Foodborne Disease Handbook
FOODBORNE DISEASE HANDBOOK

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Volume 1  Bacterial Pathogens

Volume 2  Viruses, Parasites, Pathogens, and HACCP

Volume 3  Plant Toxicants

Volume 4  Seafood and Environmental Toxins
Introduction to the Handbook

The Foodborne Disease Handbook, Second Edition, Revised and Expanded, could not be appearing at a more auspicious time. Never before has the campaign for food safety been pursued so intensely on so many fronts in virtually every country around the world. This new edition reflects at least one of the many aspects of that intense and multifaceted campaign: namely, that research on food safety has been very productive in the years since the first edition appeared. The Handbook is now presented in four volumes instead of the three of the 1994 edition. The four volumes are composed of 86 chapters, a 22% increase over the 67 chapters of the first edition. Much of the information in the first edition has been carried forward to this new edition because that information is still as reliable and pertinent as it was in 1994. This integration of the older data with the latest research findings gives the reader a secure scientific foundation on which to base important decisions affecting the public's health.

We are not so naive as to think that only scientific facts influence decisions affecting food safety. Political and economic factors and compelling national interests may carry greater weight in the minds of decision-makers than the scientific findings offered in this new edition. However, if persons in the higher levels of national governments and international agencies, such as the Codex Alimentarius Commission, the World Trade Organization, the World Health Organization, and the Food and Agriculture Organization, who must bear the burden of decision-making need and are willing to entertain scientific findings, then the information in these four volumes will serve them well indeed.

During the last decade of the previous century, we witnessed an unprecedentedly intense and varied program of research on food safety, as we have already noted. There are compelling forces driving these research efforts. The traditional food-associated pathogens, parasites, and toxins of forty years ago still continue to cause problems today, and newer or less well-known species and strains present extraordinary challenges to human health.

These newer threats may be serious even for the immunocompetent, but for the immunocompromised they can be devastating. The relative numbers of the immunocompromised in the world population are increasing daily. We include here not just those affected by the human immunodeficiency virus (HIV), but also the elderly; the very young; the recipients of radiation treatments, chemotherapy, and immunosuppressive drugs;
Introduction to the Handbook

patients undergoing major invasive diagnostic or surgical procedures; and sufferers of debilitating diseases such as diabetes. To this daunting list of challenges must be added numerous instances of microbial resistance to antibiotics.

Moreover, it is not yet clear how the great HACCP experiment will play out on the worldwide stage of food safety. Altruism and profit motivation have always made strange bedfellows in the food industry. It remains to be seen whether HACCP will succeed in wedding these two disparate motives into a unifying force for the benefit of all concerned—producers, manufacturers, retailers, and consumers. That HACCP shows great promise is thoroughly discussed in Volume 2, with an emphasis on sanitation in a public eating place.

All the foregoing factors lend a sense of urgency to the task of rapidly identifying toxins, species, and strains of pathogens and parasites as etiologic agents, and of determining their roles in the epidemiology and epizootiology of disease outbreaks, which are described in detail throughout the Foodborne Disease Handbook.

It is very fortunate for the consumer that there exists in the food industry a dedicated cadre of scientific specialists who scrutinize all aspects of food production and bring their expertise to bear on the potential hazards they know best. A good sampling of the kinds of work they do is contained in these four new volumes of the Handbook. And the benefits of their research are obvious to the scientific specialist who wants to learn even more about food hazards, to the scientific generalist who is curious about everything and who will be delighted to find a good source of accurate, up-to-date information, and to consumers who care about what they eat.

We are confident that these four volumes will provide competent, trustworthy, and timely information to inquiring readers, no matter what roles they may play in the global campaign to achieve food safety.

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Preface

The world of nature offers many pleasant attractions. Concurrent with the increased crowding of urban areas in much of the developed world, there is a growing tendency for stressed-out city dwellers to seek peace in the wilderness, the more or less easily accessible natural areas, both terrestrial and aquatic. Much of the fauna and flora of these natural areas are quite innocuous—for the most part, only specialists are aware of exceptions. And even some of the specialists might be unaware of hazards originating outside their own sphere of expertise. Among consumers, mushroom hunters and fishermen are probably the best informed about potential hazards in their favored haunts. However, without access to specialized equipment and laboratory protocols, even the most competent specialist may be quite as unable to detect a hazard in food as the most naive consumer.

While poisonous mushrooms figure prominently in this volume of the Foodborne Disease Handbook, other dangerous botanicals are by no means neglected. By “dangerous,” we refer to a very broad range of effects on human and animal health. The poisonous plants, their toxins, and the symptoms they cause are all discussed in detail, but more than that, the reader will find current and helpful information on methods of chemical analysis and recommendations for the medical management of poisoning episodes.

Mushrooms are enormously popular around the world as a food item. Fortunately for the average consumer, grocery stores and restaurants get their mushrooms from commercial growers. Such mushrooms have no inherent toxic properties and thus are considered safe to eat and, in fact, are safe to eat. However, even with commercially produced mushrooms, the potential for microbial and insecticidal contamination should not be ignored.

In the category of organisms known as fungi, mushrooms and toadstools are relatively large and easy to recognize for what they are. There are other fungi, however, that most of us will never see and that many consumers do not even know exist. Yet they, or the toxins they elaborate, may be just as dangerous as the much more obvious poisonous mushrooms. These are the fungi that produce mycotoxins (e.g., aflatoxin). For example, edible plant foods may contain natural poisons. We have heard about molds in peanut, which are a form of fungi—and contain aflatoxin. Poisons in cotton seed, cabbage, and
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potatoes are usually either removed during processing or destroyed during cooking. Plant toxins are described in great detail—detection, identification, effects on human and animal health, epidemiology—in this volume.

Y. H. Hui
R. A. Smith
David G. Spoerke, Jr.
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I. EPIDEMIOLOGY

Epidemiological studies aid treatment facilities in determining risk factors, determining who may become exposed, and establishing the probable outcomes of various treatments. A few organizations have attempted to gather such information and organize it into yearly reports. The American Associations of Poison Control Centers (AAPCC), North American Mycological Association (NAMA), and some federal agencies all work toward obtaining epidemiological information, while the AAPCC has an active role in assisting with the treatment of exposures. Epidemiological studies assist government and industry in determining package safety, effective treatment measures, conditions of exposure, and frequency of exposure. In 1987 there were 7023 cases of mushroom poisoning reported to the AAPCC. In 1988, that figure increased to 7,834 (1). These numbers were approxi-
mately 0.6% of the total cases called to poison centers. The NAMA mushroom poisoning case registry was provided with 156 reports (4.6% of reported mushroom cases), and, in 1988, 116 cases (3.4%) were registered (1).

Studies on mushroom poisonings provide information on the type of people most commonly involved in exposures. Are these patients children experimenting in the back-yard, hikers, or mycophiles looking for dinner? Studies can also tell us which species are most commonly involved and what species were being sought. What types of symptoms are seen first, onset of symptoms, and any sequelae may also be determined and compared to accepted norms.

A. AAPCC

1. What Are Poison Centers and the AAPCC?

The group in the United States most concerned on a daily basis with poisonings due to household agents, industrial agents, and biologics (including plants and mushrooms) is the AAPCC. This is a national resource that provides information concerning all aspects of poisoning and often refers patients to treatment centers. This group of loosely affiliated centers is often supported by both government and industrial sources.

Poison centers were started in the late 1950s, the first thought to be in the Chicago area. The idea caught on quickly and at the peak of the movement there were hundreds of centers throughout the United States. Unfortunately, there were little or no standards to define what might be called a poison center, the type of staff, hours of operation, or information resources. One center may have had a dedicated staff of doctors, pharmacists, and nurses trained specifically in handling poison cases; the next center may just have had a book on toxicology in the emergency room or hospital library. In 1993, the Health and Safety Code (Sec. 777.002) specified that a poison center provide a 24-hr service for public and health care professionals and meet requirements established by the AAPCC. This action helped the AAPCC to standardize activities and staffing of the various poison centers.

The federal government does not fund poison centers, even though for every dollar spent on poison centers there is a savings of $2–9 in unnecessary expenses (2, 3). The federal agency responsible for the Poison Prevention Packaging Act is the U.S. Consumer Product Safety Commission (CPSC). The National Clearinghouse for Poison Control Centers initially collected data on poisonings and information on commercial product ingredients and biologic toxic agents. For several years the National Clearinghouse provided product and treatment information to the poison centers that handled the day-to-day management of the centers.

At first most poison centers were funded by the hospital in which they were located. As the centers grew in size and number of calls being handled, both city and state governments took on the responsibility of contributing funds. In recent years, the local governments have found it very difficult to fund such operations and centers have had to look to private industry for additional funding. Government funding may take several forms, either as a line-item on a state’s budget, as a direct grant, or as moneys distributed on a per call basis. Some states with fewer residents may contract with a neighboring state to provide services to its residents. Some states are so populous that more than one center is funded by the state. Industrial funding also varies, sometimes as a grant, sometimes as
payment for handling the company’s poison or drug information–related calls, sometimes as payment for collection of data regarding exposure to the company’s product.

