At least 651 species and 7 intraspecific taxa representing 182 genera of Hetero- and Homobasidiomycetes mushrooms contain antitumor or immunostimulating polysaccharides (Reshehtnikov et al., 2001). There are about 200 genera which contain mushroom species used by people, mostly because of their edible properties and some with medicinal properties are also valued by rural people in several countries, though this is of secondary importance.

Different scientists have contributed to the study of mushroom flora of Kashmir particularly from Gulmarg, Pahalgam, Sonamarg and some places in Srinagar and reported about 262 species of mushrooms (Abraham and Kaul, 1985, 1988, 1989; Abraham and Kachroo, 1989; Watling and Abraham, 1986). The present investigation includes the general survey and description and preliminary phytochemical and elemental analysis of some edible and medicinal species of mushrooms from Kashmir valley. The area is famous for mushrooms abundance and all the species are described in detail. The investigation is first of its kind in the area as all the mushrooms are photographed to aid in the identification and get the clear idea of surrounding habitat and morphology of mushroom including different developmental stages, presence of accessory structures on cap, shape of the cap, color of the spore print etc.

The present survey to collect mushrooms was extended to other areas that includes Shalbug, Kangan, Guganghir, Dusmarg, Sonamarg, Rawalpora, Sanat Nagar, Wanabal, Rangreth, Doodipathir from District Budgam and Srinagar and the special patches like Gulmarg, Barsu, Halan, and Khilanmarg etc. were also surveyed. Almost all the species collected possess medicinal properties. The species of mushrooms determined during the surveys performed in Kashmir province between the years 2003-2005 are listed in the
Table I. The collection of mushrooms was done under mixed forest tree species of Pine, Deodar and fir, from fruit orchards of apple, plum and under the mixed plantation of *Picea* and *Salix*. Collection of mushrooms specimens included species from class Ascomycotetes and Basidiomycotetes. Thirty mushrooms species belonging to the families *Morchellaceae*, *Helvellaceae*, *Pezizaceae*, *Sarcoscyphaceae*, *Phallaceae*, *Ramariaceae*, *Ganodermataceae*, *Polyporaceae*, *Russulaceae*, *Agaricaceae*, *Coprinaceae*, *Lyophyllaceae*, *Marasmiaceae*, *Pleurotaceae*, *Strophariaceae*, *Boletaceae* were identified. The localities, collection dates, detailed descriptions and edibility of the samples were recorded on spot along with their local uses. The medicinal property of each mushroom reported in the literature is included in the detailed comments of the observations (Chapter 5). All the taxa were identified with the help of relevant literature (Pacioni and Linecott, 1981; Pegler and Spooner, 1992, Parkayastha and Chandra, 1985) and also confirmed from M. Kuo (www.MushroomExpert.com) and Index Fungorum, an Internet resource, to find the current status for species names and check the synonyms (www.indexfungorum.org). Expert advice was also taken from Dr. T. N. Kaul, former Deputy Director and Head Regional Research Laboratory Jammu & Kashmir (CSIR).

The identity of mushrooms was authenticated by referring the recent monographs and through comparison with authentic herbarium specimens at Regional Research Laboratory (CSIR), Srinagar. The taxonomic arrangement follows Ainsworth and Bisby's Dictionary of the Fungi, 8th ed. (Hawksworth et al., 1995; Kuo, 2003). Edible species were identified using local and scientific knowledge. Local practices are based on empirical evidence of edibility, though local beliefs sometimes falsely exclude edible species. A scientific name provides access to published information on properties, but conflicting advice may exist. Local and scientific knowledge were used together as a guide to properties of wild mushrooms.

Out of the thirty enumerated mushrooms species, 24 are edible; but the degree of edibility varies in different regions of the Kashmir valley. The most widely consumed mushroom includes *Morchella* spp, *Coprinus* spp, *Helvella* spp and *Agaricus bisporus*. Some species are consumed by the inhabitants of particular regions due to scarcity of vegetables e.g. *Peziza repanda*. It is consumed by the people of Kangan area particularly Poshkar forest about 12,000-13,000 ft. high. Other species belonging to genus *Russula* and *Ramaria* said to be edible but generally not collected due to lack of awareness. *Psychoverpa bohemica* is consumed and sold in the market as a substitute or mixed with

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*Morchella* due to their close resemblance. It is collected in bulk and is abundant in the spring season.

