

Mushroom poisoning

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Abstract

The diversity of toxicity syndromes caused by mushroom ingestion entails, on one hand, a many-sided and flexible approach to diagnosis that can benefit from any information obtained from the patients or company, and on the other hand, a need to identify, in collaboration with mycologists, the causative species. The known syndromes are systematised and a proposal is made

for the implementation of detailed enquiries that standardise the information. A model form to serve as starting point for the design of such enquiries is included.

Key words: mushroom poisoning, intoxication, mushrooms, enquiry.

Introduction

Cases of mushroom poisoning (mycetism) are a recurrent event, albeit with low incidence in Portugal. This fact, and the seasonality of incidents, contribute to the Emergency Services' relatively low awareness of the variety of situations that can occur, and the respective treatments. Hence, when they are called upon to deal with such cases, they may not always give a sufficiently precise diagnosis.

The Portuguese population is essentially mycophobic, and the picking and consumption of wild mushrooms is generally restricted to rural areas, and to a small number of species. This fact can limit cases of poisoning to a typology that is easily recognizable locally. For example, at the Hospital do Espírito Santo, in Évora,¹ the majority of cases are associated with the consumption of *Amanita ponderosa* Malç. & Heim, known in the Alentejo district as "silarca", as it can be confused with the lethal species *Amanita verna* (Bull.)Lam.

Nevertheless, there are always cases with different etiology, as has become even more evident in recent years, owing to the presence of markedly mycophiles immigrants from the Slavic countries and speakers of the Romanian language, whose consumption habits

extend to a considerable number of species. In fact, Mycology registers several dozen European species of significant gastronomic interest,^{2,3} most of which entail a risk of confusion, even for experienced pickers. Moreover, it was seen that a large proportion of the cases analyzed in Évora were due to lack of due attention, or excessive confidence on the part of these pickers.¹

This review aims to facilitate the process of diagnosing mushroom poisoning, through the proposal of two tools: a classification of the known syndromes, and a model questionnaire to be applied when diagnosing the victim of the presumed poisoning. Lists of relevant species for Portugal are contained in the appendix, arranged by syndrome and by common name.

Mycetism syndromes

The systematization of syndromes given in this section is intended to facilitate a quick diagnosis, and to identify those that are generally more severe, with a period of onset of more than five hours after ingestion. As some syndromes can be covered from more than one symptomatology perspective, the reference to some of them is repeated where relevant, to establish their discrimination.

Table I summarizes this systematic treatment.

The most likely species that cause mushroom poisoning in Portugal are indicated, where possible, using the scientific binomial by which they are best known as the most functional option. The appendix is referred to, for searching on some corresponding common names and the scientific binomials currently accepted, in cases where there has been a recent

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review of the taxonomic nomenclature.

Except where specifically referenced, this section was compiled based on two highly regarded guides.^{3,4} Generic information can also be consulted in the INTOX Databank⁵ of the WHO International Program on Chemical Safety (ICPS).

I – Start of symptoms up to 5 hours after the last ingestion

Gastrointestinal syndrome

Violent abdominal pains, nausea, vomiting and diarrhea, without hepatic failure: resinoid syndrome, most likely caused by *Omphalotus olearius* (due to confusion with *Cantharellus cibarius*), generally associated with olive-trees (oleasters), but the list of species is much longer: in forest systems, *Entoloma sinuatum* and other entoloma, species of the *Boletus satanas* group, of the *Agaricus xanthodermus* group, and (in alpine zones) *Tricholoma pardinum*; also found in meadows and clearings, a species of the genus *Chlorophyllum* (easily confused with *Chlorophyllum rhacodes*).

Treat with antispasmodics.

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Analyze hepatic function markers (transaminases and lactate dehydrogenase) to exclude phalloidin syndrome.

Indigestion (which can be severe) generally provoked by excessive consumption, associated with trehalose or chitin sensitivity, osmotic pressure due to mannitol, or to allergy to antibiotic substances of the fungus: digestive syndrome, often caused by species that are harmless to other individuals.

Symptomatic treatment.

Diarrhea, generally benign, due to laxative substances: digestive syndrome, associated with *Ramaria formosa* and related and species of *Suillus* from which the outer skin has not been removed.

