Review Articles

A Minireview on Mushroom: Emphasis on the Wild Mushroom of Jordan

Abdulazeem S. Salhab *[1]

Introduction

Mushrooms are large and highly diverse group of organisms called fungi that are similar in many aspects to plants. Since mushroom lack the chlorophyll pigments, thus, mushroom cannot produce their own food, but, they obtain their food by breaking down dead organic matter (saprobes) or in some cases by attacking and living on or within other living plants (parasites). From taxonomic point of view, most mushroom species belong to Basidiomycetes and few species belong to Ascomycetes mushrooms. The number of mushroom species on earth is estimated to be 140,000 and only 14.000 species of them are known.[1,2]

Mushrooms are considered to be a rich source for nutrients and biologically active compounds. The market values for medicinal mushrooms, and their derivative dietary supplements, world-wide was about US$ 1.2 billion in 1991 and then Jumped to US$ 6 billion in 1999.[3,4] Mushrooms similar to medicinal plants have a great potential for production of useful bioactive compounds that belong to several chemical groups. The pharmacologically active compounds from mushrooms have a wide spectrum of activities such as: antimicrobial, antitumor, antiallergic, immunomodulating, anti-inflammatory, antiatherogenic, hypoglycemic, hepatoprotective and centrally active compounds.[5-9] Further, attention is now being paid to the possibility of using mushrooms as a source of protein for human diets in underdeveloped countries, because some mushroom types (e.g. truffles) are relatively rich in protein contents. Mushrooms which are presently under cultivation rank above all vegetables and most legumes in protein content and have significant levels of B and C vitamins and a low content of fats and cholesterol.[10-12] B-glucan, isolated from mushrooms such as *Phellins linteus* for example, is a polysaccharide in the form of fiber. B-glucagon has lipid-lowering effects, blood sugar reduction, weight reduction, immune modulator and anticarcinogenic effect.[14-16] Furthermore, *Lentinus edodes* and *Grifol frondosa* mushrooms have been shown to reduce blood pressure in hypertensive rats as well as to decrease cholesterol blood level. Agaricus are reported to activate T-lymphocytes and to augment immune function in tumor-bearing rats.[17, 18]

(J Med J 2007; Vol. 41 (3): 170- 178)

Received	***Accepted***
February 20, 2007	*March 12, 2007*

Mycotoxins of Mushroom

Mycotoxins refer to fungal compounds that poison other organisms.[19] Euripides is credited with the first report of mushroom poisoning in 430 B.C., when he wrote the tragic fatal poisoning of his wife and three children following mushroom ingestion.[20] Clinically, mushroom poisoning is divided into several groups of toxins based on the principle toxins present in the mushroom ingested. The principle toxin groups are: Cyclopeptides, Orellanine,

1- Department of Pharmacology, Faculty of Medicine, University of Jordan, Amman, Jordan.
*** Correspondence should be addressed to:**
Abdulazeem S. Salhab
E- mail: assalhab@ju.edu.jo

© 2007 DAR Publishers/ University of Jordan. All Rights Reserved.

Monomethyl hydrazine, disaffirm-like, hallucinogenic indoles, muscarine, isoxazole and GI specific irritants (Fig.1). The majority of toxic ingestions of wild mushroom mainly involve children under 6 years of age. Typically, the child will take one or two bites from toxic mushroom out of curiosity and then he/she experiences some sort of toxicity. Adult mushroom hunters who seek mushrooms for nourishment may ingest one or more mushrooms and also experience toxicity. Table (1) summarizes the main mushroom species producing mycotoxins, the table also summarizes the chemical properties and their toxicity features of the ingested toxic mushroom.