Morels (*Morchella* spp.) mostly found in conifer temperate forests. All of the species in this genus are edible and delicious. They are highly prized for their culinary uses, particularly as a gourmet food and are used in gravies, sauces and soups. Morels are not only delicious; they are also a healthy and nutritious food. They are good source of protein on a dry weight basis, are low in calories and rich in minerals. Some individuals may have adverse reactions from eating morels, however, especially when they are consumed raw. The mushroom produced by the morel fungi has a characteristic appearance although the mushrooms of several closely related fungi have somewhat similar appearances. Morels grow in the temperate forests of Asia, Europe, the Near East and North America and are associated with many temperate trees. They tend to be abundant in early spring, shortly after snowmelts. Morels are exported fresh only about two weeks of the entire growing season because pests rapidly attack them. India and Pakistan are the major producing countries, each producing about 50 t/a of dry morels, all of which are exported. Afghanistan and China are two additional countries that trade morels internationally. All are gathered in forests although some research is under way to develop means of artificial cultivation. In Pakistan, there is a race between men, women and children to see who can handpick the greatest quantity of morels. These are sold fresh or in dried form to local shopkeepers, who dry them. No further processing is involved until they reach the wholesalers/exporters. The exporters de-stalk, grade and sometimes fumigate the morels before they are exported. France, Germany and Switzerland are the main importers of dried morels from India and Pakistan. International trade in fresh morels is limited because of the short life of these mushrooms. However, short distances between some producing countries and markets make trade in fresh morels possible.

Some edible as well as inedible species have local medicinal uses but not on a large scale due the availability of vast wealth of other traditionally used medicinal plants in the valley. Dry powdered form of a few mushrooms is used for the treatment of various ailments. The edibility and local medicinal uses of these mushrooms is mainly based on information gathered through personal interaction with local populace, herbalist, and the practitioner of herbal medicines (hakims).
Two species viz. Sarcoscypha cocinea and Peziza repanda have been reported for the first time from Kashmir. There are no earlier reports of their collection from the region.

The medicinal use of most of the mushrooms is reported in various traditional pharmacopias for their tremendous healing and immune enhancing properties like in Traditional system of Chinese medicine (TCM) and more recent use for their anti-cancer and anti-HIV properties (Jong and Donovick, 1989). Important among them are:

*Trametes versicolor*. A wood-rotting polypore that grows on the side of felled logs and other dead or dying wood. *Trametes versicolor* has medicinal properties and is used in cancer treatments, both as preventative and as curative. The mushroom accounts for around 16 percent of Japan's national expenditures on anti-cancer agents. The species ingredients are also thought to enhance T-cell proliferation and are taken in the Asian countries as a nutraceutical. Furthermore, *Trametes versicolor* is used as immune stimulant; antibiotic; against pulmonary disorders; as antiviral; against hepatitis; and for the infections of the respiratory, urinary and digestive tracts. In Japan a nutritional supplement containing *T. versicolor* is generally used as a health food, and testing in Japan has shown that it has cholesterol-lowering properties.

*Fomes fomentarius*. Another wood rotting mushroom growing on tree stands as a parasite and on stumps especially *Populus*. Considered to be the best medicinal mushroom with anti viral and anti tumor properties. *Fomes fomentarius* extract is known for anti-inflammatory property.

*Ganoderma applanatum*. This is a wood rotting mushroom parasitic on wood of *Salix* and *Populus*. Number of compounds from this mushroom show inhibitory effect on the replication of human immunodeficiency virus Antibacterial properties

Some of the important genera of wild mushrooms that are in use and brought into trade are:

*Agaricus*. Species from this genus are regularly collected from the wild but only cultivated forms are exported. Some species are poisonous like *A. xanthomomas*. *A. bisporus* is the mostly commonly cultivated edible fungus. The medicinal *A. blazei* is exported from Brazil to Japan and cultivated and sold in China. There are about sixty
edible species reported from twenty-nine countries, out of which forty-three are consumed in thirteen countries. Seventeen species have been proved edible through experiments but are not used as food and six have medicinal property (including species used as food and those which are edible).

**Amanita.** There are a notable number of poisonous species belonging to this genus. *A. phalloides* is a major cause of deaths around the world from consumption of wild mushroom. There are about eighty-three species reported from 31 countries and out of which used as food in 15 countries. Forty two species are consumed and thirty-nine are edible but not consumed and seven are medicinal. *A. caesarea* is highly valued in countries such as Mexico, Turkey and Nepal. Few species are traded across national borders.