TABLE I

Latency	Pathology	Main signs	Syndrome
Short (up to 5 hours)	Gastrointestinal	Abdominal pain, without hepatic failure	Resinoid
		Indigestion, or diarrhea without complications	Digestive
		Nausea and hemolysis	Hemolytic
	Cardiovascular	Bradycardia, vasodilation	Muscarine
Tachycardia, mucosa dryness, neurological disorders		Pantherine	
Hypotension, intravascular coagulation		Paxillus*	
Neurological	Facial rubor, palpitations	Coprine	
	Hallucinations	Psilocybin	
Long (more than 5 hours)	Gastrointestinal	Euphoria, hallucinations or aphrodisiac effect, cardiovascular disorders	Pantherine
		Acute gastroenteritis, vomiting, diarrhea, hepatic failure after apparent remission	Phalloidin*
	Gastroenteritis, nausea, possible hepatitis	Gyromitrin*	
	Renal	Late renal failure	Orellanine*
Myopathic	Fatigue progressing to late-onset rhabdomyolysis, with high creatine kinase	Rhabdomyolysis*	
Neurological	Paresthesia with intense pain in the extremities	Acromelalgia/erythromelalgia	

Nausea and vomiting associated with hemolysis: hemolytic syndrome, caused by ingestion of raw or poorly cooked specimens, either of *Amanita rubescens* (or other amanitas) or species of the genera *Morchella* or *Helvella*.

Cardiovascular syndrome

Bradycardia, vasodilation, hypotension, diaphoresis and excessive salivation (also miosis, intestinal problems, nausea and vomiting): muscarine syndrome, due to toxins of the autonomic nervous system present in *Inocybe patouillardii* and the like, in white mushrooms of the *Clitocybe dealbata* group, or in *Mycena pura*, *M. rosea* and related.

Atropine or belladonna tincture. Can be fatal (*Inocybe*).

Tachycardia, vasoconstriction, hyperactivity, mucosa dryness (also neurological disorders due to stimulant, hallucinogenic or aphrodisiac substances present in the fungus): pantherine syndrome, caused by *Amanita pantherina*, *A. muscaria* or *A. junquillea* (in decreasing order of toxicity).

Treat with sedatives and barbiturates. Can be fatal (*A. pantherina*).

Hypotension, intravascular coagulation, jaundice, kidney failure, resulting from immunological hypersensitivity acquired by repeated consumption of *Paxillus involutus*: Paxillus syndrome.

Treat by renal compensation (can be fatal).

Facial rubor, palpitations and considerable discomfort: Coprine syndrome, due to alcohol intolerance when ingesting *Coprinus atramentarius*, *C. micaceus* or others. The intolerance lasts for several days and is similar to the effects of the drug Antabuse.

Neurological syndrome

Hallucinogenic (identical to that provoked by LSD): psilocybin syndrome, due to the psilocin or psilocybin present in *Psilocybe semilanceata* and related (these mushrooms are illegally commercialized or cultivated at home, and they are generally consumed by individuals who are aware of their effects).

Euphoria, hallucinations or aphrodisiac effects, with cardiovascular alterations: see above, pantherine syndrome.

II — Start of symptoms more than 5 hours after the last ingestion

Alcohol intolerance, with facial rubor, palpitations and considerable general discomfort: see above, Coprine syndrome.

Gastrointestinal syndrome

First symptoms 6 to 12 (24) hours after the last ingestion, with acute gastroenteritis, uncontrollable vomiting, profuse diarrhea, intense dehydration (these symptoms may be preceded by malaise, with respiratory difficulty and dizziness), hepatic failure: phalloidin syndrome, generally caused by ingestion of *Amanita phalloides* (usually in the Fall up to the beginning of Winter, but also in the Spring), *Amanita verna* (end of Winter and Spring) or *A. virosa*.

Treat as early as possible (antidote silibinin, and

penicillin); confirm with hepatic function markers (transaminases and lactate dehydrogenase), supervise for several days, until liver recovery is confirmed. Renal function should also be monitored. An intermediate phase of apparent remission occurs 24 hours after ingestion, followed by hepatic failure (sometimes with hepatomegaly and abdominal pain) with high mortality rates (depending on the quantity ingested).

