Revisión
Poisonous mushrooms; a review of the most common intoxications

A. D. L. Lima, R. Costa Fortes, M. R. C. Garbi Novaes, and S. Percário

1Laboratory of Experimental Surgery. University of Brasília-DF, Brazil/Paulista University-DF, Brazil. 2Science and Education School Sena Aires-GO/University of Brasília-DF/Paulista University-DF, Brazil. 3School of Medicine. Institute of Health Science (ESCS/FEPECS/SESDF)/University of Brasília-DF, Brazil. 4Institute of Biological Sciences. Federal University of Pará, Brazil.

Abstract

Mushrooms have been used as components of human diet and many ancient documents written in oriental countries have already described the medicinal properties of fungal species. Some mushrooms are known because of their nutritional and therapeutic properties and all over the world some species are known because of their toxicity that causes fatal accidents every year mainly due to misidentification. Many different substances belonging to poisonous mushrooms were already identified and are related with different symptoms and signs. Carcinogenicity, alterations in respiratory and cardiac rates, renal failure, rhabdomyolysis and other effects were observed in toxicity studies with various species including edible and therapeutic ones. Proper identification is important to avoid accidents and toxicity studies are necessary to assure the safe use of mushrooms as food and for medicinal purposes.

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Key words: Toxicity. Mushrooms. Toxins. Review.

Introduction

Approximately 140,000 species of mushrooms have already been catalogued all over the world, about 2,000 being considered safe for human consumption and about 700 have therapeutic properties.1 A great variety of species was classified as poisonous and represents risks to health if ingested. Apart from mushrooms that contain psychoactive toxins, ingestion of toxic mushrooms is invariably accidental and caused by misidentification of species.2,3

There are some mushrooms that contain exceptionally powerful toxins that represent a real hazard to health even when ingested in small doses. Most toxins were well studied and are described in literature, such as amatoxins that are cytotoxic and cause harm to kidney and liver and orellanine that is nephrotoxic.2 Some species are well utilized for food and medicine due to the presence of pharmacologically active substances and essential nutrients. Because of these properties, mushrooms were described as popular remedies in ancient oriental documents and some of them became ingredients in traditional medicine.4,5,6 Even in species with beneficial properties toxic substances were already found.7

Before using species of mushroom for human consumption it is necessary to characterize their toxicological profile because even in some edible species toxic substances have been identified. The toxicity studies consist of exposing species of mammal to a
toxic agent during a specific period of time. The aim of
the present work is to review the most common intox-
ications caused toxic species and the toxic potential
caused by edible and medicinal mushrooms.

Poisonous species of mushrooms

Some species of mushrooms are known as toxic and
in some countries many cases of mushroom poisoning
are reported every year. In the year 1998 in France
1,675 cases of intoxications by mushrooms were
reported and in this country alone it is estimated that 8-
10,000 cases are expected to be registered every year.
Most of these accidents are due to incorrect identifica-
tion of species that is often made by empirical and
traditional knowledge. A wide variety of toxic mush-
rooms belong to different genus that will be discussed
bellow.

Genus Amanita

The family Amanitaceae (genus Amanita) is well
known as having many toxic species. Amatoxins are
present in species of Amanita genus such as: Amanita phalloides, A. virosa, A. verna, A. ocreata, A. bisporigera,
A. suballiacea, A. tenuifolia and A. hygroscopica. The
family of amatoxin comprises a neutral component
designated as alpha-amanitin, an acid one called beta-
amaninamine from A. phalloides and amanaminine from A. virosa. Other toxins also found in Amanita genus belong to
the family of phallotoxin that includes phalloin, phal-
loidin, phallisin, phallacidin, phallacin and phalliscin.
Virotokin is also found in this genus and are closed
related the phallotoxins.

The specie A. phalloides is responsible for the
majority of the fatalities caused by mushroom poison-
ing. The toxic effects are caused by phallotoxin and amatoxin. Phallotoxin causes alterations of entero-
cyes cellular membrane, while amatoxin inhibits
protein synthesis at a transcriptional level within ente-
rocytes, hepatocytes and proximal renal tubular cells.
After ingestion of A. phalloides, amatoxin causes
necrosis of liver cells with mortality rates ranging from
about 10% to 20%. Only a minority of patients need
emergency liver transplantation.