**Lactarius.** Many different species from this genus are regularly collected and eaten. Common one being species such as *L. deliciosus* that is highly esteemed and there is a valuable trade in Europe. Several species are frequently sold in local markets. Despite widespread popularity there are little reports of export activity, perhaps reflecting the diversity of species on offer. Total ninety-four edible species belonging to this genus are reported from thirty-nine countries; and about fifty-six are used as food in seventeen countries. About thirty-eight are reported edible with no consumption and seven are medicinal.

**Lentinus.** Although many different species are collected and used locally only two or three are of any significance. Key species probably *L. tuber-regium*, valued for its medicinal properties. There is little or no export trade. Total twenty-eight edible species are reported from twenty-four countries and about sixteen species are being used as food in eight countries; five are medicinal and twelve are edible.

**Lycoperdon.** There are many records of species being eaten but typically reports are of small-scale collecting and use. Only market sales known for this genus are in are in Mexico. Commonly collected species are *L. pyriforme* and *L. perlatum*. Twenty-two edible species are reported from nineteen countries; out of which nine are used as food in seven countries. Ten species are reported edible without worldwide consumption and ten are medicinal.
**Marchella.** Highly valued genus with several species that are collected in abundance in certain years especially during spring and early summer and are a major source of (export) revenue in several countries. Species are not always eaten in countries where they are collected. Common species include *M. esculenta*. Total number of edible species is eighteen, which are reported from twenty-eight countries, and fourteen are being consumed as food in ten countries. Four species besides being edible don’t have wide consumption and five are medicinal.

**Pleurotus.** Species from this genus occur widely and are regularly picked from the wild though seldom traded. Common species is *P. ostreatus* in terms of amounts eaten, predominantly from cultivation. Other species are said to be tastier. Total forty are edible species reported from thirty-five countries and about twenty-two are used as food in nineteen countries. Eighteen are edible and seven are medicinal.

**Ramaria.** There are many records of local use of mushroom species belonging to this genus. They are regularly sold in the markets in Nepal and Mexico and elsewhere. About forty-four edible mushrooms have been collected from eighteen countries and out of that thirty-three are reported to be used as food in seven countries. This genus includes several major species but *R. botrytis* is the most commonly collected and used. Some species are poisonous; others (eleven) are edible but not wide consumption some have medicinal properties (five).

**Russula.** It is one of the most widespread and commonly eaten genera that contain many edible species. Also include poisonous varieties though most of them can be eaten after cooking. Regularly sold in markets but species names not always recorded. Notable species include *R. delica* and *R. virescens*. 128 edible species are reported from twenty-eight countries, of which only 71 are used as food in twelve countries. Others (about fifty four) are edible but not widely consumed and twenty-five are medicinal.

Some of the mushrooms reported in this study are with conflicting reports on edibility. They are:

*Coprinus atramentarius* – is said to be edible if eaten in the absence of alcohol; this produces an unpleasant effect if imbibed at the same time, hence it is advised not to
consume with alcohol otherwise there is chance of mushroom poisoning (Lineoff and Mitchel, 1977).

*Helvella lacunosa* - Widely eaten but also reported as toxic if eaten raw. It also shows resemblance to poisonous species (*Gyromitra esculenta*, false morel). (Lineoff and Mitchel, 1977).

*Morchella esculenta* - Edible and good to taste; consumed fresh as well as dry but when cooked properly. Considered to be to be poisonous if eaten raw (Lineoff and Mitchel, 1977).

*Ramaria formosa* - Edible in Nepal (Adhikari and Durrieu, 1996) but said to be poisonous in several other countries, including Bulgaria (Jordanov, Vancev and Fakirova, 1978).

Certain other species are reported poisonous, although very small in number; they are lethal that has created potential barriers to mushroom eating and to wider marketing of edible mushrooms in many places. The threat posed by poisonous and lethal species is often overstated. Incidents of poisoning and deaths are few and far between compared to the regular and safe consumption of edible species, but publicity and cultural attitudes continue to fuel an intrinsic fear of wild mushrooms in some societies. This is more commonly found in developed countries and has undoubtedly led to general beliefs that global use of wild edible mushrooms is small-scale and restricted to key areas. Knowing the scientific name of a mushroom can provide a good indication of its edibility but the only reliable guide to edibility is the knowledge that someone has eaten a particular type of mushroom and survived. Local practices and preferences are therefore another useful source of information after scientific knowledge. There are also conflicting reports in field guides about the edibility of many mushrooms. Some recommend eating species that others reject as poisonous. People from eastern Finland regard the false morel, *Gyromitra esculenta*, as a culinary delicacy once it has been carefully pre-cooked. Guides in the United States and elsewhere state emphatically that the fungus is poisonous and should not be eaten. The number of species eaten locally is sometimes only a fraction of those available. Rural and tribal people have a positive yet informed approach to eating wild fungi, which people living in cities lack. Educated people living in towns...
lose the strong local traditions that rural communities maintain and even acquire a suspicious attitude towards wild mushrooms.

