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C. BIJEESH, K.B. VRINDA AND C.K. PRADEEP



J. Mycopathol, Res, 54(4) : 477-483, 2017;
ISSN 0971-3719

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Department of Botany,
University of Calcutta,
Kolkata 700 019, India

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Mushroom poisoning by *Chlorophyllum molybdites* in Kerala

C. BIJEESH, K.B. VRINDA* AND C.K. PRADEEP

Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Palode, Thiruvananthapuram 695562, Kerala

Received : 15.07.2016

Accepted : 10.08.2016

Published : 30.01.2017

Cases of poisoning by *Chlorophyllum molybdites* is reported from the state of Kerala. A morphological description of the material causing the poisoning is provided and the associated case history is described. An overview of this species distribution in Kerala is given.

Key words: Agaricales, mycetismus, systematic

INTRODUCTION

Mycetismus or mushroom poisoning is an important health concern and a potentially fatal state that usually occurs after incidental ingestion of poisonous mushrooms. Depending on the type of mushroom, the adverse effects range from mild gastrointestinal symptoms to major cytotoxic effects resulting in organ failure and death. Toxicity may also vary depending on the amount and age of the mushroom, the season, the geographic location and the way in which the mushroom was prepared prior to ingestion. Although only 3% of mushrooms are poisonous, it is difficult to distinguish them from others. Therefore, rural people usually make errors and consume poisonous mushrooms instead of non-toxic ones. Unfortunately, there are no simple methods available to distinguish edible mushrooms from poisonous ones and no safe ways to detoxify the poisonous varieties.

Mushroom poisoning by *Chlorophyllum molybdites* (G. Mey.) Masee, a gastrointestinal irritant, has been reported in the medical and botanical literature since 1900. The symptoms vary in severity and consist of nausea, vomiting, diarrhea and abdominal pain. These symptoms usually occur within three hours after ingestion of the mushroom. The diarrhea may be profuse and may become bloody. Primary effect is short-lived gastrointestinal irritation. The toxin responsible was identified as a polymeric protein. Toxin was destroyed when heated at 70⁰ Celsius for 30 minutes. Poisoning follows ingestion of either raw or cooked mushrooms, though cooking can reduce toxicity in some cases. Most cases of gastrointestinal irritant mushroom ingestion will develop a self limited illness and recover over a period of hours, with no more than simple supportive care, notably fluid replacement.

In Kerala, scattered cases of mushroom poisoning are reported every year. The paper describes

*Corresponding author : drvindakb@hotmail.com

two incidents of poisoning by the mushroom *Chlorophyllum molybdites*, a common agent of mushroom poisoning in many countries. Both poisoning incidents occurred were associated with severe gastrointestinal symptoms including profuse diarrhea, vomiting and intestinal pain. In each case, hospitalization was required. The duration of hospitalization was two days. The paper includes a description of the mushroom, the geographic distribution of the species, the signs and symptoms of poisoning and its treatment.

MATERIALS AND METHODS

This study was performed by examining the files of wild mushroom poisoning patients who were admitted to the Medical College Hospital, Thiruvananthapuram and interviewing the victims of poisoning. Based on reports on wild mushroom poisoning in all the leading dailies of Kerala, the mushroom research team of JNTBGR I visited the Medical College Hospital at Thiruvananthapuram and collected as many details as possible from the hospital as well as the patients. Mushroom specimens responsible for the poisoning were immediately collected from the same localities from where the victims had collected them. Collected specimens were systematically analyzed and identified following standard taxonomic methodology (Singer, 1986). Microscopic examination of tissues was made from thin free-hand sections revived in 10% KOH and stained in 2% Congo red. Examinations were made directly using a Leica DME 1000 research microscope. Spores were examined in Melzer's reagent or 3% KOH. Spore measurements were taken from hymenial tissues. Approximately 30 basidiospores from sections were measured and dimensions for spores are given using notation of the form (*a*-) *b*-*c* (-*d*). The range *b*-*c* contains a minimum of 90% of the measured values. *a* represents the smallest value measured and *d* represents the largest value measured. Metachromy of spore walls was checked in Cresyl Blue in dilute aqueous solution. Colour codes and notations are from Kornerup and Wanscher (1978). All the collections examined are deposited in the Mycological Herbarium of TBGRI [TBGT (M)].