Species with hallucinogenic effects are also found in
amanita genus. A. pantherina and A. muscaria are well
known toxic mushrooms that have been mistaken for
the edible mushroom A. rubescens. Two dissoociative
constituents such as ibotenic acid (IBO) and muscimol
(MUS) are responsible for the hallucinogenic effects.
IBO is a powerful agonist of N-methyl-D-aspartic-acid
(NMDA) receptor and MUS is a potent GABA_A
agonist. The intoxications caused by A. muscaria for
long time were believed to be due to muscarine, but it
was demonstrated that this substance is present in small
amounts.

A. muscaria and A. pantherina grow in North Amer-
ica, Europe, Africa and Japan, in recent years it has
been reported that young people in several countries
have intentionally eaten A. muscaria to evoke halluci-
nations. The most common symptoms of intoxication
are motor depression, ataxia, changes in mood, percep-
tion and feelings, dizziness, euphoria, drowsiness,
gastrointestinal disturbances and muscle twitches.
The pantherina-muscaria syndrome is atropine-like
and in the number and severity of poisoning cases
fatality is rare. In most cases recovery is complete after
24 hours. The treatment is mainly symptomatic
cholinesterase inhibitors may be recommended as it
counteracts the effects of poisoning, benzodiazepins
or phenobarbitone can be used in case of seizures.

The treatment of patients intoxicated with species
containing amatoxins includes detoxification, careful
monitoring and sometimes liver transplantation is
necessary.

Genus Clitocybe and Inocybe

A particular syndrome that affected five people in the
region of Savoie in France was later identified as intox-
ication caused by the mushroom Clitocybe amoeno-
lenos. First symptoms appeared 24 hours after ingestion.
Patients presented paresthesia of the toes and fingers
followed by paroxysmal burning pain lasting 2-3 hours,
notably at night. A sensation of heat, numbness, oedema
and local erythema are associated with crises. Symp-
toms are partially relieved with cold water, acetylsali-
cylic acid, morphine and clomipramine. Recovery is
completely after 1-4 months.

The administration of high dose of C. amoeno-
lenos in rats caused weight loss, locomotor disability and
erythema of the toes. Examination of the sciatic nerves
showed decreased axon density and neuronal fiber
degeneration. The poisonous specie C. acromelalga can be
confused with the edible one Lepista inversa. The sub-
stances pointed out as responsible for the symptoms
are the acromelic acids A-E. Acromelic acid (ACRO)
is a kainate analogue that is assumed to be involved in
poisoning episodes. ACRO has two isomers, ACRO-
A, which is the most potent and ACRO-B. ACRO-A
was demonstrated to have a powerful excitatory action
on mechanosensitive unmyelinated afferents in
skeletal muscle of the rat.

Species of genus Clitocybe also cause muscarinic
syndrome. The species C. dealbata, C. rivulosa, C.
candicans, C. cerussata, and C. phyllophila are
described in literature as poisonous mushrooms due to
the presence of muscarine in their chemical composi-
tion. Approximately 15 minutes to 2 hours after inges-
tion patient can present gastrointestinal problems,
miosis, hypersecretion and in severe cases bradycardia