2. Preliminary phytochemical and elemental analysis

Seven edible mushroom species were analysed for the determination of chemical constituents (carbohydrates, saponins, phenols, alkaloids and tannins), soluble protein, crude protein, total soluble sugar, vit. C, amino acid and elements present in them. The results are discussed hereunder.

Chemical constituents

Mushrooms were tested for the presence of carbohydrates, alkaloids, saponins, phenols, and tannins. Of the seven edible species screened, carbohydrates, saponins and phenols were detected in all the mushroom samples. The presence in majority of mushrooms is also evident from the literature. Glycoside was detected in *Coprinus atramentarius* only. In literature glycosides are reported from different wild mushrooms. Tannins and alkaloids were not detected from any of the samples (Table 2).

The most notable of the many phytochemicals reported in mushrooms are various complex carbohydrates (polysaccharides) created from long chains of monosaccharides, or simple sugars. These polysaccharides trigger an immune response in the human body. Other bioactive compounds reported in medicinal mushrooms that contribute to their nutritional and therapeutic powers include alkaloids, nucleotides, amino acids, proteoglycans, terpenes, triterpenes, unsaturated fatty acids, sterols (such as ergosterol), and phosphatidyl choline and other phospholipids. Current studies suggest that mushrooms hold great promise as both prophylactic and therapeutic agents for a wide range of health concerns.

Total soluble protein

All the species analysed here had substantially higher amounts of protein ranging from 17.80 μg g⁻¹ dw to 31.32 μg g⁻¹ dw (Table 3, fig. 1). Highest concentration of protein (31.32 μg g⁻¹ dw) was recorded in *Coprinus comatus* followed by *Pleurotus ostreatus* (29.99 μg g⁻¹ dw), *Coprinus atramentarius* (29.18 μg g⁻¹ dw), *Morchella vulgaris* (28.94 μg g⁻¹ dw), and *Lentinus tigrinus* (23.90 μg g⁻¹ dw). The least content was recorded in...
Helvella acetabullum (17.80 µg g⁻¹ dw). Mendel (1898) has recorded 25.4 g/100g dw protein in Coprinus comatus and 29.18 µg g⁻¹ dw protein in C. atramentarius. Earlier reports show protein ranging from 31.25 g/100g dw to 35.68 g/100g dw in Morchella spp. (Kaul, 1978a). Protein in P. ostreatus was recorded 32.9 g/100g dw (Kaul and Janardhan, 1970), 30.4 g/100g dw (FAO 1972) 10.5 g/100g dw (Mendel, 1898), Jandaik and Kapoor (1975), Singh and Rajarathnan (1977), Sethi and Anand (1978) recorded 47.93 g/100g dw, 33.24 g/100g dw and 28.42 g/100g dw protein respectively, from Pleurotus spp. Mendel (1898) recorded 20.5 g/100g dw in C. atramentarius, 23.4g/100g in Morchella esculenta and 25.4/100g dw in C. comatus protein. The results obtained in the present study are almost similar to those reported earlier.

The nutritional value in terms of proteins is usually very high in the majority of mushrooms. FAO (2004) studies confirm that wild edible mushrooms are nutritious and a suitable alternative for well-known foodstuffs. They compare favorably using standard measures such as amino acid score, essential amino acid index, biological value and nutritional index that assess the nutritional value of food. This allows for comparisons to be made between foods with small amounts of high quality proteins and those that have large amounts of lower nutritional values. The contribution to diet depends on the amounts eaten by people, the species involved and the frequency of consumption (FAO, 2004). Wild mushrooms are excellent for malnourished children (Scrunjogi, 2005). Mushrooms contain proteins, which are easily absorbed by the body tissues and used to boost the immunity.

Crude protein

The crude protein content of mushroom (dry weight basis) was also estimated by multiplying the amount of the total nitrogen (N) by 4.38 to eliminate non-protein nitrogen (FAO, 1970). Crude protein ranged from 9.372% in Lentinus tigrinus up to 25.04% in Coprinus comatus (Table 3, Fig. 1). The %age of crude protein in Coprinus atramentarius, Ramaria Formosa, Morchella vulgaris, Pleurotus ostreatus and Helvella acetabullum was recorded as 21.43%, 15.28%, 22.02%, 16.53% and 21.68% respectively. Earlier records show 31.6% protein in Lentinus tigrinus (Chandra and Purkayastha, 1976) and 31.1% in Morchella esculenta (Litchfield, 1967). The crude
protein of other *Pleurotus* species was recorded as 24.2% (Bano et al., 1981). The results obtained are in accord with earlier studies.