First symptoms 5 to 48 hours after ingestion, with gastroenteritis, debilitation, nausea and vomiting (also profuse diarrhea and fever): gyromitrin syndrome, due to the ingestion of *Gyromitra esculenta* and related, as well as *Cudonia circinans*, *Spathularia flavida* or poisonous species of *Helvella*.

Treat symptomatically, paying attention to a later phase with potentially fatal hepatitis (where hemolysis, kidney failure, neurological problems, delirium, cramps and generalized convulsions also occur).

Renal syndrome

First symptoms can occur several days after ingestion (for this reason it is not easy to make the association with mushroom ingestion), with kidney failure that may become permanent in non-fatal cases: Orellanine syndrome, caused by *Cortinarius orellanus* and related.

Treat symptomatically, generally in association with hemodialysis.

Phalloidin syndrome, see above, can also manifest itself in kidney deficiency, but always secondary to hepatic insufficiency.

Myopathic syndrome

First symptoms 1 to 3 days after the ingestion of *Tricholoma equestre* or very similar species in several consecutive meals, with fatigue, whether accompanied or not by myalgias, progressing to rhabdomyolysis, at the end of 1 week after ingestion,⁷ which may or may not be accompanied by kidney failure, and which can be fatal; other symptoms include nausea, facial erythema and profuse diaphoresis. Very high creatine kinase serum levels. Although phalloidin syndrome may also involve myopathy, it shows symptoms earlier, and primarily involves hepatic failure. A similar syndrome was described in China, caused by ingestion of *Russula subnigricans*,⁸ and it is possible that it could occur with other species considered harmless, when ingested in large quantities by sus-

ceptible individuals.⁹

Treatment of renal protection, with drip-feed hydration, correction of electrolytes (hypercaliemia, hypo- and hypercalcemia), nephroprotector N-acetylcysteine, and perfusion of isotonic bicarbonate (urine alkalinization).

Neurological syndrome

Acromelalgia and erythromelalgia (paresthesia, intense pain, heat and erythema of the extremities, which may or may not be accompanied by insomnia), about 24 hours after the ingestion of *Clitocybe amoenolens*, and known for a long time in Japan due to another very similar species, *C. acromelalga*.⁶

Treat with analgesics, local relief of heat, nicotinic acid.

III – Other risks of mushroom ingestion

Accumulation of heavy metals

Risk resulting from the consumption of mushrooms from polluted zones (within the radius of influence of roads, industrial zones or mines).

Accumulation of radioactivity

Particularly from ingestion in zones affected by the Chernobyl radioactive cloud.

Model questionnaire to be used in an Emergency Service

Taking into account the experience acquired from a first questionnaire involving rescued victims,¹ a new model was designed aimed expressly at providing support to GPs in Emergency Services, attempting to draw a compromise between the need to maximize the information provided, and speed of filling out the questionnaire. It consists of nine questions aimed at facilitating a diagnosis of poisoning through the description of the syndromes made in this article. There is also a space, where the identification of the poisonous mushroom can be added, in collaboration with mycologists. This form is permanently available at the Digital Repository of the Universidade de Évora, URI <http://hdl.handle.net/10174/1399>

Each Emergency Service should preferably adapt this model in order to adjust to the current practice, including here the possibility of reducing the number of questions; however, it should be kept in mind that excessive simplification might limit its usefulness in certain cases.

Conclusion

A systematized knowledge of mycetism syndromes and their respective treatments enables a flexible response to situations that arise. It is understood that potentially fatal cases, in a mycophobic nation like Portugal, practically consist of phalloidin syndrome, but the presence of mycophile cultures in our country makes this scenario significantly more complicated. Additionally, situations of digestive, resinoid or hemolytic syndrome, and also pantherine syndrome, can be very frequent¹ and allow a sufficiently differentiated follow-up, once the phalloidin syndrome has been excluded.