Poisonous mushrooms

<table>
<thead>
<tr>
<th>Author/year of publication</th>
<th>Genus</th>
<th>Clinical findings</th>
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</thead>
<tbody>
<tr>
<td>Wessely et al., 2007</td>
<td>Cortinarius</td>
<td>A 26 years old woman became anuric after several days of nausea and vomiting and presented elevated BUN and creatinine after ingestion of mushrooms belonging to Cortinarius genus. In renal biopsy she presented interstitial nephritis and more than 1 year later she had to be submitted to chronic dialysis.</td>
</tr>
<tr>
<td>Mount et al., 2002</td>
<td>Cortinarius</td>
<td>A 17 years-old Caucasian male had picked and ingested raw and wild mushrooms hoping that they were hallucinogenic. He presented to the hospital with a one week nausea and diarrhea, for previous 3 days he was anuric and on examination he had no abnormalities. Serum biochemistry showed abnormal creatinine and urea consistent with renal failure. After 4 weeks he had no recovery of renal function and required ongoing haemodialysis.</td>
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<tr>
<td>Mount et al., 2002</td>
<td>Cortinarius</td>
<td>A 26 years-old Caucasian male ingested approximately 12 uncooked mushrooms for hallucinogenic purposes, 2 days later he went to hospital because of vomiting and epigastric pain. Following admission he became progressively oliguric and renal biopsy showed widespread cellular and oedematous interstitial fibrosis. As there was no recovery of renal function he had to be submitted to chronic haemodialysis.</td>
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<tr>
<td>Giannini et al., 2007</td>
<td>Amanita</td>
<td>A retrospective evaluation of the history and clinical outcome of each patient treated from 1988 to 2002 in the Toxicological Unit of Careggi General Hospital (University of Florence, Italy) for amatoxin poisoning was conducted. The clinical data of 111 patients were evaluated; their biological parameters were monitored every 12-24 hours until discharge. Two patients died; both were admitted to the hospital more than 60 hours after mushroom ingestion and 105 recovered completely.</td>
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<td>Enecker-Jans et al., 2007</td>
<td>Amanita</td>
<td>Two patients, a 54-year-old man and a 51-year-old woman, presented abdominal pain, vomiting and diarrhea; these symptoms developed 9 and 15 hours, respectively, after consumption of soup. The poisoning with the specie Amanita phalloides was later confirmed by the results of urinalysis. The patients were discharged in good condition 8 days later.</td>
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<td>Aygul et al., 2010</td>
<td>Amanita</td>
<td>A 24-years-old female was admitted in a hospital with abdominal pain, nausea, emesis and weakness. She had consumed a mushroom 6 hours before admission. A nasogastric tube was placed for aspiration and administration of charcoal. Simultaneously fluid and electrolyte resuscitation to treat the emesis was given in the course of intoxication. Patient developed multiple organ failure in spite of supportive treatment such as intravenous inotropic therapy and dialysis. An intra-aortic balloon counterpulsation catheter was placed because of gradual deterioration of her clinical status. After this procedure she improved gradually until complete recovery.</td>
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<tr>
<td>Bedry et al., 2001</td>
<td>Tricholoma</td>
<td>Seven women (age range, 22 to 60 years) presented severe rhabdomyolysis one week after eating wild mushrooms. All patients reported fatigue and muscle weakness accompanied by myalgia. After 3 or 4 days weakness worsened and the production of dark urine was observed. Electromyography was performed and revealed muscle injury without involvement of peripheral-nerve. Three of the patients presented increasing dyspnea at rest and signs of acute myocarditis, all three patients died.</td>
</tr>
<tr>
<td>Saviu et al., 2002</td>
<td>Clitocybe</td>
<td>A 32 years old woman ingested a specie of the genus Clitocybe in 3 consecutive meals. She presented paresthesia of fingers and toes, crises of paroxystic pain lasting 2-3 hours with sensation of local heat, oedema and local erythema. Clinical examination was normal, body temperature and blood pressure was normal. Following admission to the hospital pain crises increased mainly at nigh. She recovered completely after several months.</td>
</tr>
<tr>
<td>Dehay et al., 2009</td>
<td>Clitocybe</td>
<td>Two patients a man and his wife, both were 67 years old, ingested the specie Clitocybe rivulosa wrongly identified as Marasmius oreades. The wife presented abdominal pain, diarrhea and intense sweating followed by and unconsciousness state. Artificial ventilation was needed because of bronchial hypersecretion. High blood pressure and alterations in cardiac rate were also noticed such as convulsions. Patient died one week after hospital admission, her husband presented moderated muscarinic syndrome 15 hours after mushrooms ingestion. He presented nausea, diarrhea, intense sweating, myosis and bronchial hypersecretion. Symptomatic treatment was instituted and administration of atropine. Recovery was completely. Patient was discharged from hospital the day after admission.</td>
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<tr>
<td>Gonnori and Yoshioka, 2003</td>
<td>Psilocybe</td>
<td>A fatal case of magic mushroom poisoning happened with a 27 years old man that was found in an irrigation canal. Two cultivation pots of mushrooms were found in his room, which was identified as Psilocybe subcubensis. The victim might have been influenced by theses hallucinogenic substances. As a result he died of winter cold temperature.</td>
</tr>
</tbody>
</table>
and collapses. The treatment of this syndrome is symptomatic and atropine can be administered to counteract the effects of muscarine.21

There are approximately 40 species belonging do Inocybe genus in China, and they are known to be not edible. The species: I. asterezora, I. fastigiata f. subcandida, I. gobeyi, I. lilacina, I. nappies, I. pallidcremea, I. patowillandii, I. radiate, I. repanda and I. rimosus have toxic properties. They produce neurotoxic and psychotic effects due to the presence of biogenic amines, muscarin, aeruginacin a thymethylammonium analogue of psilocbin which effects will be discussed later in this article.22 Intoxications caused by members of this genus is similar to the ones caused by Clitocybe because the species contain muscarine.23