**Total soluble Sugar**

The total sugar content in mushroom species ranged from 0.8 μg g⁻¹ dw to 8.76 μg g⁻¹ dw (Table 2, fig. 1). The highest content was recorded in *Coprinus comatus* and the least in *Lentinus tigrinus*. The sugar content in *Morchella esculenta* was 5.55 μg g⁻¹ dw, in *C. atramentarius* 6.00 μg g⁻¹ dw and in *Ramaria formosa* 2.39 μg g⁻¹ dw. Sugar content recorded in *Pleurotus ostreatus* and *Helvella acetabulum* was 1.61 μg g⁻¹ dw and 1.23 μg g⁻¹ dw. Earlier reports recorded 5.21% of total sugar content in *Chlorophyllum molybdites* (Goyal et al., 1987).

**Ascorbic acid (Vit. C)**

The concentration of Vitamin C was recorded in the order of *Lentinus tigrinus* > *Ramaria formosa* > *Coprinus comatus* > *Helvella acetabulum* > *Morchella esculenta* > *Pleurotus ostreatus* (Table 2, fig. 1). The highest value recorded was 405.16 nmol g⁻¹ dw in *Lentinus tigrinus* and least 196.96 nmol g⁻¹ dw in *Pleurotus ostreatus*. The concentration of ascorbic acid in other mushrooms was recorded 272.66 nmol g⁻¹ dw in *Coprinus atramentarius*, 336.83 nmol g⁻¹ dw in *C. comatus*, 395.66 nmol g⁻¹ dw in *Ramaria formosa*, 217.00 nmol g⁻¹ dw in *Morchella vulgaris* and 323.33 nmol g⁻¹ dw in *Helvella acetabulum*. Ascorbic acid content in the literature has been reported to be in the range of 13.0-14.7 mg/100g in various mushroom fruiting bodies (Zakia, 1967). Goyal et al (1987) recorded 404.42- 599.06 μg g⁻¹ dw in *Lentinus edodes* and 363.80-373.78 μg g⁻¹ dw in *Pleurotus ostreatus*. Mushrooms are a good source of vitamins (Oei, 1996). Vitamins are very unstable in sunlight or heat and therefore they could be easily destroyed and due to this sometime results may vary.

**Amino acid**

Amino acid content in *Coprinus comatus* was recorded as 3.17 μg g⁻¹ dw followed by 2.14 μg g⁻¹ dw in *Coprinus atramentarius* and 1.55 μg g⁻¹ dw in *Ramaria formosa* (Table 2, fig. 1). Least content was recorded in *Helvella acetabulum* with 0.59 μg g⁻¹ dw. Amino acid content in other mushrooms was recorded as 0.98 μg g⁻¹ (*Lentinus tigrinus*).
0.860.86 µg g⁻¹ dw (Morechella vulgaris) and 0.99 µg g⁻¹ dw (Pleurotus ostreatus). The amino acid content of mushrooms, their quality and predicted nutritional value have been discussed by various workers (Crisan and Sands, 1978; Rajaratnam and Bano, 1991; Buswell and Chang, 1993). Most of the earlier work has been done for the qualitative estimation of almost all the essential amino acids.

Elemental composition

The present study showed that wild edible mushrooms have the ability to accumulate certain elements, especially potassium, sodium, cadmium, copper, arsenic, mercury, zinc, and selenium etc., hence are useful sources of many mineral elements for the balanced diet. This is consistent with earlier studies, which show that certain fungi can accumulate very high concentrations of metals (Soylak et al., 2004; Mendil et al., 2004). The quantities could vary according to the growth substrates (Sadler, 2003; Stanits, 2005). Mushrooms could provide a useful source of potassium and calcium as indicated by the study. Even within the same species, there could be variations in the quantities of the minerals since differences could be as a result of the variations in the ability to utilize nutrients in a given substrate (Chang and Hoyes, 1978). The micronutrients in mushrooms could help to relieve disorders, which range from constipation to heart disease and cancer. For example potassium in mushrooms regularizes the heartbeat and improves oxygen supply to the brain (Serunjogi, 2005) hence relieving stress. Calcium could be used by the body to build strong bones, and could play an important role in the proper functioning of the nervous system. In the body, calcium and phosphorus are at a balance. Too much phosphorus in the body could lower the amount of calcium and could lead to loss of calcium from the skeleton. Most of the nutrients in mushroom cannot be destroyed by sunlight and therefore dried ones still serve the purpose.