RESULTS AND DISCUSSION

Chlorophyllum molybdites (Meyer ex Fr.) Masee in *Bull. Misc. Inf. Kew.* 1898: 136 (1898).
Agaricus congolensis Beeli, *Bull. Soc. R. Bot. Belg.*

61(1): 92 (1928)
Agaricus molybdites G. Mey., *Prim. fl. Esseq.* : 300 (1818)
Chlorophyllum esculentum Masee, *Bull. Mis. Inf., Kew.* 136 (1898)
Chlorophyllum molbdites var. *congolense* (Beeli) Heinem., *Fl. Icon. champ. Congo* 16: 323 (1967).
Chlorophyllum molbdites var. *luteolosperma* Singer, *Pap. Mich. Acad. Sci* 32: 139 (1948) [1946]
Chlorophyllum molbdites var. *marginatus* (A.H. Smith) D.A. Reid & Eicher, *Bot. Bull. Acad. Sin., Taipei* 32: 328 (1991)
Chlorophyllum molbdites (G. Mey.) Masee, *Bull. Mis. Inf., Kew.* 136 (1898) var. *molbdites*
Lepiota molybdites (G. Mey.) Sacc., *Syll. Fung.* (Abellini) 5: 30 (1887)
Lepiota molybdites var. *marginata* A.H. Sm., *Mushrooms in their natural habitats*: 429 (1949)
Lepiota molybdites (G. Mey.) Sacc., *Syll. Fung.* (Abellini) 5: 30 (1887) var. *molybdites*
Leucocoprinus molybdites (G. Mey.) Pat., *Bull. Soc. mycol. Fr.* 29: 215 (1899)
Macrolepiota molybdites (G. Mey.) G. Moreno, Banares & Heykoop, *Mycotaxon* 55: 467 (1995).
Mastocephalus molybdites (G. Mey.) Kuntze, *Revis. Gen. pl.* (Leipzig) 2: 860 (1891).

Pileus 9.5-30 cm diam., soft and fleshy, globose in the bud expanding convex, plano-convex and finally applanate, with or without an umbo; surface 'champagne' (4B4), 'amber yellow' (4B6), 'greyish orange' (5B4), 'golden blonde' (5C4) or 'cinnamon brown' (6D6), uniformly coloured in the bud, soon breaking in to more or less concentrically arranged patches of recurved squamules, more concentrated around the umbo, floccose and evanescent elsewhere, background white to dull white turning yellow, then reddish and finally brown on bruising; margin inflexed when young, becoming straight, entire to incised, appendiculate, cuticle easily peeling off from the margin, revealing the underlying white context; margin non-striate, often striate. Lamellae free, remote from the stipe, up to 1.8 cm wide, creamy white to 'milky white' (1A2), becoming 'greyish yellow' (1B3) and then to 'olive brown' (4D4) with age, turning reddish-brown on bruising, ventricose, crowded, with lamellulae of 4-6 lengths; edge concolourous to the sides, serrate. Stipe 9-21 cm x 1-2.2 cm, central, cylindrical, equal with a broad base or narrowly tapering upwards from a bulbous base; surface white, turning yellow, then reddish brown and finally brown on bruising, covered with white, minute, floccose

