Phytochemicals in Edible Wild Mushroom

Rupali Jarwal
Christian Eminent College, Indore
Email id:- rupalijarwal67@gmail.com

Abstract: In this 21st century the whole world is health conscious. The large population of the world is looking for natural remedies to get rid of such serious diseases in which mushroom plays an important role. They have phytochemicals (flavonoids, antioxidants, carotenoids, sulphides etc.) which help to protect cellular system and reduces the risk of chronic diseases. Mushrooms are highly rich source of proteins and a lower amount of fat. The protein content of mushrooms are reported to be twice of that of vegetables and four times that of oranges and significantly higher than wheat. Phytochemicals are compounds that are produced by plants. Some of these phytochemicals are believed to protect cells from damage that could lead to cancer. These bioactive compounds together with the high antioxidant activities obtained in some species and the nutrient contents in all species may be responsible for their nutritional and therapeutic uses. Mushrooms are rich in natural antioxidants; they also accumulate a variety of secondary metabolites including phenolic compounds, polyketides, terpenes, and steroids.

Keywords: Wild mushrooms, phytochemicals, antioxidants, enzymes.

Introduction:

Phytochemicals are the chemicals found in plants that are biologically active but not nutritive. These are the power house natural chemicals inside plants which basically give the plant protection against diseases and they also have disease preventing properties in humans too. They are believed to protect plants from variety of injurious agents, including insects and microbes, the oxygen they produce and the UV light they capture and transform into the nutrients we need. During 1980's and 1990's many laboratories started studying about phytochemicals to "mine" plants for bioactive substances that might be used as medicines (neutraceuticals) or for other chemical applications. As they are present naturally in plants foods, they promise to create a new philosophy of "functional foods" eating not just to maintain the basic health but also to prevent diseases.

Phytochemicals interact with each other in the body producing synergistic effect that is greater than the sum of the effect of individual phytochemicals. They interact with macronutrients as well as with vitamins and minerals. Most of them need to work with other phytochemicals to produce the therapeutic effect on the body. Most of the phytochemicals have antioxidant activity which has the tendency to protect the cells against oxidative damage such as: allyl sulfides, carotenoids, flavonoids, polyphenols etc. Other phytochemicals which interfere with enzymes are protease inhibitors, terpenes.

Carotenoids are yellow, orange and red pigments synthesize by plants. The most carotenoids are alpha-carotene, beta-carotene, beta-cryptoxanthim, lutein and lycopene. According to the results of epidemiological studies, suggest that diets high in carotenoids rich foods are associated with reduce risk of cardiovascular disease and some cancers.

Flavanoids are also, the most important antioxidants which promote several health effects i.e., antiviral, anticancer, anti-inflammatory and anti-allergic. Flavanoids are the group of plant metabolites thought to provide health benefits through cell signalling pathways and antioxidants effects .These molecules are present in variety of fruits and vegetables. They are ubiquitous in plants and are the most common type of polyphenolic compounds found in the human diet (Sally Roberson, 2018). Antioxidants are the substances that can prevent slow damage to cells caused by free radicals, unstable molecules that the body produces as a reaction to environmental and other pressures examples include vitamin C, E, selenium and carotenoids and so on. Although it helps to neutralize free radicals in our bodies and boost overall health. (Natalie Olsen, 2018)

Mushroom is described as a macro-fungus with a unique fruiting body, which can be hypogenous or epigeous, large enough which can be seen by naked eyes (Chang & Miles, 1989). They are found to be rich in proteins, minerals, vitamins while they are low in lipids (Pathak *et al*., 1997). Mushrooms have phytochemicals and other compounds which are strong antioxidants (Fang *et al*., 2002; Liu, 2004). Phenolic compounds, alkaloids, saponins, flavonoids, tannins, sterols, triterpenes, coumarins and cyanogenic glycosides have been obtained in wild mushrooms (Adebayo *et al*., 2012).