Every year the AAPCC reports a summary of plant and mushroom exposures. As an example, data on mushroom exposures from 1989 and 1990 are listed in Tables 1 and 2.

The totals do not equal 100%, as not everyone who was exposed to a mushroom went to an emergency department, and not all calls concerning mushroom exposures were due to poisonings. As can be seen by these statistics, there are a large number of exposures, but very few serious outcomes due to mushroom exposures.

The same type of information is available for plant exposures. Each plant and mushroom has its own code number in the POISINDEX® reference system, which is entered by the poison center specialist taking the call. Thus, if the plant or mushroom is known at the time of exposure and the right code is entered, the database will describe ages, sexes, signs and symptoms, treatment, and outcomes for any particular plant or mushroom.

2. Regional Centers
The number of listed centers has dropped significantly since its peak of 600 plus. Many centers have been combined into regional centers. These regional poison centers provide poison information and telephone management and consultation, collect pertinent data, and deliver professional and public education. Cooperation between regional poison centers and poison treatment facilities is crucial. The regional poison information center should work with various hospitals to determine the capabilities of the treatment facilities of the region and to identify and have a working relationship with analytical toxicology laboratories, emergency departments, critical care wards, medical transportation systems, and extracorporeal elimination methods availability. This should be done for both adults and children.

A “region” is usually determined by state authorities in conjunction with local health agencies and health care providers. Documentation of these state designations must be in writing unless a state chooses (in writing) not to designate any poison center or accepts a designation by other political or health jurisdictions. Regional poison information centers should serve a population base of greater than one million people and must receive at least 10,000 human exposure calls per year.

The number of certified regional centers in the United States is now under 50. Certification as a regional center requires the following (4):
1. Maintenance of a 24 hr/day, 365 days/year service.
2. Service to both health care professionals and the public.
3. Availability of at least one specialist in poison information in the center at all times.
4. A medical director or qualified designee, on call by telephone, at all times.
5. Service readily accessible by telephone from all areas within the region.
6. Comprehensive poison information resources and comprehensive toxicology information covering both general and specific aspects of acute and chronic poisoning.
7. A list of on-call poison center specialty consultants.
8. Written operational guidelines, which provide a consistent approach to evaluation, follow-up, and management of toxic exposures. These guidelines must be approved in writing by the medical director of the program.
9. A staff of certified professionals manning the phones (at least one of the persons on the phone has to be a pharmacist or nurse with 2000 hr and 2000 cases of supervised experience).
10. A 24-hr/day physician (board certified) consultation service.
11. An ongoing quality assurance program.
12. Other criteria, as determined by the AAPCC, may be established with membership approval.
13. The regional poison information center must be an institutional member in good standing of the AAPCC.

Many hospital emergency rooms still maintain a toxicology reference such as the POISINDEX system to handle routine exposure cases, but rely on regional poison centers to handle most of the calls in their area.

B. Staffing a Poison Center

The staffing of a poison center varies considerably from center to center. The three professional groups most often involved are physicians, nurses, and pharmacists. Who answers the phones is somewhat dependent on the local labor pool, moneys available, and the types of calls being received. Other groups called on to serve in a center (with appropriate supervision) include students in medically related fields, toxicologists, and biologists. Persons responsible for answering the phones are either certified by the AAPCC or are in the process of obtaining the certification. Passage of an extensive examination in toxicology is required for initial certification, with periodic recertification required.

Regardless of who takes the initial call, there is a medical director and other physician backup available. These physicians have specialized training or experience in toxicology, and are able to provide in-depth consultations for health care professionals calling a center.

1. Medical Director

A poison center medical director should be board certified in medical toxicology, internal medicine, pediatrics, family medicine, or emergency medicine. The medical director should be able to demonstrate ongoing interest and expertise in toxicology as evidenced
Poison Centers for Plant Toxin Exposure

by publications, research, and meeting attendance. The medical director must have a medical staff appointment at a comprehensive poison treatment facility and must be involved in the management of poisoned patients.

2. Managing Director

The managing director must be a registered nurse, pharmacist, or physician, or hold a degree in a health science discipline. The individual should be certified by the American Board of Medical Toxicology (for physicians) or by the American Board of Applied Toxicology (for nonphysicians). They must be able to demonstrate ongoing interest and expertise in toxicology.

3. Specialists in Poison Information

These individuals must be registered nurses, pharmacists, or physicians, or be currently certified by the AAPCC as a specialist in poison information. Specialists in poison information must complete a training program approved by the medical director and must be certified by the AAPCC as a specialist in poison information within two examination administrations of their initial eligibility. Specialists not currently certified by the Association must spend an annual average of no less than 16 hr/week in poison center related activities. Specialists currently certified by the AAPCC must spend an annual average of no less than 8 hr/week. Other poison information providers must have sufficient background to understand and interpret standard poison information resources and to transmit that information understandably to both health professionals and the public.

4. Consultants

In addition to physicians specializing in toxicology, most centers also have lists of experts in many other fields. Poison center specialty consultants should be qualified by training or experience to provide sophisticated toxicology or patient care information in their area(s) of expertise. In regard to botanic exposures, the names and phone numbers of persons in a botanic garden, various nurseries, gardening clubs, or mushroom clubs are often available, with experts willing to donate their expertise in identification and handling cases within their specialty.

C. Types of Calls Received

All types of calls are received by poison centers, most of which are handled immediately with a few others referred to more appropriate agencies. Which calls are referred depends on the center, its expertise, and the appropriateness of a referral. Below are types of calls that generally fall into each group. There is considerable variation between poison centers, and if there is doubt, call the poison center and they will tell you if your case is more appropriately referred. Poison centers do best on calls regarding acute exposures. Complicated calls regarding exposure to several agents over a long period that produce nonspecific symptoms are often referred to another medical specialist, to the toxicologist associated with the center, or to an appropriate government agency. The poison center will often follow up on these cases to track outcome and type of service given.

Types of Calls Usually Accepted

Drug identification.
Actual acute exposure to a drug or chemical.
Actual acute exposure to a biologic agent (plants, mushrooms, various animals).
Information regarding the toxic potential of an agent.
Possible food poisoning.
Drug information calls.

Types of Calls Often Referred
Questions regarding treatment of a medical condition (not poisoning).
General psychiatric questions, with no drugs or chemicals involved.
Proper disposal of household agents such as batteries, bleach, insecticides.
Use of insecticides (e.g., which insecticide to use, how to use it) unless related to a health issue—for example, a person allergic to pyrethrins wanting to know which product does not contain pyrethrins).
Drug information calls.

1. Data Collection
AAPCC has certain rules about data collection. Records of all calls/cases handled by the center must be kept in a form that is acceptable as a medical record. The regional poison information center must submit all its human exposure data to the American Association of Poison Control Centers’ National Data Collection System. The regional poison information center must tabulate its experience for regional program evaluation on at least an annual basis.

In 1983 the AAPCC formed the AAPCC Toxic Exposure Surveillance System (TESS) from the former National Data Collection System. Currently TESS contains nearly 16.2 million human poison exposure cases. Sixty-five poison centers, representing 181.3 million people, participate in the data collection. The information has various uses to both governmental agencies and industry, providing data for product reformulations, repackaging, recall, bans, injury potential, and epidemiology.

The summation of each year’s surveillance is published in the American Journal of Emergency Medicine each year in late summer or fall (11, 12).

D. How Calls Are Handled
Most poison centers receive requests for information via the telephone. Calls come from both health care professionals and consumers. Only a few requests are received by mail or in person; these are often medicolegal or complex cases. Most centers can be reached by a toll-free phone number in the areas they serve, as well as a local number. Busy centers will have a single number that will ring on several lines. Calls are often direct referrals from the 911 system. In most cases, poison center specialists are unable to determine the exact plant or mushroom species, so it is difficult to give plant/mushroom-specific information. Often there is an attempt to at least identify the genus involved so as to estimate toxicity. In cases where few, if any, symptoms occur, and the more seriously toxic biologics can be ruled out, there is often minimal additional effort put forth to determine the plant/mushroom species. The patient is followed by telephone to assure no signs or symptoms develop. When symptoms are present, experienced plant/mushroom identifiers are often utilized to make identification as precise as possible with the available botanic material.

Poison information specialists listen to the caller, recording the history of the case on a standardized form developed by the AAPCC. Basic information such as the agent
involved, the amount of agent, time of ingestion, symptoms, previous treatment, and current condition are recorded, as well as patient information such as sex, age, phone number, who is with the patient, relevant medical history, and sometimes patient address. All information is considered a part of a confidential medical record.

The case is evaluated (using various references) as:

1. information only, no patient involved
2. harmless and not requiring follow-up
3. slightly toxic, no treatment necessary but a follow-up call is given
4. potentially toxic, treatment given at home and follow-up given until case resolution
5. potentially toxic, treatment may or may not be given at home, but it is necessary for the patient to be referred to a medical facility
6. emergency—an ambulance and/or paramedics are dispatched to the scene

Cases are usually followed until symptoms have resolved. In cases where the patient is referred to a health care facility, the receiving agency is notified that the patient is in transit. The history is relayed, toxic potential discussed, and suggestions for treatment given.