The Status of the Wild Mushroom in Jordan

A few number of scientific studies were conducted on the wild mushroom in Jordan. The first research study was done in 1992 by collecting two hundred and seventeen specimens of wild mushroom from 15 different localities in Jordan.[27] In this study, fifty six mushroom species were identified, among which Boletus species was the first mushroom species recorded in the world. Among the most distributed species were: *Panaeolus ater*, *Lepista irina*, *Boletus badius* and *Clitocybe rivulosa*. Acute toxicity tests of the aqueous extracts of the collected mushrooms were performed using Swiss albino mice. The results of those tests revealed that the most toxic species were: *Clitocybe clavipes*, *C. dealbata*, *C. sinopicoides*, C. vibecina, *Coprinus macrocephallus*, *Cortanrius ochrolecus*, *Lyophyllum decastes*, *Phaliota ochrotilor* and *Tricholoma saponacium*. Table (3) presents the toxic species, their site and time of collection. While, Figure (3) shows some photographs of the above-mentioned toxic mushrooms.

The aqueous extracts of tested mushrooms caused death in all mice within 4 hours of testing. Furthermore, the results of the toxicity tests revealed that 71% of the wild mushrooms collected in this study (49 species) caused death to 20-80% of the tested mice within one week of mushroom extract administration. Such extreme toxicity of wild mushroom is alarming and necessitates further acute and chronic toxicity evaluations.

It is essential to isolate and identify the major toxicants of this group of mushrooms in order to avoid future poisoning accidents among Jordanians. Further, it is worth mentioning that 4 out of 9 assayed species belong to the genus clitocybe. It is documented that few members of clitocybe genus are considered edible; While others are poisonous, which contain muscarine among other poisons. Moreover, individual species of Clitocybe is difficult to be distinguished by nonexperts. Therefore, further studies are necessary to be conducted on these species, in order to disseminate information among Jordan public openions and to educate people about the biohazards of such wild mushroom.

Another area of research on the wild mushroom of Jordan was carried out by Dabbour and Takruri.[28,29] The work was conducted to evaluate protein quality of 4 types of Jodanian edible mushrooms: *Terfezia claveryi*, *Pleurotus ostreatus*, *Tricholoma terreum* and *Agaricus macrosporus*. The results of the study showed that the four mushroom species have lower protein quality if compared to casein. This research, based on animal experiments, suggested that mushroom protein of the four should be classified as nutritionally incomplete when fed to grown animals, being the sole dietary source. It has to be emphasized that these results were linked to 4 species of mushrooms and therefore, Dabbour and Takruri findings cannot be generalized to all edible mushroom types grown in Jordan.

A methyl colored pictorial book on the wild mushrooms of Jordan was published recently by Rashad Natour, the Professor of Mycology at the Biological Sciences Department of the University of Jordan. This medium-sized book describes over 236 mushroom species grown wildly in Jordan. A brief description of mushroom fruit, edibility, habitat and the season of collection were recorded in the book. The book is of great benefit to Jordanian students, teachers and mushroom hunters since it contains a useful key

for the recognition and identification of the wild mushrooms grown in Jordan.[30]

The Concept of Edibility vs. Inedibility of the Wild Mushrooms

Most mushrooms that cause human poisoning cannot be made nontoxic by cooking, canning, freezing or any other means of processing. The toxicity of mushroom are generally acute and manifested by a variety of symptoms and prognosis, depending on the quantity and the species consumed.

Generally, there is no simple method to distinguish the edible from the inedible mushroom. It is recommended by experts that people has to follow certain guidelines in eating mushrooms such as:

1. Learn how to identify mushroom species.
2. Eat only the species that you are able to identify.
3. Avoid overeating of mushrooms.
4. Keep children away from eating unknown mushrooms.
5. Save one or two intact mushroom fruit for identifying purposes.
6. If you eat suspected mushroom consult your physician.

Generally, mushroom poisoning in Jordan may not be considered as a serious problem. This may be due to the following factors:

1. Jordan has a limited forest area.
2. Mushroom hunting habit among Jordanian adults is not common
3. The scarce rain season may be a limiting growth factor for wild mushroom.

Anyway, the above-mentioned reasons among others should not discourage Jordanian researchers to conduct work on the edibility of wild mushroom. Further, another area of research has to be conducted in the isolation of certain medicinally and economically important bioactive ingredients.