The compounds seem to wipe the free radicals produce in the normal natural metabolism of aerobic cells, mostly in the form of reactive oxygen species (ROS). These include superoxide (O2 -) and hydroxyl (OH-) radicals among several others. Exogenous sources of free radicals include tobacco smoke, ionizing radiation, certain pollutants, organic solvents and pesticides (Barja, 2004). Once in a while, most of the free radicals are neutralized by cellular antioxidant defense enzymes e.g. Superoxide dismutase (SOD) or catalase (CAT). Non-enzymatic molecules like ascorbic acid and carotenoids are found to be present in mushrooms and they also act as antioxidants (Fang *et al*., 2002; Isabel *et al*., 2004). The maintenance of equilibrium between free radicals production and antioxidant resistance is an essential condition for normal organism performance (Hollman, 2000). Mushroom neutraceuticals describe a new class of compounds extractable from either the mycelium or fruit body of mushrooms and embodies both their nutritional and medicinal features. They are consumed as a dietary supplement which has potential therapeutic applications. Mushroom neutraceuticals are enriched food materials which are used for maintenance of healthy diet (Chang & Miles, 1989; Shiuan, 2004). Concoction of mushrooms has been used to prevent beriberi (Beriberi is a disease caused by a vitamin B-1 deficiency). In addition, the decoction has been used for the treatment of abscesses and wounds (Yu *et al*., 2009).

Some phytochemicals (e.g., β-carotene, β-cryptoxanthin) have been linked to obesity prevention, although the evidence is not as strong (Mirmiran *et al.*, 2012). Higher dietary phytochemical indexes and some phytochemicals showed potentially promising effects on appetite and weight control (Mirmiran *et al.*, 2012). For example, pinolenic acid, found in Korean pine nuts, may suppress appetite by triggering release of the satiety hormone cholecystokinin (Pasman *et al.*, 2008).

Mushroom cultivation:

Starting from the first artificial cultivation of mushroom on a mixture of soil, sand and maize meal (in ratio of 12: 6: 1) in soil jars, improved production techniques were developed later on by various workers. It is gaining a huge fame among the potential mushroom growers as well as with the point of view of consumers due to its attractive shape and size, simple growing technique, low capital investment, wide substrate range, viable yield, long shelf-life and ability to flourish in a wide range of climatic conditions. Quality and quantity plays an important role in the successful production of any mushroom species. Land requirement is a minimum and any alternative room of the house can be converted into a mushroom growing room, or a hut built on a piece of land can also be used for the purpose. The raw materials required for crop cultivation or generated by the farmers on their own fields (paddy/wheat/or any other cereal straw). The raw materials requirement for cultivating a crop of mushroom is reusable cereal straw/organic waste/organic by products. The main by products used for substrate preparation for mushroom farming are wheat / paddy straw, sugarcane baggage, saw dust, cotton seed meal/soybean meal, scores of the locally available agro by products and other agro waste materials like banana pseudo stem/ corn cobs/ groundnut hull etc. Poultry manure is also used as nitrogen rich supplement for compost making for mushroom cultivation. These raw materials are locally available in all the rural areas of the country (Subbulakshmi & Kannan, 2016).

Phytochemical analysis in mushroom:

Phytochemicals are non-nutritive components present in a plant-based diet ('phyto' is from the greek word, meaning plant) that exert protective or disease-preventing effects. They have been associated with protection from and/or treatment of chronic diseases such as heart disease, cancer, hypertension, diabetes and other medical conditions (Surh, 2003). A range of different phytochemicals, including tocols, folate, sterols, phenolic acids and alkylresorcinols, are found in barley in small amounts. The folate content in the barley grain is higher than that observed for wheat and oats (Andersson *et al.,* 2008) and showed that the levels of phytochemicals in barley can be manipulated by breeding and that the contents of single phytochemicals may easily be adjusted by careful selection of a genotype. Mushrooms store a variety of secondary metabolites, including phenolic compounds, polyketides, terpenes and steroids. In addition, a mushroom phenolic compound has been found to be a tremendous antioxidant and synergist that is not mutagen.