E. References Used

References used also vary from center to center, but virtually all U.S. centers use a toxicology system called POISINDEX (5), which contains lists of products, their ingredients, and suggestions for treatment. The system is compiled using medical literature and medical specialists from throughout the world. Biologic products such as plants, insects, mushrooms, animal bites, and so forth are handled similarly. An entry for an individual plant might contain a description, toxic substance present, potential toxic amounts, and most dangerous plant part. The physician or poison information specialist is then referred to a treatment protocol that may be used for a general class of agents. An example would be: *Philodendron* exposures are referred to a protocol on oxalate-containing plants. This system is available on microfiche, a CD ROM, over a network, or on a mainframe. It is updated every 3 months. Not every plant and mushroom is on the system, but a great many are listed by both their scientific and common names.

Various texts are also used. Among those mushroom sources stated as helpful in a survey of poison centers, Miller (6), Kingsbury (7), Rumack and Salzman (8), POISINDEX (5), Lincoff and Mitchell (9), and Stamets (10) are frequently mentioned. It is very difficult to identify plants and mushrooms using a description given over the phone, so often the assistance of garden club or mushroom club members, local greenhouses, botanic gardens, and various specialists is requested.

Some poison centers have more experience with certain types of poisonings than do others, and these centers are often consulted during a more complex case.

A recent trend has been for various manufacturers not to provide product information to all centers via POISINDEX, but to contract with one poison center to provide for poison information services for the whole country. Product information is given to only that center and cases throughout the country can only be handled by that one center.

F. How Poison Centers Are Monitored for Quality

Most poison centers have a system of peer review. One person takes a call, another reviews it. Periodic spot review is done by supervisory and physician staff. General competence
is assured by certification and recertification via examination of physicians and poison information specialists. Most regional centers have journal clubs where challenging cases are discussed.

G. Professional and Public Education Programs

The regional poison information center is required to provide information on the management of poisoning to the health professionals throughout the region who care for poisoned patients. Public education programs, aimed at educating both children and adults about poisoning dangers and other necessary concepts related to poison control, should be provided.

In the past, several centers provided stickers or logos such as Officer Ugh, Safety Sadie, and Mr. Yuck. These stickers could be placed on or near potentially toxic substances. While the intent was to identify potentially toxic substances that the children should keep away from, the practice has been much curtailed on the new assumption that in some cases the stickers actually attracted the children to the products.

In the spring of every year there is a poison prevention week. National attention is focused on the problem of potentially toxic exposures. During this week many centers run special programs for the public. This may include lectures on prevention, potentially toxic agents in the home, potentially toxic biologic agents, or general first aid methods. Although this week is an important time for poison centers, public and professional education is a year-round commitment. Physicians often have medical toxicology rounds, journal clubs, and lectures by specialty consultants. Health fairs, school programs, and various women's clubs are used to educate the public. The extent of these activities is often determined by the amount of funding from government, private organizations, and public donations.

H. Related Professional Toxicology Organizations

**AACT**  
American Association of Clinical Toxicologists  
Address: c/o Medical Toxicology Consultants; Four Columbia Drive; Suite 810; Tampa, FL 33606

**AAPCC**  
American Association of Poison Control Centers  
Address: 3201 New Mexico Avenue NW; Washington, DC 20016  
Phone: 202-362-7217  
FAX: 202-362-8377

**ABAT**  
American Board of Applied Toxicology  
Address: Truman Medical Center, West; 2301 Holmes St.; Kansas City, MO 64108  
Phone: 816-556-3112  
FAX: 816-881-6282

**ABEM**  
American Board of Emergency Medicine  
Address: 300 Coolidge Road; East Lansing, MI 48823  
Phone: 517-332-4800  
FAX: 517-332-2234

**ACEP**  
American College of Emergency Physicians (Toxicology Section)  
Address: P.O. Box 619911; Dallas, TX 75261-9911
ACGIH  American Conference of Governmental and Industrial Hygienists  
Address: Kemper Woods Center; Cincinnati, OH 45240  
Phone: 513-742-2020  
FAX: 513-742-3355

ACMT  American College of Medical Toxicology (formerly ABMT)  
Address: 777 E. Park Drive; P.O. Box 8820; Harrisburg, PA 17105-8820.  
Phone: 717-558-7846  
FAX: 717-558-7841  
e-mail: lkoval@pamedsoc.org (Linda L. Koval)

ACOEM  American College of Occupational and Environmental Medicine  
Address: 55 West Seegers Road; Arlington Heights, IL 60005  
Phone: 708-228-6850  
FAX: 708-228-1856

ACS  Association of Clinical Scientists  
Address: Dept. of Laboratory Medicine; University of Connecticut Medical School; 263 Farmington Ave.; Farmington, CT 06030-2225  
Phone: 203-679-2328  
FAX: 203-679-2328

ACT  American College of Toxicology  
Address: 9650 Rockville Pike; Bethesda, MD 20814  
Phone: 301-571-1840  
FAX: 301-571-1852

AOEC  Association of Occupational and Environmental Clinics  
Address: 1010 Vermont Ave., NW, #513; Washington, DC 20005  
Phone: 202-347-4976  
FAX: 202-347-4950  
e-mail: lo478x@gwis.circ.gwu.edu

ASCEPT  Australian Society of Clinical and Experimental Pharmacologists and Toxicologists  
Address: 145 Macquarie St.; Sydney N.S.W. 2000, Australia  
Phone: 61-2-256-5456  
FAX: 61-2-252-3310

BTS  British Toxicology Society  
Address: MJ Tucker, Zeneca Pharmaceuticals; 22B11 Mareside; Alderley Park, Macclesfield; Cheshire, SK10 4TG; United Kingdom  
Phone: 0428 65 5041

CAPCC  Canadian Association of Poison Control Centers  
Address: Hopital Sainte-Justine; 3175 Cote Sainte-Catherine; Montreal, Quebec H3T1C5  
Phone: 514-345-4675  
FAX: 514-345-4822

CSVVA (CEVAP)  Center for the Study of Venoms and Venomous Animals  
Address: UNESP; Alameda Santos; N 647; CEP 01419-901; Sao Paulo, SP, Brazil  
Phone: 55 011 252 0233  
FAX: 55 011 252 0200
I. International Affiliations

AAPCC members attend various world conferences to learn of toxicology problems and new methods used by these agencies. An especially close relationship has formed between the American and Canadian Poison Center (CAPPC) associations. Once a year the AAPCC and CAPPC hold a joint scientific meeting and invite speakers and other toxicology spe-
Poison Centers for Plant Toxin Exposure

A specialist from throughout the world to attend. Some international affiliated organizations are listed with the North American groups above.

J. Toxicology and Poison Center Web Sites

Association of Occupational and Environmental Clinics  This group is dedicated to higher standards of patient-centered, multidisciplinary care emphasizing prevention and total health through information sharing, quality service, and collaborative research. Address: lo478x@gwis.circ.gwu.edu

Directory of Mycologists  List of U.S. and Latin American mycologists who may be available for consultation. Address: http://www.keil.ukans.edu/~fungi

Directory for Mycorrhizal and Edible Fungi  Address: http://www.mykopat.slu.se/mycorrhiza/edible/home.phtml

Finger Lakes Regional Poison Center  Address: pwax@ed.urmc.rochester.edu

Latin American Mycologists  A site for identifying some Latin American mycologists. Address: http://bragg.ivic.velvic/ALM/directorio/direct/html

Medical/Clinical/Occupational Toxicology Professional Groups  A list of primarily U.S. professional groups interested in toxicology. There is a description of each group, its address, phone numbers, and contact names. Keyword: poison centers, toxicology. Address: http://www.pitt.edu/~martint/pages/motoxorg.htm

Poison Net  A mailing list dedicated to sharing information, problem solving, and networking in the areas of poisoning, poison control centers, hazardous materials, and related topics. The list is intended for health care professionals, not the lay public. The moderators do not encourage responses to individual poisoning cases from the public: Key word(s): poisoning, poison control centers

K. North American Mycological Association

In 1984 Ken Cochran started the Mushroom Poisoning Case Registry for the North American Mycological Association. This was kept at the University of Michigan until 1988, then was transferred to Ken Lampe at the American Medical Association in Chicago. Since his death in 1990, John Trestrail III has kept the records at the Blodgett Regional Poison Center in Grand Rapids, Michigan (1).