Genus Cortinarius

The genus Cortinarius comprises between 2,000-3,000 species of mushrooms that were considered as non-toxic until 1950. One hundred-and-thirty-five cases of intoxication caused by C. orellanus were described from 1953-1962 in Poland. Poisoning syndrome is characterized by a delayed acute tubulopathy that can progress to chronic renal insufficiency.22

In several case reports it was demonstrated that the mushrooms C. speciosissimus and C. orellanus are nephrotoxic due to the presence of the cyclopeptide orellanine whose metabolites are supposed to be most active. In additional studies it was shown that the oxidation of orellanine in renal tissue may accumulate quinone compounds which bind covalently with biological structures leading to cell damage.24

The symptoms of orellanine intoxication may appear between 2-20 days after ingestion. Initially people can experience nausea, vomiting and abdominal pain. This is followed by intense thirst, chills, polyuria or oliguria and possibly anuria. Hemodialysis may be necessary until renal function gradually improves.25

Some species of genus Cortinarius can be confused with members of Psilocybe genus which is known as magic because the hallucinogenic properties. This fact has led to several cases of accidental intoxication because Psilocybe mushrooms are used for some people for recreational purposes.24

Genus Gyromitra

Species of genus Gyromitra, family Helvellaceae are really attractive to hunters and gourmets because of their taste. However, some species of Gyromitra contain a well known toxin named gyromitrin, whereas other species are non-toxic. This is one of the reasons why intoxications occur, toxic and non-toxic species are sometimes difficult to distinguish because they are mixed-up. The other reason is that the toxin is water soluble and volatile, boiling for long time and drying allows ingestion without risk of poisoning, but if these procedures are not done properly intoxication may occur.2

The third reason for intoxication is the confusion with species that are consumed frequently. The specie G. esculenta is known as false morels and is commonly confused with morels such as Morchella esculenta and M. elata. The toxin gyromitrin is the responsible for the effects of this specie. Intoxications have occurred not only by eating fresh false morels but also by the inhalation of vapors from cooking.2,25

Intoxications caused by G. esculenta were reported by the Swedish Poisons Information Centre which handled 706 inquiries in the period of 1994-2002. Most common symptoms are gastrointestinal (vomiting and diarrhea) and neurological (vertigo, fatigue, tremor, ataxia, nystagmus). A few patients have developed mild to moderate liver damage and haemolysis. After ingestion gyromitrin is hydrolysed in stomach forming hydrazines that are cytoxic, convulsants and irritating to mucous membranes.2,25

The other effect of gyromitrin include carcinogenesis due to the hepatic metabolization that produces free radicals with mutagenic properties in animals and are also responsible for the hepatic problems. Symptoms of intoxication start 8-12 hours after ingestion. Treatment consists of monitoring the symptoms and administrating vitamin B6 intravenously considering that gyromitrin inactivates this vitamin.25

Genus Psilocybe

The use of psychoactive substances of fungal origin for recreational purposes has become an increasing problem in many countries all over the world. Species of genus Psilocybe are known due to their psychedelic effects caused by psilocybin.27 Common psilocybin containing mushrooms are: P. semilanceata, P. Mexicana, P. bohemica, P. cubensis and P. baeocistis.28

The symptoms of intoxication occur 30 minutes after ingestion of fresh or dried mushroom and start with anxiety, nausea, vertigo and asthenia, neurosensorial symptoms consists of visual problems, disorientation, motor incoordination and sympathomimetic symptoms consist of mydriasis, tachycardia and hypertension. Recovery is completely 4 to 12 hours after ingestion. The need of hospitalization is rare and in exceptional cases myocardial infarction may occur in adult patients while children may present hyperthermia, seizures and coma.25

Toxicity caused by commonly consumed mushrooms

Some species known as edible and medicinal also have substances that can cause harm to health, but the dose and magnitude of effects on humans must be care-
fully studied. Ostreolysin is a cytolytic protein that was isolated from mushrooms of the genus Pleurotus that was able to cause cytolytic pore formation when administered by intravenous route to rats. As a consequence it was observed blood pressure increase, cardiac ischemia, tachycardia, hypoxia and elevated serum potassium.28

The administration of the mushroom *Phellinus linteus* to rats bearing experimentally induced prostatic
hyperplasia leads to an enlargement of prostate stroma which is involved in transforming growth factor-beta (TGF-β) regulation. The prostate is known to be regulated by various growth factors. Among them the TGFs have been reported to play important role in prostate cell growth regulation. The administration of P. linteus increased the expression of TGF-β compared to animals treated with placebo.29