Past scenario of wild mushrooms:

Phytochemicals have been proposed as one pain management solution, knowledge of their utility is partial. The intention was to perform a systematic review of the biomedical literature for the use of phytochemicals for management of cancer therapy pain in human subjects. Even though phytochemical therapy has historically been used as a treatment for cancer, treatment of cancer pain in general is challenging. The use of phytochemical therapy for the treatment of cancer pain is further confounded by historical myths and phytochemical isolates of poorly defined chemical composition. In particular, plants and the phytochemicals from these plants have been investigated for their anti-inflammatory properties. One example is the dried fruits of flowering shrub *Carissa carandas*. In this case, a specific plant containing potentially numerous compounds active against pain, as opposed to a specific phytochemical, was investigated (Harrison *et al*., 2015).

On the other hand, during the last decade, an attempt has been made to collect and identify wild-growing mushrooms which are a compilation of research studies conducted during the past recent years to identify and collect wild mushroom species and studied for their phytochemical possibilities as well. Small-scale studies that have been reported, shows that collection of a limited sample of wild mushrooms to assess their medicinal properties. Collection of macro-fungi from this region has begun since 2003. In a study, collection and identification of several species of the genus *Cortinarius* were reported. The genus *Cortinarius* is the largest group of *Agarics* (Asef *et al*., 2007). In 2007, collection and identification of species of medicinally important *Ganoderma* spp. was reported (Moradali *et al*., 2007). The detection method was based on micro- and macro-morphology and host relationships. A study reported collection and identification of mushrooms belonging to the order *Agaricales, Boletales, Cantharellales, Geastrales,* and *Russulales* orders, from Northern Iran (Gorgan, 2010).The collected micro-fungi were identified according to the macroscopic and microscopic characteristics of the specimens, as well as their characteristic responses to some chemical reagents (Karim *et al*., 2013). Some of the chosen wild *A. bisporus* were also further subjected to mycelia growth characterization (Masoumi *et al*., 2015). Therefore, it was possible to maintain mycelia and fruiting bodies of the collected wild specimens and facilitate further reproduction of medicinal biomaterials.

A comparative study of the organic acids and phenolics composition and of the total alkaloids content of entire wild edible mushrooms (*Russula cyanoxantha, Amanita rubescens, Suillus granulatus* and *Boletus edulis*) and correspondent caps and stipes was also reported to be performed. All species presented oxalic, citric, malic and fumaric acids, with *A. rubescens* exhibiting the highest total organic acids content. Organic acids were preferably fixed in the mushroom cap. Among phenolics, only p-hydroxybenzoic acid was found in *A. rubescens* and

S. granulatus, in very low amounts. *B. edulis* was the species that presented the highest total alkaloid amounts.

Current scenario of wild mushrooms:

Currently, researchers have used several methods to identify wild mushrooms. Morphological and non-PCR molecular techniques (such as isozymes and restriction fragment length polymorphism (RFLP) have developed PCR-based methods such as random amplified polymorphic DNA (RAPD), amplified fragment length polymorphisms (AFLP), simple sequence repeat (SSR), and inter-simple sequence repeats (ISSR). These PCR-based markers were further replaced with DNA barcodes. A DNA barcode is defined as 500- to 800-bp sequences to detect species of all eukaryotic kingdoms using primers that are applicable for a broad classification group.