Reports to the registry are made on a standard form, which is available free of charge or may be photocopied. The reporting is voluntary, and most often comes from physicians,

Table 3  NAMA Mushroom Exposures

<table>
<thead>
<tr>
<th># of exposures</th>
<th>% nonhuman</th>
<th># of genera</th>
<th>% unk. genera</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>6</td>
<td>26</td>
<td>15.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient age¹</th>
<th>Under 6</th>
<th>6 to 12</th>
<th>13 to 17</th>
<th>18 to 49</th>
<th>50 to 69</th>
<th>Over 70</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>1%</td>
<td>0%</td>
<td>37%</td>
<td>13%</td>
<td>6%</td>
<td></td>
</tr>
</tbody>
</table>

¹ These reports represent a different age distribution than seen in the AAPCC cases, where 80.5% are under 6 years of age.
poison centers, and mushroom club representatives. Because reporting is voluntary, it is also irregular. The number of cases recorded by NAMA is smaller than that reported by AAPCC, and they are not necessarily the same cases. Interpretation of these data and comparison to the AAPCC data is difficult, if not impossible. Other shortcomings of this database are that no species identifications are questioned, nor are any symptoms eliminated or evaluated based on the type of mushroom exposure. It is possible that symptoms reported could be due to coincidental illness, infection, or environmental conditions. Still, it is an attempt at gathering information on adverse reactions involving mushrooms. Table 3 is based on reports from 21 U.S. states or Canadian providences, but two states (Colorado and Oregon) represented 43% of the cases. This is thought to be due to more diligent reporting, rather than actual higher incidence of poisonings. These cases represent exposures reported in 1989 and 1990.

II. POISON INFORMATION CENTERS IN THE UNITED STATES

The Poison Control Center telephone numbers and addresses listed below are thought to be accurate as of the date of publication. Poison Control Center telephone numbers or addresses may change. The address and phone number of the Poison Control Center nearest you should be frequently checked. If the number listed does not reach the poison center, contact the nearest emergency service, such as 911 or local hospital emergency rooms. The author disclaims any liability resulting from or relating to any inaccuracies or changes in the phone numbers provided below.

**ALABAMA**

*Birmingham*
Regional Poison Control Center*
Children's Hospital of Alabama
1600 Seventh Avenue, South Birmingham,
AL 35233-1711
(800) 292-6678 (AL only)
(205) 933-4050

*Tuscaloosa*
Alabama Poison Control System, Inc.
408 A Paul Bryant Drive, East
Tuscaloosa, AL 35401
(800) 462-0800 (AL only)
(205) 345-0600

**ALASKA**

*Anchorage*
Anchorage Poison Center
Providence Hospital
P.O. Box 196604
3200 Providence Drive
Anchorage, AK 99519-6604
(800) 478-3193 (AK only)

*Fairbanks*
Fairbanks Poison Center
Fairbanks Memorial Hospital
1650 Cowles St.
Fairbanks, AK 99701
(907) 456-7182

* Indicates a Regional Center designated by the American Association of Poison Control Centers.
Poison Centers for Plant Toxin Exposure

ARIZONA

Phoenix
Samaritan Regional Poison Center*
Good Samaritan Medical Center
1130 East McDowell Road, Suite A-5
Phoenix, AZ 85006
(602) 253-3334

Tucson
Arizona Poison and Drug Information Center*
Arizona Health Sciences Center, Room 1156
1501 N. Campbell Ave
Tucson, AZ 85724
(800) 362-0101 (AZ only)
(602) 626-6016

(800) 825-2722
(213) 222-2312

Orange
University of California Irvine Medical Center Regional Poison Center*
101 The City Drive, South
Route 78
Orange, CA 92668-3298
(800) 544-4404 (CA only)
(714) 634-5988

Richmond
Chevron Emergency Information Center
15299 San Pablo Avenue
P.O. Box 4054
Richmond, CA 94804-0054
(800) 457-2202
(510) 233-3737 or 3738

Sacramento
Regional Poison Control Center*
University of California at Davis Medical Center
2315 Stockton Boulevard Rm HSF-124
Sacramento, CA 95817
(800) 342-3293 (northern CA only)
(916) 734-3692

San Diego
San Diego Regional Poison Center*
University of California at San Diego Medical Center
225 West Dickinson Street
San Diego, CA 92013-8925
(800) 876-4766 (CA only)
(619) 543-6000

San Francisco
San Francisco Bay Area Poison Center*
San Francisco General Hospital
1001 Potrero Avenue Rm 1E86
San Francisco, CA 94122
(800) 523-2222
(415) 476-6600

San Jose
Regional Poison Center*
Santa Clara Valley Medical Center
751 South Bascom Avenue
San Jose, CA 95128
(800) 662-9886, 9887 (CA only)
(408) 299-5112, 5113, 5114

ARKANSAS

Little Rock
Arkansas Poison and Drug Information Center
University of Arkansas
College of Pharmacy
4301 West Markham, Slot 522
Little Rock, AR 77205
(800) 482-8948 (AR only)
(501) 661-6161

CALIFORNIA

Fresno
Fresno Regional Poison Control Center*
Fresno Community Hospital & Medical Center
2823 Fresno Street
Fresno, CA 93721
(800) 346-5922 (CA only)
(209) 445-1222

Los Angeles
Los Angeles County University of Southern California Regional Poison Center*
1200 North State, Room 1107
Los Angeles, CA 90033
COLORADO

Denver
Rocky Mountain Poison Center*
8802 Ninth Avenue
Denver, CO 80220-6800
(800) 332-3073 (CO only)
(303) 629-1123

CONNECTICUT

Farmington
Connecticut Poison Control Center
University of Connecticut Health Center
263 Farmington Avenue
Farmington, CT 06030
(800) 343-2722 (CT only)
(203) 679-3456

DELWARE

Wilmington
Poison Information Center
Medical Center of Delaware
Wilmington Hospital
501 West 14th Street
Wilmington, DE 19899
(302) 655-3389

DISTRICT OF COLUMBIA

Washington
National Capital Poison Center*
Georgetown University Hospital
3800 Reservoir Road, North West
Washington, DC 20007
(202) 625-3333

FLORIDA

Jacksonville
Florida Poison Information Center
University Medical Center
655 West Eighth Street
Jacksonville, FL 32209
(904) 549-4465 or 764-7667

HAWAII

Honolulu
Kapiolani Women’s and Children’s
Medical Center
1319 Punahou Street
Honolulu, HI 96826
(800) 362-3585, 3586 (HI only)
(808) 941-4411

Tallahassee
Tallahassee Memorial Regional Medical Center
1300 Miccosukk Road
Tallahassee, FL 32308
(904) 681-5411

Tampa
Tampa Poison Information Center*
Tampa General Hospital
Davis Islands
P.O. Box 1289
Tampa, FL 33601
(800) 282-3171 (FL only)
(813) 253-4444

GEORGIA

Atlanta
Georgia Regional Poison Control Center*
Grady Memorial Hospital
80 Butler Street South East
Box 26066
Atlanta, GA 30335-3801
(800) 282-5846 (GA only)
(404) 616-9000

Macon
Regional Poison Control Center
Medical Center of Central Georgia
777 Hemlock Street
Macon, GA 31208
(912) 744-1146, 1100 or 1427

Savannah
Savannah Regional Poison Control Center
Memorial Medical Center Inc.
4700 Waters Avenue
Savannah, GA 31403
(912) 355-5228 or 356-5228

HAWAII

Honolulu
Kapiolani Women’s and Children’s
Medical Center
1319 Punahou Street
Honolulu, HI 96826
(800) 362-3585, 3586 (HI only)
(808) 941-4411
Poison Centers for Plant Toxin Exposure

IDAHO

Boise
Idaho Poison Center
St. Alphonsus Regional Medical Center
1055 North Curtis Road
Boise, ID 83706
(800) 632-8000 (ID only)
(208) 378-2707

ILLINOIS

Chicago
Chicago and NE Illinois Regional Poison Control Center
Rush Presbyterian—St. Luke’s Medical Center
1653 West Congress Parkway
Chicago, IL 60612
(800) 942-5969 (Northeast IL only)
(312) 942-5969

Normal
Bromenn Hospital Poison Center
Virginia at Franklin
Normal, IL 61761
(309) 454-6666

Springfield
Central and Southern Illinois Poison Resource Center
St. John’s Hospital
800 East Carpenter Street
Springfield, IL 62769
(800) 252-2022 (IL only)
(217) 753-3330

Urbana
National Animal Poison Control Center
University of Illinois Department of Veterinary Biosciences
2001 South Lincoln Avenue, 1220 VMBSB
Urbana, IL 61801
(800) 548-2423 (Subscribers only)
(217) 333-2053

INDIANA

Indianapolis
Indiana Poison Center*
Methodist Hospital

IOWA

Des Moines
Variety Club Drug and Poison Information Center
Iowa Methodist Medical Center
1200 Pleasant Street
Des Moines, IA 50309
(800) 362-2327
(515) 241-6254

Iowa City
University of Iowa Hospitals and Clinics
200 Hawkins Drive
Iowa City, IA 52246
(800) 272-6477 or (800) 362-2327 (IA only)
(319) 356-2922

Sioux City
St. Luke’s Poison Center
St. Luke’s Regional Medical Center
2720 Stone Park Boulevard
Sioux City, IA 51104
(800) 352-2222 (IA, NE, SD)
(712) 277-2222

KANSAS

Kansas City
Mid America Poison Center
Kansas University Medical Center
39th and Rainbow Boulevard
Room B-400
Kansas City, KS 66160-7231
(800) 332-6633 (KS only)
(913) 588-6633

Topeka
Stormont Vail Regional Medical Center
Emergency Department
1500 West 10th
Topeka, KS 66604
(913) 354-6100