Agaricus bisporus is the most consumed mushroom world-wide but is has been pointed out as potentially carcinogenic due to the substantial amounts of aromatic hydrazines, an established class of direct-acting chemical carcinogens. Life-time administration of A. bisporus raw or baked to mice three days a week followed by balanced semi-synthetic diet for the remaining days, induced tumors in a number of tissues. The administration of the methanolic and aqueous extracts of this same mushroom is weakly mutagenic. The ethanolic extract of this mushroom is increased in the presence of fungal mammalian enzyme systems purified mushroom tyrosinase and rat hepatic cytosol.30,31

The specie Pleucybella porrigens popularly known as Sugihiratake is a white mushroom widely distributed in the mountain areas of Japan and is commonly used as ingredient to various processed foods, but this was pointed out as hazardous due to the presence of substances analogous to vitamin D that are able to cause cryptogenic encephalopathy in patients with renal failure.32

The acute toxicity of Agaricus silvaticus was evaluated by administering the aqueous extract of this mushroom in the dose of 1.5 g/kg/day of body weight to adult male and female rats by gavage every 2 hours and 40 minutes, during a period of 24 hours, followed by a protocol of The National Health Surveillance Agency (ANVISA, Brazil). It was observed that not only the administration of A. silvaticus aqueous extract but also the placebo, caused the temporary appearance of apathy, respiratory alterations and piloerection, that were slightly more persistent in the group treated with the fungus. Biochemical and histopathological were not statistically significant among the groups. The administration of the A. silvaticus aqueous extract induced very low toxicity.33

Species of genus Tricholoma especially T. equestre (T. flavovirens), known as yellow tricholoma, has been implicated in 12 human poisonings causing a delayed rhabdomyolysis severe enough to be fatal in 3 cases reported in France. The symptoms were muscular weakness, fatigue and myalgias within 24-72 hours after ingestion. The substance responsible for toxic effects was not identified.7

T. equestre is a wild mushroom considered in Europe as a delicacy. Toxicity is observed after a consumption of considerable amounts of fresh mushroom which ranges from 100 to 400 g at 3 to 9 consecutive meals.34

A neurological syndrome appears after the ingestion of the specie Hapalopus rutilans that is considered edible. Common symptoms consist of visual distur-

bances, somnolence, hypotonia and hepatic and renal insufficiency.35 Hepatic cytology and renal insufficiency were described in children.32,36

Conclusion

In countries where mushrooms are highly consumed, a number of intoxications are reported every year mainly due to misidentification of species. Hazardous toxins are present in these species and are able to cause different syndromes that can be fatal depending on the amount ingested. Accidental ingestion of mushrooms is difficult to avoid especially in countries where eating wild species is common. Proper identification is important to avoid accidents and the identification of symptoms and signs of intoxication as soon as possible enables the success of treatment. Intoxications caused by commonly consumed mushrooms were already described, for this reason edible mushrooms and the ones having pharmacological potential must be carefully studied in order to identify the possibility of intoxications, so more studies have to be carefully conducted, clinical and experimental assays with medicinal species must investigate the side effects that may occur.

References


The most common consequence of mushroom poisoning is simply gastrointestinal upset. Most "poisonous" mushrooms contain gastrointestinal irritants that cause vomiting and diarrhea (sometimes requiring hospitalization), but usually no long-term damage. However, there are a number of recognized mushroom toxins with specific, and sometimes deadly, effects. Review Article Mushrooms: A Potential Natural Poisonous mushrooms; a review of the most common intoxications. Download PDF. 7 downloads 0 Views 81KB Size Report.

Poisonous mushrooms. Genus Clitocybe and Inocybe A particular syndrome that affected five people in the region of Savoie in France was later identified as intoxication caused by the mushroom Clitocybe amoenolens. First symptoms appeared 24 hours after ingestion. Patients presented paresthesia of the toes and fingers followed by paroxysmal burning pain lasting 2-3 hours, notably at night. Conocybe filaris Poisonous Conocybe filaris mushrooms. This species is a common lawn mushroom in the Pacific Northwest region of the United States. Ingestion can cause lethal organ failure. blickwinkel/Alamy. Conocybe filaris is an innocent-looking lawn mushroom that is especially common in the Pacific Northwest. Featuring the same mycotoxins as the death cap mushroom, C. filaris is potentially fatal if eaten. One of these species, Amanita bisporigera, is considered to be the most toxic North American mushroom. Symptoms take 5 to 24 hours to appear and include vomiting, delirium, convulsions, diarrhea, liver and kidney failure, and often lead to death. Podostroma cornu-damae.