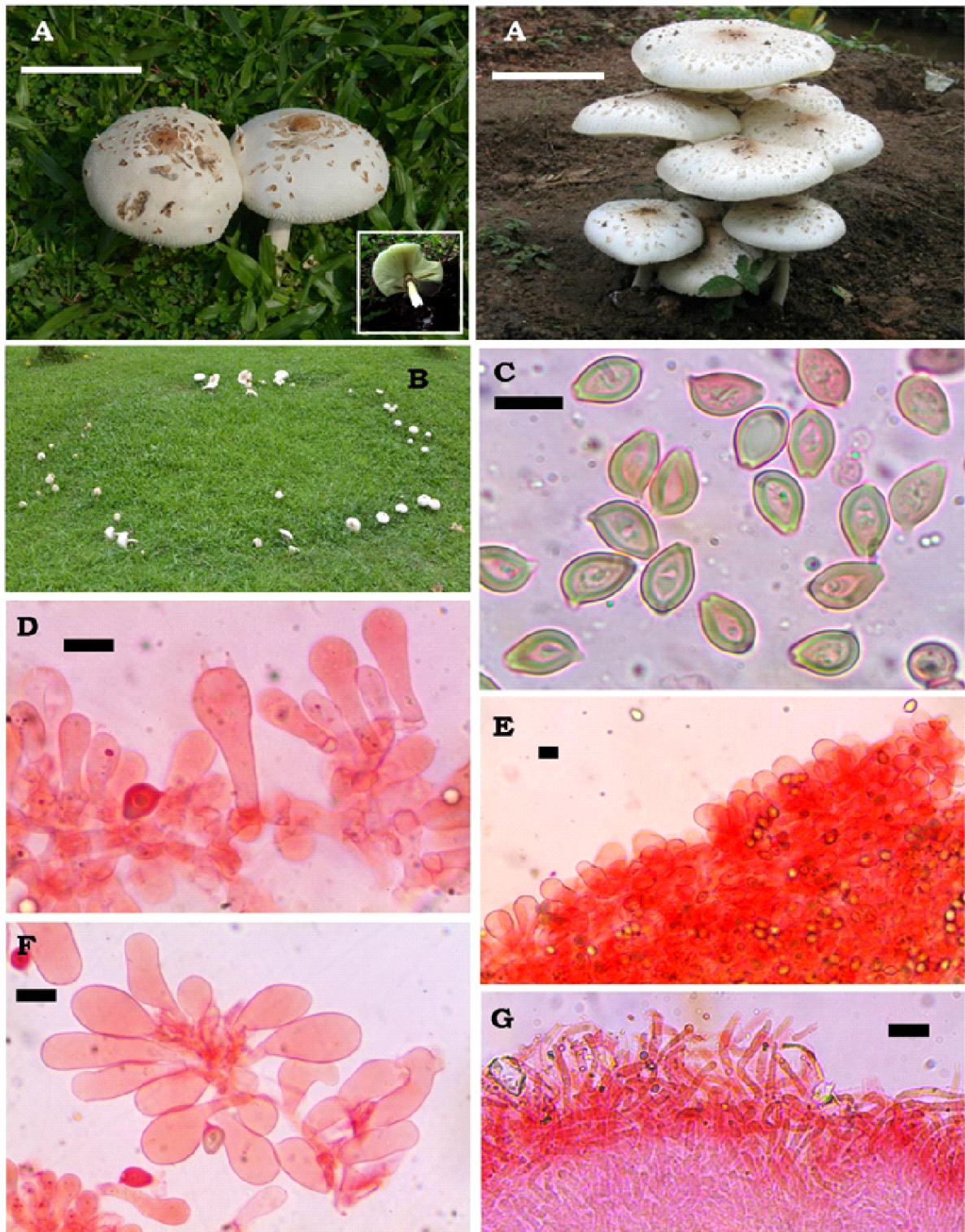


Fig. 1 : *Chlorophyllum molybdites*, **A.** habit *in situ*; **B.** fairy ring; **C.** spore; **D.** basidia; **E.** gill edge; **F.** cheilocystidia; **G.** pileipellis Scale bars, A=10 cm; C-G = 10 μ m

squamules above the annulus, fibrillose below, becoming smooth and glabrous, stuffed, dry, brittle, with a white basal mycelial mass. Annulus superior, movable, double-edged, vinaceous buff with a pale brown fimbriate rim. Context soft, up to

1.5 cm wide at the disc, white, staining yellow to yellow-orange to reddish brown when cut and eventually becoming brown. When cut across the stem, oxidation reactions cause color changes that begin with yellow or orange and progress to brown.

Spore print pale green.

Spores 10-13 x 6.5-9 µm, Q=1.5, broadly ellipsoid to ellipsoid sometimes slightly amygdaliform, apically truncated by a broad germ pore, smooth, greenish, with a thick, complex wall and a conspicuous hilar appendix, dextrinoid. Basidia 27.5-38.5 x 12-13 µm, clavate to inflated clavate, 4-spored, sterigma up to 3.8 µm long. Lamella-edge sterile with abundant cheilocystidia. Cheilocystidia 27.5-46.2 x 12-22 µm, clavate to inflated clavate, with a broad obtuse apex, often with a long pedicel, thin-walled, hyaline. Pleurocystidia absent. Hymenophoral trama sub regular, consisting of thin-walled, hyaline, 4.5-16.5 µm wide hyphae. Subhymenium pseudoparenchymatous. Pileipellis an erect trichoderm at the disc with septate, cylindrical, apical elements, 15.5- 49.5 x 5.5-9 µm, with obtuse apices, or often with narrower tip, overtopped by scale cells forming a tangled mass of cylindrical, septate, 5.5-11.5 µm wide hyphae, the trichoderm soon disrupting away from the disc. Pileal context composed of thin-walled, hyaline, interwoven, 3.5-7 µm wide hyphae, inflated up to 22.5 µm. Stipitipellis a narrow cutis, composed of 7-26.5 µm wide hyphae, thin-walled, hyaline or with a yellowish pigment; stipe cuticle just below the annulus composed of a tangled mass of cylindrical elements, often cystidioid, 40.6-119 x 8.5- 14.5 µm, thin-walled, versiform, sometimes with a long apical appendage. Clamp connections and oleiferous hyphae present.