General Measures in the Treatment of Mushroom Poisoning

Although there is no universal remedy or antidote to be used in emergency treatment of mushroom poisoning, still, the therapeutic strategy comprises general measures that have to be followed in poisoning emergency such as:

1. Eliminating the ingested mushroom such as gastric lavage and/ or intestinal lavage.
2. Administrating large amounts of activated animal charcoal.
3. Forced diuresis.
4. Hemoperfusion.
5. Hemodialysis or peritoneal dialysis.
6. Administration of antidote if available.
7. Symptomatic treatment e.g: rehydration and restoration of mineral balance, convulsions, fever etc..

Summary

In summary, the wild mushroom is widely distributed in the green part of Jordan, some of it are extremely toxic and others are edible. Serious efforts are needed to identify both types and to isolate the major chemical constituents of the toxic mushroom in Jordan. It is difficult to suggest a universal detoxification methods or antidotes without knowing exactly the nature of mushroom toxicants. Furthermore, extremely useful pharmacological constituents may be obtained from the wild mushroom of Jordan.

Table 1: Classification of toxic mushroom and their clinical features.

Mycotoxin	***Mycotoxin Characteristics***	***Mushroom species***	***Clinical features***
Cyclopeptides	*Bicyclic octapeptides: alpha, beta and gamma amananitines, mw: 900 thermostable, 0.1 mg/kg body weight are lethal to man. Amatoxins are potent inhibitors to RNA polymerase II in eukaryotic cells.*	*Amanita phalloids, A. virosa, A.verna, A. ocreata, A. bisporigera. Lepiot helveola Galerina marginata G. venenata, G. automnalis Conocybe fillaris*	*Profuse diarrhea, abdominal pain, hematuria, hepatic and renal failure, cardiomyopathy, convulsions, coma and death within a week of ingestion. Mortality rate: 50-90%.*
Orellanine	*A bipyridine N- oxide, cooking, freezing or drying do not affect the toxicity of orellanine. The LD50 value in mice = 15-20 mg/kg (i.p), and the oral 33 mg/kg. Human lethal dose estimated as 100-200 g of mushroom. Orallenine inhibits the synthesis of proteins, RNA and DNA in vivo.*	*Amanita smithiana, Cortinarius, orellanus C. limonis, C. rubellus C. speciosissimus*	*Abdominal cramps, vomiting, seizures, coma, death rate (2-4%).*
Gyromitrin	*Votatile hydrazine derivative, it reduces CNS pyridoxine, and GABA synthesis.*	*Gyromitra esculenta, G. gigas, Helvella lacunose, H. elastica, Paxina species.*	*Abdominal discomfort (6-10h after ingestion), severe headache, vomiting and sometimes diarrhea, liver injury, mortality rate (2-4%)*
Muscarine	*Heat stable, parasympathomimetic compound, acts like acetylcholine, not degraded by cholinesterases, it activates acetylcholine receptors.*	*Clitocybe dealbata, Inocybe fastigiata, I. lilacina, I. pudica I. geophylla, Boletus spp.*	*Cholinergic syndrome: lacrimation, miosis, salivation, bronchospasm Deaths are rare, may be resulted from cardiac or respiratory failure in severe cases*
Mucinmol/Ibotenic acid	*Thermo-stable compounds Ibotenic acids stimulates NMDA receptors Mucimole is an analogus to GABA, stimules GABA receptors*	*Fly Agaric (Amanita muscarin), A. pantherina, A. cokeri, P Panaeolus campanulatus*	*Lethargy, stupor, alternating mania, and delirium, Fatalities rarely occur in adults, but in children, accidental consumption of large quantity may cause death*
Psilocybin (Hallucinogenic indoles)	*Alters brain serotonin . Effects like LSD.*	*Psilocybe baeocystis, P. caerulescens, P. cubensis Conocybe cyanopus Gymnopilus spp Panaeolus foenisecii, P. subbalteatus*	*Hallucinations, unmotivated laugh, euphoria, agitation, dysphoria, seizures in children. Mushroom is sometimes eaten for their psychotropic effects by some American native tribes*
Coprin	*Coprin interferes with metabolism of alcohol.*	*Coprinus atramentarius Clitocybe claviceps*	*Headache, nausea, vomiting, and cardiovascular disturbances*

References: 21-26.