Elements such as iron, copper, zinc and manganese are essential metals since they play an important role in biological systems, for metabolic reactions like transmission of nerve impulses, rigid bone formation and regulation of water and salt balance among others. Whereas lead and cadmium are non-essential metals as they are toxic, even in traces (Schroeder, 1973). The essential metals can also produce toxic effects when the metal intake is excessively elevated.
Selenium (Se) was detected in all mushrooms analyzed that ranges from 41.144 μg g⁻¹ dw (Helvella acetabulum) to 1260.8 μg g⁻¹ dw (Lentinus tigrinus) (Table 5, fig. 4). Modern research suggests that selenium together with Vitamin E is known to help prevention of prostrate cancer, the second most common cancer in men after skin cancer. It has been found that aging men show decrease in blood selenium levels, such men require more selenium in their diets (Combs et al. 1997) and mushrooms can be used to supplement Se deficiency.

Iron (Fe) content ranged from 128.3μg g⁻¹ dw in Lentinus tigrinus to 1097 μg g⁻¹ dw in Helvella acetabulum (Table 4, fig. 3). Iron values for various mushrooms have been reported to be in the ranges: 31.3–1190 μg g⁻¹ dw (Sesli Tuzen, 1999), 568–3904 μg g⁻¹ dw (Turkekul et al. 2004) and 56.1–7162 μg g⁻¹ dw (Isildak et al., 2001), respectively. Iron values for the species investigated presently are in agreement with those reported in the literature.

The Potassium (K) in mushrooms ranged from 1566.7μg g⁻¹ dw to 3383 μg g⁻¹ dw. Highest value of Potassium (K) was found in Coprinus atramentarius (3383 μg g⁻¹ dw) (Table 4, fig. 3). This is in accord with the observations made by Bano and Rajaratnam (1982), and Crisan and Sands (1978). Kaul (1978a) reported 3831.90 mg 100g dry wt of potassium in Morchella esculenta. In Pleurotus ostreatus, 3793.90 mg 100g dry wt of potassium has been recorded (FAO 1972). Potassium helps to maintain normal heart rhythm, fluid balance, and muscle and nerve function. Food and Drug Administration recently proved the disease fighting capability of potassium. Diets that are rich in potassium are capable of reducing high blood pressure and stroke.

The concentration of Manganese (Mn) was found between 20 μg g⁻¹ dw (Lentinus tigrinus) and 446.5μg g⁻¹ dw (Helvella acetabulum) (Table 4, fig. 3). Two species recorded highest concentration of Mn i.e. 446.5μg g⁻¹ dw (Helvella acetabulum) and 200.7μg g⁻¹ dw (Pleurotus ostreatus). The manganese values recorded so far in the mushrooms are 7.6–56.2 μg g⁻¹ dw (Demirbas, 2001), 21.7–74.3μg g⁻¹ dw (Isildak et al. 2004) and 7.1–81.3 μg g⁻¹ dw (Tuzen, 2003), respectively. Mn contents obtained in Helvella acetabulum and Pleurotus ostreatus are much higher than those in the literature. Mn content in Coprinus atramentarius, Coprinus comatus, Ramaria fommosa and
Zinc (Zn) was detected in all mushroom samples, which range from 95.7 μg g⁻¹ dw to 121.5 μg g⁻¹ dw. The highest Zn content (121.5 μg g⁻¹ dw) was recorded in *Morchella vulgaris* (Table 4, fig. 3). Zinc is widespread among living organisms due to its biological significance. Mushrooms are known as zinc accumulators in the fruiting body (Bano et al., 1981; Isiloglu et al., 2001). Zinc concentrations of mushroom samples in the literature have been reported to be in the ranges: 40.3–64.48 μg g⁻¹ dw (Mendil et al., 2004) and 29.3–158.8 μg g⁻¹ dw (Isiloglu et al., 2001). The results obtained in the present study are more or less similar to the earlier studies.

Sodium (Na) was detected in all the mushroom samples that ranged from 50 μg g⁻¹ dw in *Ramaria formosa* to 950 μg g⁻¹ dw in *Lentinus tigrinus* (Table 4, fig. 3).