The questionnaire model for patients or their companions, suggested here, is designated to facilitate the collection of information to form a basis for diagnosis, within a scenario of systematized knowledge of the range of known syndromes. Item 4 is particularly relevant, as the long-latency syndromes (more than 5 hours after the most recent ingestion) are generally those that lead to death (*Table I*). These questionnaires might also be used to produce a cumulative record of this kind of incident with potential epidemiologic interest.

The availability of mycologists to help identify the mushrooms can be very important. Ideally one should have access to mushroom specimens in good condition, prior to culinary preparation; if this is not possible, and as the morphological description given from memory is not always reliable, the materials that can be collected from the gastric content containing microscopic characters that may be sufficient for identification. This collaboration should involve the establishment of operating protocols that guarantee effective forwarding of the materials and relevant information. ■

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APPENDIX

List of toxic European species (by syndrome)

Muscarinic, gastrointestinal or resinoid syndrome (including digestive)

Agaricus pilatianus
Agaricus praeclaresquamosus
Agaricus romagnesii
Agaricus xanthodermus
Amanita rubescens (if not properly cooked)
Boletus luridus (if not properly cooked)
Boletus purpureus (or *B. rhodopurpureus*,
B. xanthocyaneus)
Boletus queletii (se não for bem cozinhado)
Boletus satanas
Calocera viscosa
Choiromyces meandriformis (if not properly cooked)
Clitocybe acromelalga
Clitocybe candida
Clitocybe hydrogramma
Cortinarius aleuriusmus
Cortinarius cyaneus
Cortinarius purpurascens
Cortinarius traganus
Cortinarius volvatus
Entoloma lividum = *E. sinuatum*
Gymnopilus spectabilis = *G. junonius*
Hygrocybe conica
Hygrophoropsis aurantiaca (if not properly cooked)
Hypholoma fasciculare
Lactarius bresadolanus
Lactarius pominsis
Lactarius torminosus
Lepiota clypeolaria
Lepiota cristata
Lepista glaucocana
Lepista sordida
Leucoagaricus bresadolae = *L. americanus*
Leucopaxillus candidus = *Clitocybe candida*
Leucopaxillus giganteus
Macrolepiota venenata
Macrolepiota rhacodes var. *hortensis* = *Chlorophyllum brunneum*
M. rhacodes var. *bohémica* = *Ch. rhacodes*
Omphalotus illudens
Omphalotus olearius
Pholiota squarrosa
Ramaria formosa
Ramaria pallida
Ramaria mairei
Russula alutacea
Russula badia
Russula foetens
Russula olivacea
Russula queletii
Russula rhodopus
Russula sanguinea
Scleroderma verrucosum
Stropharia ferrii = *S. rugosoannulata*
Tricholoma groenense

Tricholoma josserandii
Tricholoma sulphureum
Tricholoma pardinum
Tricholoma tigrinum
Tricholoma vaccinum
Tricholoma virgatum

Mycoatropine or pantherine syndrome

Amanita muscaria
Amanita pantherina
Amanita junquillea = *A. gemmata*

Cyclopeptide or phalloidin syndrome

Amanita phalloides
Amanita verna
Amanita virosa
Galerina marginata
Lepiota brunneoincarnata
Lepiota helveola
Lepiota josserandii = *L. subincarnata*

Hallucinogenic, indole or pseudo-schizophrenic syndrome (psilocybin)

Stropharia melanosperma
Psilocybe semilanceata

Nitritoid, Coprine, acetaldehyde or pseudo-antabuse syndrome

Coprinus atramentarius = *Coprinopsis atramentaria* (with alcohol)
Coprinus micaceus = *Coprinellus micaceus* (with alcohol)

Muscarine, sudorien or mycocholinergic syndrome

Clitocybe cerussata = *C. phyllophila*
Clitocybe dealbata
Inocybe patouillardii = *I. erubescens*
Mycena pura
Mycena rosea

Orellanine syndrome (of cortinarius)

Cortinarius cinnabarinus
Cortinarius citrinofulvescens
Cortinarius limonius
Cortinarius orellanus
Cortinarius speciosissimus = *C. rubellus*
Cortinarius splendens
Cortinarius vitellinus

Gyromitrin or hydrazinic syndrome

Gyromitra gigas
Gyromitra esculenta
Helvella
Cudonia circinans
Spathularia flavida

Rhabdomyolysis

Tricholoma auratum = *T. flavovirens* = *T. equestre*

Paxillus Syndrome

Paxillus involutus

Acromelalgia, erythromelalgia

Clitocybe amoenolens

Note: the lists of synonyms always end with the scientific name considered correct.