Table 2: Some toxic mushrooms species collected in Jordan.

Mushroom species	Mice mortality within 4 hr (%)	Collection Site	Date
Clitocybe clavipes	100	Amman National Park	Jan. 88
Clitocybe dealbata	100	Amman National Park	Jan. 88
Clitocybe sinopicoides	100	Amman National Park	Jan. 88
Clitocybe vibecina	100	Dibbin	Dec. 87
Coprinus macrocephalus	100	Private Garden/Amman	Dec. 87
Cortinarius ochroleucus	100	Al-hummar	Jan. 88
Lyophyllum decastes	100	Naur	Jan. 88
Phaliota ochrotilora	100	Not recorded	Tricholoma saponacium
Tricholoma saponacium	100	Amman National, Park, Naur, Zay.	Jan. 88 (different dates)

Figure (the map of Jordan)

Figures

Clitocybe dealbata

Clitocybe vibecina

Clitocybe clavipes

Amanita pantherina

Coprinus macrocephalus

Lyophyllum decastes

Cortinarius ochroleucus

References

1. Hawksworth DL. Mushrooms: the extent of unexplored potential. Int J Med Mushrooms 2001; 3: 333-337.
2. Lindequist U, Niedermeyer T and Julich W. The pharmacological potential of mushrooms. e CAM 2005; 2: 285-299.
3. Chang ST. Mushroom research and development equality and mutual benefit. In: Royse DJ (ed). Proceedings of the 2nd International Conference on Mushroom Bilogy and Mushroom Products. Pennsylvania State University, 1996, 1-10.
4. Wasser SP, Nevo E, Sokolov D. et al. Dietery supplements from medicinal mushrooms: diversity types and variety of regulations. Int J Med Mushrooms 2000; 2: 1-19.
5. Mothana RA, Jansen R, Julich WD, et al. Ganomycin A and B, new antimicrobial farnesyl hydroquinones from the basidiomycetes Gonoderma pfeifferi. J Nat Prod 2000; 63: 416-418.
6. Kahlos K, Kangas L, Hiltumen R. Antitumor activity of some compounds and fractions from n-hexane extract of Inonotus obliquus *in vitro*. Acta Pharm Fennica 1987; 96: 33-40.
7. Reshetnikov SV, Wasser SP, Tan KK. Higher basidiomycetes as a source of antitumor and immunostimulating polysaccharides (review). Int J Med Mushrooms 2001; 3: 361-394.
8. Sano M, Yoshino K, Matsuzawa, T, et al. Inhibitory effects of edible higher basidiomycetes mushroom extracts on mouse type IV allergy. Int J Med Mushrooms 2002; 4: 37-41.
9. Bobek P and Galvavy S. Hypocholesteremic and antiatherogenic effect of oyster mushroom (Pleurotus ostreatus) in rabbits. Nahrung 1999; 43: 339-342.
10. Kono S, Aynehchi S, Dolin DJ, et al. Anticancer and hypoglycemic effects of polysaccharides in edible and medicinal maitake mushroom (Grifola fondosa). Int J Med Mushrooms 2002; 4: 185-195.
11. Kim SH, Song YS, Kim SK, et al. Anti-inflammatory and related pharmacological activity of the n-BuOH subfraction of mushroom Phellinus linteus. J Ethnopharmacol 2004; 93: 141-146.
12. Wang MY, Lin Q, Che QM, et al. Effects of total triterpenoids extract from Ganoderma Lucidum on experimental liver injury models induced by carbon tetrachloride or D-galactosamine in mice. Int J Med Mushrooms 2002; 4: 337-342.
13. Mizuno T. Bioactive substance in Hericium erinaceus and its medicinal utilization. Int J Med Mushrooms 1999; 1: 105-119.
14. Kuplfatil C, Geginat G, Holf H. Lentin has a stimulatory effect on innate and adaptive immunity against murine listeria monocytogenes infection. Int Immunopharamcol 2006; 6: 686-696.
15. Braatan JT, Wood PJ, Scott FW et al. Oat beta-glucan reduces blood cholesterol concentration in hypercholesterrolemic subjects. Eur J Clin Nut 1994; 48: 465-474.
16. Anderson JW, Randles KM, Kendall CW et al. Carbohydrate and fiber recommendations for individuals with diabetes: a quantitative assessement and meta-analysis of the evidence. J Am Coll Nutr 2004; 23: 5-17.
17. Benjamin, DR. Mushrooms: Poisons and Panaceas; WH Freeman and company: New York, 1995.
18. Kabir Y, Yamaguchi M and Kimura S. Effects of Shiitake (Lentinus edodes) and Maitake Grifola frondosa) mushrooms on blood pressure and plasma lipids of spontaneously hypertensive rats. J Nutr Sci Vitaminol 1987; 33: 341-346.
19. Bennett JW. Mycotoxins, mycotoxicoses, mycotoxicology and Mycopathologia. Mycopathologia 1987; 100: 3-5.
20. Grossman CM, Malbin B. Mashroom poisoning: a review of the literature and report of two cases caused by a previously undescribed species. Ann Intern Med 1954; 4: 249-259.
21. Pacioni G, Lincoff G. Simon and Schuster's Guide to Mushrooms. New York: simon and Schuster; 1981: 9-14.
22. Lampe K, Mc Cann MA. AMA Handbook of poisonous and injurious plants. Chicago: American Medical Association, 1985; 208.
23. Arora D. Mushrooms Demystified. Ber Keley, CA: Ten Speed Press; 1986.
24. Lincott GH. The Audubon Society field Guide to North American Mushrooms. New York: Alfred A. Knoopt, 1981.