1701 North Senate Boulevard
Indianapolis, IN 46202-1367
(800) 382-9097
(317) 929-2323
Wichita
Wesley Medical Center
550 North Hillside Avenue
Wichita, KS 67214
(316) 688-2222

MARYLAND

Baltimore
Maryland Poison Center*
University of Maryland School of Pharmacy
20 North Pine Street
Baltimore, MD 21201
(800) 492-2414 (MD only)
(410) 528-7701

KENTUCKY

St. Thomas
Northern Kentucky Poison Information Center
St. Luke Hospital
85 North Grand Avenue
Ft. Thomas, KY 41075
(513) 872-5111

Louisville
Kentucky Poison Control Center of Kosair Children’s Hospital
315 East Broadway
P.O. Box 35070
Louisville, KY 40232
(800) 722-5725 (KY only)
(502) 589-8222

MASSACHUSETTS

Boston
Massachusetts Poison Control System*
The Children’s Hospital
300 Longwood Avenue
Boston, MA 02115
(800) 682-9211 (MA only)
(617) 232-2120 or 735-6607

LOUISIANA

Houma
Terrebonne General Medical Center Drug and Poison Information Center
936 East Main Street
Houma, LA 70360
(504) 873-4069

Monroe
Louisiana Drug and Poison Information Center
Northeast Louisiana University School of Pharmacy, Sugar Hall
Monroe, LA 71209-6430
(800) 256-9822 (LA only)
(318) 362-5393

MICHIGAN

Adrian
Bixby Hospital Poison Center
Emma L. Bixby Hospital
818 Riverside Avenue
Adrian, MI 49221
(517) 263-2412

Detroit
Poison Control Center
Children’s Hospital of Michigan
3901 Beaubien Boulevard
Detroit, MI 48201
Outside metropolitan Detroit; (800) 462-6642 (MI only)
(313) 745-5711

MAINE

Portland
Maine Poison Control Center
Maine Medical Center
22 Bramhall Street

Detroit
Poison Control Center
Children’s Hospital of Michigan
3901 Beaubien Boulevard
Detroit, MI 48201
Outside metropolitan Detroit; (800) 462-6642 (MI only)
(313) 745-5711

Grand Rapids
Blodgett Regional Poison Center
1840 Wealthy Street, South East
Grand Rapids, MI 49506
Within MI: (800) 632-2727
Poison Centers for Plant Toxin Exposure

Kalamazoo
Bronson Poison Information Center
252 East Lovell Street
Kalamazoo, MI 49007
(800) 442-4112 616 (MI only)
(616) 341-6409

1465 South Grand Boulevard
St. Louis, MO 63104
(800) 392-9111 (MO only)
(800) 366-8888 (MO, West IL)
(314) 772-5200

MINNESOTA

Minneapolis
Hennepin Regional Poison Center*
701 Park Avenue South
Minneapolis, MN 55415
(612) 347-3144
(612) 347-3141 (Petline)

St. Paul
Minnesotan Regional Poison Center*
St. Paul-Ramsey Medical Center
640 Jackson Street
St. Paul, MN 55101
(800) 222-1222 (MN only)
(612) 221-2113

St. Louis
Regional Poison Center*
Cardinal Glennon Children’s Hospital

MINNESOTA

St. Louis
Regional Poison Center*
Cardinal Glennon Children’s Hospital

MISSISSIPPI

Jackson
University of Mississippi Medical Center
2500 North State Street
Jackson, MS 39216
(601) 354-7660

Hattiesburg
Forrest General Hospital
400 S. 28th Avenue
Hattiesburg, MS 39402
(601) 288-4235

MISSISSIPPI

Hattiesburg
Forrest General Hospital
400 S. 28th Avenue
Hattiesburg, MS 39402
(601) 288-4235

NEBRASKA

Omaha
The Poison Center*
Children’s Memorial Hospital
8301 Dodge Street
Omaha, NE 68114
(800) 955-9119 (WY, NE)
(402) 390-5400, 5555

NEVADA

Las Vegas
Humana Hospital–Sunrise*
3186 Maryland Parkway
Las Vegas, NV 89109
(800) 446-6179 (NV only)

Reno
Washoe Medical Center
77 Pringle Way
Reno, NV 89520
(702) 328-4144

NEW HAMPSHIRE

Lebanon
New Hampshire Poison Center
Dartmouth-Hitchcock Medical Center
1 Medical Center Drive
Lebanon, NH 03756
(800) 562-8236 (NH only)
(603) 650-5000
**NEW JERSEY**

*Newark*
New Jersey Poison Information and Education Systems*
201 Lyons Avenue
Newark, NJ 07112
(800) 962-1253 (NJ only)
(201) 923-0764

*Phillipsburg*
Warren Hospital Poison Control Center
185 Rosberg Street
Phillipsburg, NJ 08865
(800) 962-1253
(908) 859-6768

**NEW MEXICO**

*Albuquerque*
New Mexico Poison and Drug Information Center*
University of New Mexico
Albuquerque, NM 87131
(800) 432-6866 (NM only)
(505) 843-2551

**NEW YORK**

*Buffalo*
Western New York Poison Control Center
Children's Hospital of Buffalo
219 Bryant Street
Buffalo, NY 14222
(800) 888-7655 (NY only)
(716) 878-7654

*Mineola*
Long Island Regional Poison Control Center*
Winthrop University Hospital
259 First Street
Mineola, NY 11501
(516) 542-2323, 2324, 2325

*New York City*
New York City Poison Control Center*
455 First Avenue, Room 123
New York, NY 10016
(212) 340-4494
(212) 764-7667

*Nyack*
Hudson Valley Regional Poison Center
Nyack Hospital
160 North Midland Avenue
Nyack, NY 10920
(800) 336-6997 (NY only)
(914) 353-1000

*Rochester*
Finger Lakes Regional Poison Control Center
University of Rochester Medical Center
601 Elmwood Avenue
Rochester, NY 14642
(800) 333-0542 (NY only)
(716) 275-5151

*Syracuse*
Central New York Poison Control Center
SUNY Health Science Center
750 E Adams Street
Syracuse, NY 13210
(800) 252-5655
(315) 476-4766

**NORTH CAROLINA**

*Asheville*
Western North Carolina Poison Control Center
Memorial Mission Hospital
509 Biltmore Avenue
Asheville, NC 28801
(800) 542-4225 (NC only)
(704) 255-4490 or 258-9907

*Charlotte*
Carolinas Poison Center
Carolinas Medical Center
100 Blythe Boulevard
Charlotte, NC 28232-2861
(800) 848-6946
(704) 355-4000

*Durham*
Duke Regional Poison Control Center
P.O. Box 3007
Durham, NC 27710
(800) 672-1697 (NC only)
(919) 684-8111

*Greensboro*
Triad Poison Center
Moses H. Cone Memorial Hospital
Poison Centers for Plant Toxin Exposure

1200 North Elm Street
Greensboro, NC 27401-1020
(800) 953-4001 (NC only)
(919) 574-8105

Hickory
Catawba Memorial Hospital Poison Control Center
810 Fairgrove Church Road, South East Hickory, NC 28602
(704) 322-6649

NORTH DAKOTA

Fargo
North Dakota Poison Center
St. Luke’s Hospital
720 North 4th Street
Fargo, ND 58122
(800) 732-2200 (ND only)
(701) 234-5575

OHIO

Akron
Akron Regional Poison Center
281 Locust Street
Akron, OH 44308
(800) 362-9922 (OH only)
(216) 379-8562

Canton
Stark County Poison Control Center
Timken Mercy Medical Center
1320 Timken Mercy Drive, North West Canton, OH 44607
(800) 722-8662 (OH only)
(216) 489-1304

Cincinnati
South West Ohio Regional Poison Control System and Cincinnati Drug and Poison Information Center*
University of Cincinnati College of Medicine
231 Bethesda Avenue ML #144
Cincinnati, OH 45267-0144
(800) 872-5111 (Southwest OH only)
(513) 558-5111

Cleveland
Greater Cleveland Poison Control Center
2074 Abington Road
Cleveland, OH 44106
(216) 231-4455

Columbus
Central Ohio Poison Center*
700 Children’s Drive
Columbus, OH 43205
(800) 682-7625 (OH only)
(614) 228-1323

Dayton
West Ohio Regional Poison And Drug Information Center
Children’s Medical Center
One Children’s Plaza
Dayton, OH 45404-1815
(800) 762-0727 (OH only)
(513) 222-2227

Lorain
County Poison Control Center
Lorain Community Hospital
3700 Kolbe Road
Lorain, OH 44053
(800) 821-8972 (OH only)
(216) 282-2220

Sandusky
Firelands Community Hospital Poison Information Center
1101 Decatur Street
Sandusky, OH 44870
(419) 626-7423

Toledo
Poison Information Center of Northwest Ohio
Medical College of Ohio Hospital
3000 Arlington Avenue
Toledo, OH 49614
(800) 589-3897 (OH only)
(419) 381-3897

Youngstown
Mahoning Valley Poison Center
St. Elizabeth Hospital Medical Center
1044 Belmont Avenue
Youngstown, OH 44501
(800) 426-2348 (OH only)
(216) 746-2222
Zanesville
Bethesda Poison Control Center
Bethesda Hospital
2951 Maple Ave
Zanesville, OH 43701
(800) 686-4221 (OH only)
(614) 454-4221