Currently, ITS markers are often used by researchers to identify wild mushrooms (Das *et al.*, 2013). However, there are several reports showing the ability of other barcodes for mushroom identification. For example, the mitochondrial cytochrome oxidase I (COXI) was shown to be more effective than ITS in *Ascomycota* and *Basidiomycota,* especially in *A. bisporus* (Vialle *et al.*, 2009). As per the recent discoveries, ITS and intergenic spacer (IGS) regions were able to differentiate between species of Iranian wild *Agaricus*. On the contrary, ISSR markers were sufficiently potent to detect the polymorphism among closely related genotypes of within species of *Agaricus* (Malekzadeh *et al.*, 2014). Another study reported that identification of *Pleurotus* spp. (among and within species) was efficiently performed by IGS1 and ITS sequences.

Medicinal mushrooms have health-promoting benefits. Recently, a many substances of mushroom origin have been isolated, identified and shown to have physiological activities, such as antitumor, immunomodulating, cardiovascular, antihypercholesterolemia, antibacterial, antiviral, antiparasitic, hepatoprotective, and antidiabetic activities (Wasser, 2014). Currently, commercial products from medicinal mushrooms are mostly obtained through the field-cultivation of the fruiting body. However, in this case the quality of the final product is difficult to control. Submerged fermentation of the mycelial form of mushroom producing fungi has attracted much attention as a promising alternative for efficient production of the biomass of medicinal mushrooms and their active metabolites. However, for the production to be successful at industrial scale, various technical problems need to be solved, including characterization and changes that occur during the submerged cultivation of mushrooms in bioreactors and their effects on growth and product formation. These informations, outlines the key factors that affect the submerged cultivation of mushrooms in bioreactors, including oxygen supply, shear and mixing, morphology and rheology, as well as two-stage farming strategies and high-cell-density cultivation strategies such as fed-batch fermentation (Tang, 2003).

It is also reported that phytochemicals from certain groups were found to have an exceptional antioxidant activity both in vitro and in vivo. It is recognized that these metabolites will relate

ISSN: 2278-4632
Vol-10 Issue-6 No. 13 June 2020

with physiological antioxidants like ascorbic acid or tocopherol and will finally synergise the biological effects of both. Flavonoids and phenylpropanoids are found to cause oxidation with the help of the peroxidase enzyme and act as H_2O_2 scavengers. In a number of studies, it was observed that the antioxidant prospective of plants containing phenol, usually related to electron donation, reduced the capability in the metal ion chelating. In conclusion, it was also reported that certain mushrooms contain elevated levels of total phenol and elevated antioxidant activity and a promising capture of H_2O_2, due to which these are persuasive to develop as a foundation of a medicinal plant for therapy (Kasote *et al*., 2015; Rahimah *et al*., 2019).

Since 1970s many mushroom fungi have been increasingly used as a source of medicinal compounds and medical aids or health food supplements. It contains phytochemical compounds as well as the phytotoxicity assay may be accomplished due to the presence of active biological compounds. In drug discovery, the major secondary metabolites are of potential pharmacological interest. Drug discovery is the major affect of our age to overcome many life-threatening diseases like cancer. Plant-based compounds have been playing an important role in the development of number of clinically useful anticancer agents namely taxol, vinblastine, vincristine, the camptothecin derivatives, topotecan and irinotecan and etoposide derived from epipodo phyllotoxin. Various studies have shown many secondary metabolites as a source of bioactive compounds with allelo chemical potential have great chemical diversity and are involved in many metabolic and ecological processes. In drug discovery, the major secondary metabolites (terpenoids, phenolics and alkaloids) are of potential medicinal interest. The mentioned structure diversity is reflected in a variety of biological activities as, for instance, inhibitors of enzymes and antitumor, immunosuppressive and anti parasitic agents.