Copper (Cu) concentration were between 16.0 μg g⁻¹ dw to 228.5 μg g⁻¹ dw; the highest in *Coprinus comatus* and lowest in *Morchella vulgaris* (Table 4, fig. 3). Copper was not detected in *Lentinus tigrinus*. Copper contents of mushroom samples in the literature have been reported to be in the ranges: 4.71–51.0 μg g⁻¹ dw (Tuzen et al., 1998), 12–181 μg g⁻¹ dw (Tuzen et al., 2003) and 10.3–145 μg g⁻¹ dw (Sesli & Tuzen, 1999), respectively. Other studies also report copper from different mushrooms in the range of 34.5–83.0 μg g⁻¹ dw (Demirbas, 2002), 10.0–14.0 μg g⁻¹ dw (Isiloglu et al., 2001) and 21.1–42.6 μg g⁻¹ dw (Sivrikaya et al., 2002), respectively. Copper is one of the essential minerals that help iron in making red blood cells and delivering oxygen to every part of the body.

Chromium (Cr) was detected in all the mushroom species analysed. Chromium observed in *Coprinus atramentarius* was 0.167 μg g⁻¹ dw, in *Morchella vulgaris* 0.099 μg g⁻¹ dw, in *Lentinus tigrinus* 0.094 μg g⁻¹ dw, in *Ramaria formosa* 0.292 μg g⁻¹ dw, in *Pleurotus ostreatus* 0.105 μg g⁻¹ dw, in *Helvella acetabulum* 0.113 μg g⁻¹ dw and, in *Coprinus comatus* 0.139 μg g⁻¹ dw (Table 5, fig. 4). Chromium values in mushroom samples have been earlier reported to be in the ranges: 0.16–4.86 μg g⁻¹ dw (Malinowska et al., 2004), 0.87–2.66 μg g⁻¹ dw (Tuzen, 2003) and 7.0–11.0 μg g⁻¹ dw (Siverikaya et al., 2002).
Cadmium (Cd) concentrations in mushroom species ranged from 0.019 μg g⁻¹ dw to 0.816 μg g⁻¹ dw. The highest concentration of cadmium was found in *Lentinus tigrinus* (0.816 μg g⁻¹ dw) (Table 5, fig. 4). This could reflect either a higher rate of cadmium accumulation in this species, or it could be that this samples happened to be growing in soil that had higher levels of cadmium. However, soil analysis was not pursued. Cadmium was not detected at all from *Ramaria formosa*. Cadmium contents of mushroom samples in the literature have been reported to be in the ranges: 0.81–7.50 μg g⁻¹ dw (Svoboda et al. 2000), 0.10–0.71 μg g⁻¹ dw (Mendil et al. 2004), 0.28–1.0 μg g⁻¹ dw (Mendil et al. 2004) and 0.12–2.60 μg g⁻¹ dw (Malinowska et al. 2004). Our cadmium levels were found in accord with the results reported in the literature, however, value recorded for some species in the present study is much lower than those reported earlier in the literature.

Mercury (Hg) was present only in *Coprinus atramentarius* (24.59 μg g⁻¹ dw) (Table 5, fig. 4). Three samples of mushrooms showed the presence of Arsenic (As). Arsenic content was 7.52 μg g⁻¹ dw in *Lentinus tigrinus*, 4.44 μg g⁻¹ dw in *Coprinus comatus*, and 1.35 μg g⁻¹ dw in *Ramaria formosa*. Earlier reports recorded arsenic levels in *Agaricus macrosorbus* (0.97 mg/kg), *Lepidella procera* (0.83 mg/kg) and *Agaricus arvensis* (0.73 mg/kg).

The concentration of Carbon, Hydrogen, Nitrogen and Sulphur was in the order of CHNS across all the mushrooms analyzed. The percentage of Carbon ranged from 35.28% in *Coprinus comatus* to 40.31% in *Lentinus tigrinus*. The percentage of Hydrogen was found 6.26% in *Coprinus atramentarius* to 7.63% in *Helvella acetabulum*. The lowest Nitrogen percentage was recorded in *Lentinus tigrinus* (2.14%) and highest in *Coprinus comatus* (5.71%). Sulphur was recorded between 0.16% and 0.86% in *Helvella acetabulum* and *Coprinus atramentarius*, respectively (Table 6, fig. 2). The low concentration of sulphur in mushrooms is in accordance with the observations made for analysis of sulphur containing amino acids by different scientist. Most of the species of mushrooms are deficient in sulphur containing amino acids.
Three mushroom species *Ganoderma applanatum*, *Fomes fomentarius* and *Pleurotus ostreatus* from two different sites of the same region (Rawalpora, Wanjali) were analysed for the variation in elemental composition. Much variation was not found in the contents of N, H, S, C and crude protein in the samples from two sites but significant variation was found in the concentration of other elements like Cu, Zn, Fe, Mn, Cd and Cr (Table 7 and 8, fig. 3).