OKLAHOMA

Oklahoma City
Oklahoma Poison Control Center
Children’s Memorial Hospital
940 Northeast 13th Street
Oklahoma City, OK 73104
(800) 522-4611 (OK only)
(405) 271-5454

OREGON

Portland
Oregon Poison Center
Oregon Health Sciences University
3181 South West Sam Jackson Park Road
Portland, OR 97201
(800) 452-7165 (OR only)
(503) 494-8968

PENNSYLVANIA

Hershey
Central Pennsylvania Poison Center*
Milton Hershey Medical Center
Pennsylvania State University
P.O. Box 850
Hershey, PA 17033
(800) 521-6110
(717) 531-6111

Lancaster
Poison Control Center
St. Joseph Hospital and Health Care Center
250 College Avenue
Lancaster, PA 17604
(717) 299-4546

Philadelphia
Philadelphia Poison Control Center*
One Children’s Center
34th and Civic Center Boulevard
Philadelphia, PA 19104
(215) 386-2100

Pittsburgh
Pittsburgh Poison Center*
One Children’s Place
3705 Fifth Avenue at DeSoto Street
Pittsburgh, PA 15213
(412) 681-6669

Williamsport
The Williamsport Hospital Poison Control Center
777 Rural Avenue
Williamsport, PA 17701
(717) 321-2000

RHODE ISLAND

Providence
Rhode Island Poison Center*
593 Eddy Street
Providence, RI 02903
(401) 444-5727

SOUTH CAROLINA

Charlotte
Carolinas Poison Center
Carolinas Medical Center
1000 Blythe Boulevard
Charlotte, NC 28232-2861
(800) 848-6946

Columbia
Palmetto Poison Center
University of South Carolina
College of Pharmacy
Columbia, SC 29208
(800) 922-1117 (SC only)
(803) 765-7359

SOUTH DAKOTA

Aberdeen
Poison Control Center
St. Luke’s Midland Regional Medical Center
305 S. State Street
Aberdeen, SD 57401
Poison Centers for Plant Toxin Exposure

(800) 592-1889 (SD, MN, ND, WY)
(605) 622-5678

Rapid City
Rapid City Regional Poison Control Center
835 Fairmont Boulevard
P.O. Box 6000
Rapid City, SD 57709
(605) 341-3333

Sioux Falls
McKannan Poison Center
McKannan Hospital
800 East 21st Street
P.O. Box 5045
Sioux Falls, SD 57117-5045
(800) 952-0123 (SD only)
(800) 843-0505 (IA, MN, NE)
(605) 336-3894

TENNESSEE

Knoxville
Knoxville Poison Control Center
University of Tennessee Memorial Research Center and Hospital
1924 Alcoa Highway
Knoxville, TN 37920
(615) 544-9400

Memphis
Southern Poison Center, Inc.
Lebanheur Children’s Medical Center
848 Adams Avenue
Memphis, TN 38103-2821
(901) 528-6048

Nashville
Middle Tennessee Regional Poison Center, Inc.
501 Oxford House
1161 21st Avenue South B-101VUII
Nashville, TN 37232-4632
(800) 288-9999 (TN only)
(615) 322-6435

Medical Center Hospital
504 Medical Center Blvd.
Conroe, TX 77304
(409) 539-7700

Dallas
North Central Texas Poison Center*
Parkland Memorial Hospital
5201 Harry Hines Boulevard
P.O. Box 35926
Dallas, TX 75235
(800) 441-0040 (TX only)
(214) 590-5000

El Paso
El Paso Poison Control Center
Thomas General Hospital
4815 Alameda Avenue
El Paso, TX 79905
(915) 533-1244

Galveston
Texas State Poison Control Center
University of Texas Medical Branch
8th and Mechanic Street
Galveston, TX 77550-2780
(800) 392-8548 (TX only)
(713) 654-1701 (Houston)
(409) 765-1420 (Galveston)

Lubbock
Methodist Hospital Poison Control
3615 19th Street
Lubbock, TX 79413
(806) 793-4366

UTAH

Salt Lake City
Utah Poison Control Center*
410 Chipeta Way, Suite 230
Salt Lake City, UT 84108
(800) 456-7707 (UT only)
(801) 581-2151

TEXAS

Conroe
Montgomery County Poison Information Center

VERMONT

Burlington
Vermont Poison Center
Medical Center Hospital of Vermont
111 Colchester Avenue
Burlington, VT 05401
(802) 658-3456

VIRGINIA

Charlottesville
Blue Ridge Poison Center*
University of Virginia Health Science Center
Box 67
Charlottesville, VA 22901
(800) 451-1428 (VA only)
(804) 924-5543

Richmond
Virginia Poison Center
Virginia Commonwealth University
MCV Station Box 522
Richmond, VA 23298-0522 (800) 552-6337 (VA only)
(804) 786-9123

WASHINGTON

Seattle
Washington Poison Center
155 NE 100th Street, Suite #400
Seattle, WA 98105-8012
Within WA: (800) 732-6985
(206) 526-2121

WEST VIRGINIA

Charleston
West Virginia Poison Center*
3110 MacCorkal Avenue S.E.
Charleston, WV 25304
(304) 348-4211
(800) 642-3625 (WV only)

Parkersburg
St. Joseph’s Hospital Center
19th Street and Murdoch Avenue
Parkersburg, WV 26101
(304) 424-4222

WISCONSIN

Madison
Regional Poison Control Center
University of Wisconsin Hospital
600 Highland Avenue
Madison, WI 53792
(608) 262-3702

Milwaukee
Poison Center of Eastern Wisconsin
Children’s Hospital of Wisconsin
9000 West Wisconsin Avenue
P.O. Box 1997
Milwaukee, WI 53201
(414) 266-2222

WYOMING

Omaha, Nebraska
The Poison Center
c/o Mid-Plains Poison Center*
Children’s Memorial Hospital
8301 Dodge Street
Omaha, NE 68114
(402) 390-5555
(800) 955-9119 (NE, ID, IA, KS, MO, SD)
III. NATIONAL AND INTERNATIONAL MYCOLOGICAL ASSOCIATIONS/CLUBS/ORGANIZATIONS

ARGENTINA

Asociacion Argentina de Micologia
1141 Parque San Francisco
CP 5010 Cordoba, Argentina

Instituto de Botanica C. Spegazzini
Facultad de Ciencias Naturales y Museo de la Plata
Calle 53 No 477
1900 La Plata, Buenos Aires, Argentina

Universidad de Buenos Aires
Laboratorio de Micologia
Depart de Ciencias Biologicas
Facultad de Ciencias Exactas y Naturales
II Pabellon, 4 piso
Ciudad Universitaria (Nunez)
1428 Buenos Aires, Argentina

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Australian National Reference Laboratory in Medical Mycology
The Royal North Shore Hospital of Sydney
St. Leonards
New South Wales 2065, Australia

Plant Pathology Branch Herbarium New South Wales
New South Wales Agriculture
Biological and Chemical Research Institute
Private Mailbag No. 10
Rydalmere
New South Wales 2116, Australia

Women’s and Children’s Hospital
Mycology Laboratory
Mycology Unit
North Adelaide 5006, Australia

ARMENIA

Botanical Institute of the Academy of Sciences of Armenia
375063 Yerevan 63
Armenia

AUSTRALIA

Australian Federation for Medical and Veterinary Mycology
Mycology Laboratory
Royal North Shore Hospital
St Leonards
New South Wales, 2065 Australia

Australian Mushroom Growers Association PTY
PO Box 265
Windsor, New South Wales, NSW 2756
Australia

Australian Mycological Society Inc.
Australian Biological Resources Study
GPO Box 636
Canberra 2601, Australia

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Australian National Reference Laboratory in Medical Mycology
The Royal North Shore Hospital of Sydney
St. Leonards
New South Wales 2065, Australia

Plant Pathology Branch Herbarium New South Wales
New South Wales Agriculture
Biological and Chemical Research Institute
Private Mailbag No. 10
Rydalmere
New South Wales 2116, Australia

Women’s and Children’s Hospital
Mycology Laboratory
Mycology Unit
North Adelaide 5006, Australia

AUSTRIA

Osterreichische Mykologische Gesellschaft
Institut fur Botanik
Universitat Wien
Rennweg 14
A-1300 Wein, Austria

Verein fur Pilzkunde Tirol
AchenseestraBe 21
A 6200 Jenbach
Tirol, Austria

BELGIUM

Antwerpse Mykologische Kring
Alfons Schneiderlaans 126
2100 Deurne
Antwerpen, Belgium

Institute of Hygiene and Epidemiology
Mycology Section
Rue Juliette Wytisma 14
B-1050 Bruxelles, Belgium

Mycotheque de L’Universite Catholique de Louvain
Place Croix du Sud 3
CANADA

Alberta
Department of Botany
University of Toronto
Toronto, Ontario, Canada M5S 1A1