Conclusion:-

Since many years, mushroom fungi have been increasingly used as sources of medicinal compounds and therapeutic aids or health food supplements. It contains phytochemical compounds and due to the presence of active organic compounds, phytotoxicity assay can also be completed. These mushrooms have different chemical components. Phytochemical screening of wild mushrooms revealed the presence of saponins, alkaloids, flavonoids tannins which varies quantitatively from low to highly presence. High Flavonoids level may help provide protection against oxidative stress induced diseases by contributing along with other antioxidant vitamins, and enzyme to the total anti oxidative defense system of the human body. The medicinal values of mushroom therefore may be attributed to the presence of these phytochemicals. However, these mushrooms are grown in the wild and therefore for improved utilization, there is need to grow them domestically. Based on the result of these findings, it can be concluded that the wild mushrooms can be cultivated and investigated about its phytochemical analysis. As these mushrooms are reported to contain different quantities of chemical components, these have potential in research to be screened further.

Reference:-

- Adebayo, E.A. *et al*., (2012). Phytochemical, antioxidant and antimicrobial assay of mushroom metabollite from pleurotuspulmonarius. *Journal of Microbiology and Biotechnology Resources*, 2(2), 366-374.
- Asef, M.R., (2007). Macrofungi flora of Arasbaran 1. Cortinarius subgenus *Myxacium*. *Botanical Journal of Iran*, 8, 178-185.
- Barroso, G. *et al*., 4-7 October, (2011). Volume 1. Oral presentations (pp. 91-99) *Institute National Recherche Agronomique (INRA).*
- Chang, (2011). Recent trends in world production of cultivated edible mushroom. *Mushroom Journal*, 504, 15-17.
- Das *et al*., (2013). Nucleotide sequencing and identification of some wild mushrooms. *Science World Journal*.
- Ehssan, H.O., (2012). Screening of antimicrobial activity of wild mushrooms from Khartoum State of Sudan. *Microbiology Journal*, 2, 64-69.
- Fang, Yang, S., (2002). Free radicals, antioxidants, and nutrition. *Nutrition Journal*, 18, 872-879.
- Harrison, Anupama *et al., (*2015). Role of dried fruits of *Carissa carandas* as anti-inflammatory agents and the analysis of phytochemical constituents by GC-MS, *BioMed Research International*, 2015.
- Hollman, P.C.H., (2000). Flavonols, flavones and flavanols nature, occurrence and dietary burden. *Journal Science Food Agriculture*, 80, 1081-1093.
- Kasote, D.M. *et al*., (2015). Significance of antioxidant potential of plants and its relevance to therapeutic applications. *International journal of biological sciences*, *11*(8), 982.
- Keypour, *et al*., (2014). Survey on wood decay fungi *Ganoderma* species *(Ganodermataceae, Polyporales*) from Guilan and Mazandaran, Iran. *International Journal of Agriculture Biosciences*, 3, 132-135.
- Malekzadeh, K., *et al*., (2014). Identification and strain-typing of button mushroom using ISSR, ITS, and IGS markers. *Genetics*, 9, 343-352.
- Moradali, M.F, *et al*., (2007).The genus Ganoderma (Basidiomycota) in Iran. *Mycotaxon*, 99, 251-269.
- Pathak, Gaur, M., (1997). Mushroom Production and Processing Technology *Becham Research Institute*, CA 91010.
- Rahimah, S.B. *et al*., (2019). The Phytochemical Screening, Total Phenolic Contents and Antioxidant Activities in Vitro of White Oyster Mushroom (*Pleurotus Ostreatus*) Preparations. *Open access Macedonian journal of medical sciences*, *7*(15), 2404.
- Rahnama, K. and Habibi, R., (2015). First report of Neurospora on Corylusavellana innatural forest of Iran. *Journal of Yeast and Fungal Research*, 6, 31-36.

- Subbulakshmi M. and Kannan M., (2015). *European Journal of Experimental Biology*, 6(3), 46-54.
- Tang, J.J. Zhong, (2002). Fed-batch fermentation of *Ganoderma lucidum* for hyperproduction of polysaccharide and ganoderic acid, *Enzyme and Microbial Technology*, 31, 20–28.
- Vialle, A., Feau, N., (2009). Evaluation of mitochondrial genes as DNA barcode for *Basidiomycota* . *Molecular Ecology Resources*, 9, 99-113.