Habit and habitat

Solitary or in pairs on soil in flower beds; scattered on compost heaps, forest floor; in large groups among grass in rubber plantations; in fairy rings in open grassy areas.

Specimens examined

India, Kerala State, Thiruvananthapuram district: Eanikkara, 20 July 2014, No. 14944; Malayankizhu, 23 July 2014, No. 15240.

Additional specimens examined

India, Kerala State, Thiruvananthapuram district: Palode, 9 May 1994, No. 1487; TBGRI campus: 10 May 1994, No. 1584; 30 May 2006, No.1870; Perayam, 31 May 2006, No. 1873; TBGRI campus: 14 April 1995, No. 2017; 15 Sept. 1996, No.

3252; 11 April 97, No. 4235 ; 25 June 1998, No. 4325 ; 29 April 1999, No. 4503; 18 July 2003, No. 6274; 06 March 2008, No. 6800; 06 Oct. 2008, No. 7292 ; Braemoor, 20 Sept. 2004, No. 7878; TBGRI campus: 06 July 2008, No. 7989; 06 Nov. 2008, No. 8063; Perayam, 13 April 2005, No. 8592; TBG junction, 09 Sept. 2005, No. 9245; TBGRI campus: 22 July 2008, No. 11486; 25 July 2008, No. 11504; 15 June 2009, No. 12591; 23 June 2009, No. 12650; 30 July 2014, No.15253; 7 Aug. 2014, No.15282; Kanakakkunnu, 22 May 2015, 15670.

Chlorophyllum molybdites is a very common fungus with widespread tropical and subtropical distribution. It occurs after heavy rains, in and outside forests, on lawns, grasslands and richly manured ground, especially in flower beds in gardens. It was first reported from Kerala by Bhavani Devi (1998).

Commonly known as the 'green gill' or the 'green-gilled Lepiota', *Chlorophyllum molybdites* is an attractive fungus which may tempt any mushroom hunter to pick it unaware. This species is said to cause severe gastrointestinal disturbance in some people. The green tinge on the gills of the mature fruit bodies is a clear-cut character distinguishing this species from the similar-looking edible *Lepiota* or *Macrolepiota* species. *Chlorophyllum molybdites* can be recognized by the large, white, scaly, pileus; staining reaction of the flesh from yellow to yellow-orange to reddish brown when cut and the unique green colouration of the lamellae and the spores. It is distributed throughout Asia, North America, South America and Africa. *Chlorophyllum* is a monotypic genus. This species causes stomach upset of varying severity involving thirst, nausea, vomiting and diarrhea.

Reports of cases

Case 1

Four members of a family including two children (35 yr old father, 32 yr old mother, 8 yr old daughter and 6 yr old son), residents of Eanikkara, Thiruvananthapuram district, Kerala, ate a meal of wild mushrooms collected from the backyard of their house. They had used four fresh, large, wild mushrooms for the preparation of the typical Kerala style mushroom masala gravy for lunch. Subsequently all the four of them developed severe ab-

dominal pain, vomiting and diarrhea, nearly 2 hours after consumption of the mushroom. They were immediately taken to the Medical College hospital, Thiruvananthapuram, where they were admitted and given supportive care, including maintenance of fluid and electrolyte balance resulting in complete recovery within 24 hours. They were kept in observation for one more day and were discharged from the hospital after 48 hours.

Case 2

Six members of a family including a child were admitted to the Medical College Hospital showing the same symptoms of mushrooms poisoning as in case 1. They were contract workers from Tamil Nadu, temporarily staying at Malayankizhu, Thiruvananthapuram. They developed symptoms such as severe vomiting, diarrhea, and abdominal pain one hour after ingestion of wild mushrooms picked from the road side, growing among grasses. They claimed that the mushroom they had eaten looked very similar to the edible ones they used to eat. The patients were treated with fluids given intravenously and supportive care. All symptoms and signs resolved over the next 18 hours and the patients were discharged from the hospital after 48 hours.

In both the above cases, samples of the mushrooms gathered for food was identified as *Chlorophyllum molybdites*, a widely distributed species in Kerala, commonly known as 'pranthan koon' in Malayalam (pranthan = mad; koon = mushroom). Information gathered from country folklore in Kerala, revealed that this species cause allergy and hallucinogenic effects and hence the name 'pranthan koon'. This deadly sickener was frequently mistaken for the parasol mushroom which is also common in Kerala.