Edmonton Mycological Club
6003 109 B Ave
Edmonton, Alberta, Canada T6A 1S7

University of Alberta Microfungus Collection and Herbarium
Devonian Botanic Garden
Edmonton, Alberta, Canada T6G 2E1

British Columbia
Department of Botany and Biology
University of British Columbia
Vancouver, BC, Canada V6T 2B1

Vancouver Mycological Society
403 Third Street
New Westminster, BC V3L 2S1

Quebec
Chibougamau Mycological Club
804 5e Rue
Chibougamau, PQ, Canada G8P 1V4

Les Cercle des Mycologues de Montreal
4101 Rue Sherbrooke, Est, 125
Montreal, PQ, Canada H1X2B2

Le Cercle des Mycologues de Quebec
Pavillon Comtois
Universitaire de Laval
Ste-Foy, PQ, Canada G1K 7P4

Les Cercle des Mycologues de Rimouski
University of Quebec, Rimouski
Rimouski, PQ, Canada

Les Cercle des Mycologues de Saguenay
438 Rue Perrault
Chicoutimi, PQ, Canada G7J3Y9

Manitoba
Department of Botany
University of Manitoba
Winnipeg, Manitoba, Canada

Nova Scotia
Acadia University
Biology Department
Wolfville, Nova Scotia, Canada BOP 1X0
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<td>National Research Council</td>
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<td>2050 San Pedro de M. de Oca</td>
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<td>Ciudad La Habana, Cuba</td>
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<td>Culture Collection of Basidiomycetes</td>
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<td>Institute of Microbiology</td>
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<td>Academy of Sciences of the Czech Republic</td>
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<td>Videnska 1083</td>
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<td>142 20 Praha 4 Krc, Czech Republic</td>
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<td>Czech Republic</td>
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</tbody>
</table>
Czech Scientific Society for Mycology
PO Box 106
CZ-111 21 Praha 1
Czech Republic

Association Francaise de Lichenologie
Laboratoire de Cryptogamie
Universite Pierre et Marie Curie
7 quai Saint-Bernard
75230 Paris Cedex 05, France

Museum National D'Historire Naturelle
Laboratoire de Cryptogamie
12, rue Buffon
75005 Paris, France

Observatoire Mycologique
Neronde
71250 Mazille, France

Societe Francaise de Mycologie Medicale
Institut Pasteur
25 rue du Docteur Roux
75724 Paris, Cedex, France

Societe Mycologique de France
18, rue de l'Ermitage
75010 Paris, France

DENMARK

Foreningen Til Svampekundskabens
Fremme
PO Box 102
DK-2860 Soborg, Denmark

Societe Francaise de Lichenologie
Laboratoire de Cryptogamie
Universite Pierre et Marie Curie
7 quai Saint-Bernard
75230 Paris Cedex 05, France

GERMANY

Arbeitskreis Mykologie
Deutsche Phytomedizinische Gesellschaft
Technische Universitat Munchen
Lehrstuhl fur Phytopathologie
85350 Freising-Weihenstephan, Germany

Bayerische Landesanstalt Fur Weinbau und
Gartenbau
Residenzplatz 3
D-97070 Wurzburg, Germany

Botanischer Garten und Botanisches
Museum Berlin-Dahlem
Konigin-Luise Strass 6-8
D-14191 Berlin, Germany

Deutsche Gesellschaft Fur Mykologie E.V.
Rathausstrasse 16
D-78594 Gunnigen, Germany

Deutschsprachige Mykologische
Gesellschaft
Mykologische Laboratorium
Univ. Hautklinik
Martinistrasse 52
D-2000 Hamburg 20, Germany

ESTONIA

Estonian Academy of Sciences
Institute of Zoology and Botany/Tartu
University
Laboratory of Mycology
21 Vanemuise Street
202400 Tartu, Estonia

Societe Francaise de Mycologie Medicale
Institut Pasteur
25 rue du Docteur Roux
75724 Paris, Cedex, France

Societe Mycologique de France
18, rue de l'Ermitage
75010 Paris, France

FINLAND

Finnish Mycological Society
Societas Mycologica Fennica
Unioninkatu 44
SF-00170 Helsinki, Finland

Botanischer Garten und Botanisches
Museum Berlin-Dahlem
Konigin-Luise Strass 6-8
D-14191 Berlin, Germany

Deutsche Gesellschaft Fur Mykologie E.V.
Rathausstrasse 16
D-78594 Gunnigen, Germany

Deutschsprachige Mykologische
Gesellschaft
Mykologische Laboratorium
Univ. Hautklinik
Martinistrasse 52
D-2000 Hamburg 20, Germany

FRANCE

Association d’Ecologie et de Mycologie
Laboratorie de Systematique et d’Ecologie
Vegetae
U.E.R. Pharmacie
Rue Laguesse
59045 Little Cedex, France

FRANCE

Association Francaine de Lichenologie
Laboratoire de Cryptogamie
Universite Pierre et Marie Curie
7 quai Saint-Bernard
75230 Paris Cedex 05, France

Museum National D’Historire Naturelle
Laboratoire de Cryptogamie
12, rue Buffon
75005 Paris, France

Observatoire Mycologique
Neronde
71250 Mazille, France

Societe Francaise de Mycologie Medicale
Institut Pasteur
25 rue du Docteur Roux
75724 Paris, Cedex, France

Societe Mycologique de France
18, rue de l’Ermitage
75010 Paris, France

DENMARK

Foreningen Til Svampekundskabens
Fremme
PO Box 102
DK-2860 Soborg, Denmark

Societe Francaise de Lichenologie
Laboratoire de Cryptogamie
Universite Pierre et Marie Curie
7 quai Saint-Bernard
75230 Paris Cedex 05, France

GERMANY

Arbeitskreis Mykologie
Deutsche Phytomedizinische Gesellschaft
Technische Universitat Munchen
Lehrstuhl fur Phytopathologie
85350 Freising-Weihenstephan, Germany

Bayerische Landesanstalt Fur Weinbau und
Gartenbau
Residenzplatz 3
D-97070 Wurzburg, Germany

Botanischer Garten und Botanisches
Museum Berlin-Dahlem
Konigin-Luise Strass 6-8
D-14191 Berlin, Germany

Deutsche Gesellschaft Fur Mykologie E.V.
Rathausstrasse 16
D-78594 Gunnigen, Germany

Deutschsprachige Mykologische
Gesellschaft
Mykologische Laboratorium
Univ. Hautklinik
Martinistrasse 52
D-2000 Hamburg 20, Germany
Poison Centers for Plant Toxin Exposure

Gesellschaft Fur Natur und Umwelt
Fachhaus Mykologie
Abteilung Natur and Umwelt
Postfach 34
1030 Berlin, Germany

Institut fur Pflanzenschutz im Forst
Biologische Bundesanstalt fur Land-und
Forstwirtschaft
Messegew 11/12
38104 Braunschweig, Germany

International Society for Human and
Animal Mycology
Brandelweg 24
D-79312 Emmendingen, Germany

International Society for Mushroom
Science
Institut fur Bodenbiologie
Bundesforschungsanstalt fur Landwirtschaft
D-3300 Braunschweig
Bundesalle 50, West Germany

GREECE

University of Athens
Culture Collections of Fungi
Department of Biology
Section of Ecology and Systematics
Panepistimiopolis GR-157 84
Athens, Greece

GUAM

College of Agriculture and Life Sciences
VO6 Station, Mangilao, Guam 96913
734-2921X376

HONG KONG

Mushroom Journal of the Tropics
The International Mushroom Society for
the Tropics
c/o Department of Botany
Chinese University of Hong Kong
Shatin, New Territories, Hong Kong

HUNGARY

Hungarian Mycological Society
Department of Botany
University of Horticulture and Food
Industry
H-118 Budapest
Menesi ut 44, Hungary

ICELAND

Akureyri Museum of Natural History
PO Box 180
IS-602 Akureyri, Iceland

INDIA

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levels of a toxic compound(s) that is produced by the variety in question. The variety with the lowest level(s) of the compound(s) and best disease resistance ultimately would be selected and marketed. This method was used with success while breeding for leaf miner resistance in Apium accessions. Using IBEC would be a very important step forward in breeding programs for crops like celery, sweet potatoes, nightshade family crops, and other crops that we know contain natural toxicants.

Rodricks states that “we remain abysmally ignorant of the chemical and toxicological properties of most of the chemicals to which humans are exposed throughout their lifetimes” (50, p. 2592). In our opinion, we need to identify human health hazards due to naturally occurring chemicals in food. Scientific progress in this new frontier will require hard thinking and solid facts.