25. Berger KJ and Guss DA. Mycotoxins revisited: Part L. J Emer Med 2005; 28: 53-62.
26. Berger KJ and Guss DA. Mycotoxins revisited: Part II. J Emer Med 2005; 28: 175-183.
27. Natour RM, Salhab AS, E1-Moumani, et al. Wild Mushroom in Jordan. Dirasat 1992; 19: 47-51.
28. Dabbour IR and Takruri H. Protein quality of four types of edible mushrooms found in Jordan. Plant Food Hum Nut 2002; 57: 1-11.
29. Dabbour IR and Takruri H. Protein digestibility using corrected amino acid score method (PDCAAS) of four types of mushrooms grown in Jordan. Plant Foods Hum Nut 2002; 57: 13-24.
30. Natrour RM. Wild Mushrooms of Jordan. Al Rai commercial Press, Amman, Jordan, 2005.

مراجعة سريعة لأنواع الفطر البري في الأردن

عبد العظيم سلهب، قسم الصيدلة، كلية الطب، الجامعة الأردنية، عمان، الأردن.

الملخص

الفطر (المشروم) هو مجموعة من النباتات الفطرية التي تنمو متطفلة على المخلفات العضوية المتحللة وهية منتشرة تقريباً في جميع أنحاء العالم وخاصة في الغابات.

إن معظم أنواع الفطر (المشروم) تؤكل والبعض الآخر سام جداً ويحتوي على سموم قاتلة للإنسان أو قد يسبب له بعض الأعرض المرضية الخطيرة، وليس من السهل التمييز بين الأنواع السامة والأنواع غير السامة بدون دراسة وتدريب.

أما في الأردن فينمو النوعان كلاهما في الغابات والمناطق الزراعية، وابتدأت دراسات أولية (والتي كانت غير كافية) على المشروم في أوائل التسعينات من القرن الماضي.

تعتبر هذه الأطروحة مراجعة سريعة لبعض الأنواع السامة وغير السامة الموجودة في الأردن، ومما لا شك فيه أن موضوع المشروم بحاجة إلى دراسة أعمق من الباحثين وخاصة تمييز الأنواع السامة وكذلك فإن هناك مجالاً كبيراً لاستخراج بعض الأدوية الفعالة لعلاج أمراض كثيرة مثل السرطان، والسكري وارتفاع الضغط الشرياني وغيرها.

الكلمات الدالة: الفطر (المشروم)، الفطر السام، الفطر غير السام.