The trace elements present in the mushrooms are within the permissible levels. The considerable differences in the composition of mushroom can be correlated to direct effect on mushroom fruiting body by many variables like difference in mushroom species, composition of growth substrate, stage of harvesting etc. The results of nutritionally valuable minerals show that the mushroom species were rich in potassium, iron and manganese. This is in agreement with the report of analysis of some cultivated mushrooms like *Agaricus bisporus*, *Lentinus edodes*, and *Pleurotus ostreatus* (Mattila et al., 2001). Some elements (e.g. zinc, selenium, cobalt, copper) can act as nutrients and are essential for health. Others (e.g. mercury, cadmium, lead) have no known beneficial health effects; they may be harmful if excessive amounts are consumed. A report by Ministry of Agriculture, Fisheries and Food shows that metal and other elements are present in foods either naturally, as a result of human activities (e.g. agricultural practices, industrial emissions, car exhausts), from contamination during manufacture/processing and storage, or may be added directly (MAFF, 1998).

Gruen and Wong (1982) have indicated that edible mushrooms are highly nutritional and compared favorably with meat, egg and milk. The protein values of most mushrooms compared favorably with and in some instances surpassed those reported for most legumes except groundnut and soybeans grown in West Africa (FAO, 1970; Aletor and Aladetimi, 1989). The mineral levels, mainly potassium, sodium and iron in these mushrooms are higher than those reported for several vegetable varieties (Aletor and Aladetimi, 1989), but lower than those reported from animals (Imevbore, 1992). Some of the mushrooms are known to possess antitumorigenic and hypcholesterolaemic agents, which implies that mushrooms could hold special attraction for and may be recommended for people with cholesterol-related ailments (Chihara, 1993).

According to the latest demographic studies the world population is expected to increase nearly 9 billion by 2050 especially in developing countries and with the increase in
population the need for the food will increase. The edible mushrooms hold tremendous promise as a food source in complementing the protein and mineral supply deficits in situations of food shortage and as nutritional additions in the daily diet. Edible fleshy mushrooms have a balanced and high nutritional value, and are the storehouse of minerals and vitamins and hence make a useful contribution to diet, at the cheapest price. It is anticipated that, in the future, mushrooms will have increasing importance in medicine and biotechnology because of their unique biosynthetic capabilities and metabolic products.

Now a days mushroom is considered as the corner stones of health care system due to presence of many helpful phytochemicals in alleviating some serious diseases. Mushrooms containing phyto factors potential are now referred to as functional food or health food being known as protective food. In the modern system of disease control, mushrooms containing strong antioxidants properties or phytochemicals neutralise the injurious effects of free radicals as scavengers and thus help in specific body functions in reducing the risk of incidence of many diseases like cardiovascular problems, various types of arthritis, cancer, AIDS and various other degenerative diseases. The predominant mushrooms showing promise for their antiviral and other medicinal activities are polypores- the so-called bracket fungi or woody conks like species belonging to Genus Ganoderma, Fomes and Trametes (Collins and Ng, 1997; Hattori, 1997). The current study focuses to mushrooms especially those belonging to polyporaceae, as a rich frontier of new medicines. Many of these are long term residents of nutrient recycling by decomposing aged trees. In a time when new antiviral medicines are critically needed, mushrooms stand out as an untapped resource and deserve intensive studies.

Mushroom farming has been practiced quite long on commercial scale in the developed countries like SA, France, Holland and China. The cultivation in India is hardly about 50 years old. In India mushroom growing centers are mainly in the north and some in the south and Punjab, Haryana, Himachal Pradesh, Uttar Pradesh and Tamil Nadu. When the whole world including India in suffering from malnutrition and food shortage, we should pay utmost attention to mushroom farming for a sustained health care system. All the promising mushrooms can be brought into artificial cultivation, which not only helps in conversion of huge lignocellulosic wastes into human food but also can produce notable
biomedical products, which have many health benefits. Mushrooms and their medicinal products have a great potential for supplying healthy food and dietary supplements for domestic consumption as well as for export and if this industry is properly established it can prove beneficial to millions of people in developing countries in terms of financial, social and health improvements and has already had impact on national and regional due to its economic growth.