APPENDIX

Common names in Portugal assigned to edible species and associated potential cases of poisoning

Common name	Scientific name	Poisoning (syndrome) ^a
Míscaro or níscaro	1. <i>Lactarius deliciosus</i> (L.) Gray 2. <i>Boletus edulis</i> Bull. and related 3. <i>Tricholoma equestre</i> (L.) P. Kumm.	1. — 2. <i>Suillus</i> sp. (D) 3. <i>Amanita phalloides</i> (Vaill. ex Fr.) Link (F), <i>T. equestre</i> (R)
Yellow morel Pantorra	<i>Morchella esculenta</i> (L.) Pers.	<i>M. esculenta</i> (D), <i>Gyromitra</i> sp. (G)
Button mushroom	1. <i>Boletus edulis</i> Bull. and related 2. <i>Macrolepiota procera</i> (Scop.) Singer 3. <i>Tricholoma equestre</i> (L.) P. Kumm.	1. <i>Suillus</i> sp. (D) 2. <i>Chlorophyllum rhacodes</i> (Vittad.) Vellinga (D+) 3. <i>Amanita phalloides</i> (Vaill. ex Fr.) Link (F), <i>T. equestre</i> (R)
Yellow Knight	1. <i>Tricholoma equestre</i> (L.) P. Kumm. 2. <i>Cantharellus cibarius</i> Fr.	1. <i>Amanita phalloides</i> (Vaill. ex Fr.) Link (F), <i>T. equestre</i> (R) 2. <i>Omphalotus olearius</i> (DC.) Singer (D+)
Silarca	<i>Amanita ponderosa</i> Malç & Heim	<i>Amanita verna</i> (Bull.) Lam. (F), <i>Amanita phalloides</i> var. <i>alba</i> (Vittad.) E.-J. Gilbert (F)
Meadow mushroom, common field mushroom, pink bottom	<i>Agaricus campestris</i> L.	<i>Amanita phalloides</i> (Vaill. ex Fr.) Link (F), <i>Amanita verna</i> (Bull.) Lam. (F), <i>Agaricus xanthodermus</i> Genev. (D+)
Caesar's mushroom, Caesar's amanita, royal agaric, Caesar's agaric	<i>Amanita caesarea</i> (Scop.) Pers.	<i>Amanita muscaria</i> (L.) Lam. (P)
Parasol mushroom, etc. ^b	<i>Macrolepiota procera</i> (Scop.) Singer	<i>Chlorophyllum brunneum</i> (Farl. & Burt) Vellinga (D+)
Chanterelle, golden chanterelle	<i>Cantharellus cibarius</i> Fr.	<i>Omphalotus olearius</i> (DC.) Singer (D+)
King boletus, cep, porcini	<i>Boletus edulis</i> Bull. and related	<i>Suillus</i> sp. (D)
Shaggy mane, inky cap	<i>Coprinus comatus</i> (O.F. Müll.) Pers.	—
Black poplar mushroom or pioppino, Chinese mushroom	<i>Agrocybe aegerita</i> (V. Brig.) Singer	—
Black trumpet, black chanterelle	<i>Craterellus cornucopioides</i> (L.) Pers.	—
Saffron milk cap, red pine mushroom, pine mushroom	<i>Lactarius deliciosus</i> (L.) Gray	—
Desert truffle	<i>Terfezia arenaria</i> (Moris) Trappe e similares	—

Note: compiled from several sources (in particular, references 10 and 11). Several names have different meanings, depending on the regions.

^aF: phalloidin syndrome; D: digestive syndrome; D+: resinoid syndrome; R: rhabdomyolysis; G: gyromitrin syndrome; P: pantherine syndrome

^bAlso (common names in Portuguese): fradelho, pucarinha, gasalho, centieiro, capoa, roca, chouteiro, parasol, soutelho, cogumelo da calcinha