Chlorophyllum molybdites has been a frequent cause of mycetism in all continents as has been reported by many authors (Avizohar-Hershenzon 1967, Natarajan and Kaviyaran 1991 and Graff 1913, 1927 for Asia; Grgurinovic 1997, Southcott 1974 and Young 1989 for Australia; Arora 1991, Eilers and Nelson 1974, Lehmann and Khazan 1992, Levitan *et al.* 1981, and many others for North America and Singer 1969, 1975 for South America. Walley and Rammeloo (1994) summarized all references for Africa and Reid and Eicker (1991) provided references for most Continents.

It has always been stated that, whilst *Chlorophyllum molybdites* is usually considered poisonous, it is deliberately eaten by a number of people who claim to have enjoyed it for years, others are poisoned by it, some seriously (Lincoff and Mitchel, 1977). Some collections are eaten without causing any problems, at least not to certain individuals, suggests that the toxicity of the fungus could be dependent upon climatic and habitat factors alone or upon the susceptibility of the individual (Reid and Eicker, 1991). Eilers and Nelson (1974) demonstrated that one of the toxin(s) is indeed a thermolabile protein molecule that is destroyed when the mushroom is cooked at 70 °C during thirty minutes. So, this particular toxin can apparently be made harmless by cooking the mushroom thoroughly and lastingly (Young 1989). Edible material belonging to a green-spored *Chlorophyllum* has been reported from French Guiana (Pegler 1977, 1983) and some other American and African countries (Rammeloo and Walley 1993; Reid and Eicker 1991; Singer, 1969), but in Asia green-spored *Chlorophyllum* is apparently consistently considered poisonous (Avizohar-Hershenzon, 1967; Chang and Xiaolan 1995; Graff, 1927; Imazeki *et al.* 1988).

Poisonous mushrooms are grouped into eight classes determined by symptoms and the toxins involved. *Chlorophyllum molybdites* is a member of group VII, the gastrointestinal irritants. Ingestion of mushrooms in group VII usually produce brief gastrointestinal illness consisting of nausea, vomiting, diarrhea, and abdominal pain. The diarrhea is often bloody. Symptoms usually begin 30 min to three hours after ingestion (Lincoff and Mitchel, 1977). The symptoms mentioned in the above two case histories, particularly the intensive vomiting, and the moment of their appearance - rather soon after the ingestion - are typical for gastrointestinal syndrome and this is indeed the group of mushroom poisonings in which *C. molybdites* has always been classified.

All toxic mushrooms cause vomiting and abdominal pain, other manifestations vary significantly by mushroom type. Hall *et al.* (1987) pointed out that the degree of toxicity depends on the species ingested, amount ingested, season of the year, geographic location, cooking technique, co ingestion of alcohol, and the individual response of the pa-

tient. Generally, mushrooms that cause symptoms early (within 2 hr.) are less dangerous than those that cause symptoms later (usually after 6 hr.).

Chlorophyllum molybdites is one of the largest and most common mushrooms found in Kerala and is the most frequent cause of mushroom poisoning in Kerala. When mature, this mushroom can be relatively easy to distinguish from other mushrooms based on its large cap, the ring around its stem, and the greenish colour of its gills resulting from the green spores that it produces. Consumption of *C. molybdites* causes severe gastrointestinal distress, including stomach irritation, vomiting, and diarrhea. Although *C. molybdites* is not fatally poisonous like some other mushroom species, it is important to know the identity of this common mushroom because it is widely distributed in Kerala. Misidentification is probably the cause of most cases of mushroom poisoning cases in Kerala because many of the best-known edibles have one or more poisonous look-alikes. The two most common causes of mushroom poisoning reported from different parts of Kerala were carelessness and ignorance. These accidents would have been avoided by careful rather than casual examination of the mushrooms gathered for the meal. Wild mushroom picking and consumption should be strongly discouraged as a precaution against mushroom poisoning. It is difficult to know which wild mushrooms are safe and which are not and sometimes even experts get it wrong.

As the compound responsible for human poisoning from this species is thermo labile, destroyed when the mushroom is cooked at 70 °C during thirty minutes, suggests that those who were poisoned by this mushroom may not have cooked it sufficiently.

ACKNOWLEDGEMENTS

The authors are very grateful to the victims from the poisoning in Thiruvananthapuram, Kerala and authorities of the Medical College, Thiruvananthapuram, for their kind collaboration and willingness to supply us with all the necessary details. Bijeesh acknowledge financial support from UGC as Rajiv Gandhi National Fellowship.

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