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Naturally Occurring Toxic Chemicals in Foods


Naturally Occurring Toxic Chemicals in Foods


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Naturally Occurring Toxic Chemicals in Foods


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Naturally Occurring Toxic Chemicals in Foods


Naturally Occurring Toxic Chemicals in Foods


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Naturally Occurring Toxic Chemicals in Foods


Naturally Occurring Toxic Chemicals in Foods

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### APPENDIX

**Genus** | **Group** | **Toxin(s) in genus**
--- | --- | ---
*Rhododendron* | Ericaceae | Grayanotoxins
*Ricinus* | Euphorbiaceae | Ricin
*Robinia* | Leguminosae (Fabaceae) | Phytotoxin
*Rumex* | Polygonaceae | Oxalates
*Sanguinaria* | Papaveraceae | Sanguinarine
*Sassafras* | Lauraceae | Hepatotoxin
*Semecarpus* | Anacardiaceae | 3-Pentadecylcatechol and urushiol, oleoresins
*Senecio* | Asteraceae | Pyrrolizidine alkaloids (PAs)
*Senna* | Leguminosae | Sennosides (laxative alkaloids)
*Sesbania* | Leguminosae (Fabaceae) | Cytotoxic alkaloid
*Solandra* | Solanaceae | Solanaceous alkaloids
*Solanum* | Solanaceae | Solanaceous alkaloids
*Sophora* | Leguminosae (Fabaceae) | Quinolizidine alkaloids
*Sorghum* | Graminaceae | Cyanogenic glycoside, nitrates
*Strychnos* | Loganiaceae | Alkaloids
*Symphytum* | Boraginaceae | Pyrrolizidine alkaloids
*Taxus* | Taxaceae | Alkaloids
*Teucrium* | Lamiales | Neoclerodane deterpenoids, saponins, glycosides, flavonoids, hepatotoxins
*Thermopsis* | Leguminosae (Fabaceae) | Quinolizidine alkaloids
*Thesium* | Santalaceae | Bufadenolides
*Thevetia* | Apocynaceae | Cardiac glycosides
*Thlaspi* | Brassicaceae | Sinigrin, myrosin
*Toxicodendron* | Anacardiaceae | 3-Pentadecylcatechol and urushiol, oleoresins
*Trichodesma* | Boraginaceae | Pyrrolizidine alkaloids
*Triglochin* | Juncaginaceae | Cyanide formers
*Tylecodon* | Crassulaceae | Bufadienolides
*Urechitis* | Apocynaceae | Cardiac glycosides
*Urginea* | Liliaceae | Cardiac glycoside
*Urtica* | Urticaceae | Acetycholine, histamine
*Veratrum* | Liliaceae | Glycoalkaloids, ester alkaloids
*Verbesina* | Asteraceae | Nitrates, galegine
*Vicia* | Leguminosae (Fabaceae) | Glycosides
*Viscum* | Loranthaceae | Polypeptide
*Wisteria* | Leguminosae (Fabaceae) | Unknown
*Xanthium* | Asteraceae | Glycoside
*Zanthoxylum* | Rutaceae | Neuromuscular blockers, neoherculin
*Zea* | Graminaceae | Nitrate ion
*Zygadenus* | Liliaceae | Steroid alkaloids, glycoalkaloids

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Poisonous Higher Plants


were found in the plants upon analysis and included the tropane alkaloids tropine, pseudotropine, and tropinone, and the pyrrolidine alkaloids cuscohygrine and hygrine. At post mortem intestinal fibrosis and vascular sclerosis of the small intestine were identified.

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amine intoxication, whereas consumption of these individual foods may not cause any problem. Of particular concern is the observation that individuals receiving monoamine oxidase inhibitors in the treatment of psychiatric depression may undergo severe hypertensive crisis upon the ingestion of foods rich in biogenic amines (241, 242). Since monoamine oxidase, an enzyme produced by the liver, detoxifies amines by deamination, an inhibition of this enzyme exacerbates the toxic effects of biogenic amines.

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Antinutritional Factors Related to Proteins


Antinutritional Factors Related to Proteins


Calcinogenic glycosides usually do not occur in human foodstuffs and they are not viewed as a human health hazard. In fact, plant preparations containing the glycosides have therapeutic applications in both human and veterinary medicine (146).

Numerous cases of accidental or purposeful poisonings have been attributed to the rhizomes of *Atractylis gummifera* (birdlime thistle) and *Callilepis laureola* (oxeye daisy), which contain the hypoglycemic glycosides atractylside and the more toxic carboxyatractyloside (126, 341). Pathological conditions seen in humans are similar to those in livestock and laboratory animals and they include convulsions, cerebral edema, gastric irritation and hemorrhage, nephrosis, and hepatocellular necrosis (126).

Faba beans (broad bean, *Vicia faba*) contain the hemolytic glycosides vicine and convicine, which are also pyrimidine derivatives. The biological activity of the aglycones divicine and isouamil is usually associated with deficiency or damage. The supply of glutathione is replenished rapidly in normal red blood cells. However, if cells are deficient in glucose-6-phosphate dehydrogenase, the required reducing power for glutathione regeneration is not available and the accumulated H$_2$O$_2$ can cause irreversible cell damage. The hemolytic disease in humans is known as favism; the epidemiology of the disorder has been reviewed by Mager et al. (342).

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Glycosides


Glycosides


Glycosides


J. Zearaleone

Zearaleone can be coextracted with most of the mycotoxins in aqueous methanol solvents and purified by SPE or pH controlled liquid-liquid partitioning (453). Detection and quantitation can be achieved by TLC (539). Spraying the plate with AlCl₃ and heating can enhance the fluorescence of zearaleone (455). Several RP-HPLC methods (MeOH:H₂O; 58:42) have been described (540) using fluorescence detection. Recently the inclusion of β-cyclodextrin in the HPLC mobile phase allowed simultaneous detection of trichotheccenes in samples also containing zearaleone (453).

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ruminants, the introduction of microbes able to detoxify plant toxins has been investigated as a way to prevent intoxication due to *Leucaena leucocephala* (Hammond et al., 1989), and it may be possible to protect against intoxication with pyrrolizidine alkaloids, oxalates, and fluoroacetate (Gregg, 1995). A commercial product is available that contains propionibacteria able to efficiently metabolize and detoxify nitrate (Haliburton, 1998). Such approaches may allow for more flexibility in utilizing toxic plant–infested ranges or pastures or poorer quality forages but they do not substitute for good pasture management and feeding practices.

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Aspergillus

aflatoxic-contaminated products (99). Such techniques include hand sorting on a conveyor belt, electronic color sorting, and fluorescence under UV light (99). The fluorescence technique is used commercially for sorting peanuts, almonds, cottonseeds, and figs.

6. Biotransformation

In processes similar to those used in bioremediation techniques, it has been shown from studies in the Far East that several microorganisms, especially Rhizopus species and Neurospora sitophila, can degrade aflatoxin in peanuts by solid substrate fermentation. Aflatoxin B₁ was almost totally degraded with only a small residual amount of toxic intermediates (100).

7. Dilution of Contaminated Foodstuffs

Finally, dilution of contaminated grain with sound grain may reduce the toxicity of feed for farm animals and lower mycotoxin levels in foods destined for human consumption (92). Such mixing will occur normally during storage, transport, and processing of the foodstuff.

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fungi, and regions that retain their flora may see changes in toxin levels due to environmental effects such as drought. The outcome of such new grass-endophyte-environment interactions is unclear.

The plant-associated Clavicipitaceae have probably impacted humans since the beginnings of agriculture and will undoubtedly continue to do so (4). Negative impacts have included crop losses and illness and loss of life in humans and livestock. However, some of the ergot alkaloids produced by these fungi have found pharmaceutical use historically and currently in both developed and traditional cultures, and the Neotyphodium endophytes have been used to improve turf and forage grasses (4, 205). As we continue to learn more about the fascinating endophytic section of the Clavicipitaceae, our goal will be to avoid their toxicity but utilize their beneficial aspects for increased forage performance. It is clear that this family is universally present on the planet, has produced a negative impact on human food and feedstuffs throughout civilization, and will continue to do so unless modern techniques of science are used to minimize harmful components produced by species of this family.

ACKNOWLEDGMENTS

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borne *Fusarium* mycotoxins with ATA, SGI, and EC in humans have been reviewed in this chapter. Whereas the roles of T-2, DAS, DON, NIV, ZEA, and FB₁ in the causation of veterinary mycotoxicoses have been proven experimentally, this is much more difficult to establish in the case of human diseases attributed to foodborne *Fusarium* toxins.

In the case of human diseases, one has to make use of circumstantial and epidemiological data together with chemical analytical results on the natural occurrence of *Fusarium* toxins in incriminated foodstuffs and toxicological data in animal models. The literature on the three human syndromes for which sufficient data are available to implicate foodborne *Fusarium* toxins in their etiology has been reviewed. Several other human foodborne diseases that have been attributed to *Fusarium* mycotoxins in the literature (e.g., pellagra, Kashin-Beck disease, Keshan disease, and idiopathic cardiopathy) have not been included because the associations are based on insufficient data.

A discussion of the carryover of *Fusarium* toxins from feeds into animal products such as meat, milk, and eggs has not been included because this is considered to be a very minor vehicle of human exposure to foodborne *Fusarium* toxins, with the possible exception of ZEA and its metabolites in bovine milk.

If the new era of research on foodborne diseases caused by mycotoxins was introduced by the aflatoxins in the 1960s, the twentieth century closed with worldwide attention focused on the fumonisins. The next chapter to be written on foodborne diseases caused by *Fusarium* mycotoxins may well be called ‘‘Fumonisins—Foodborne *Fusarium* Toxins for the Third Millennium.’’

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among the common species in the genus (67). More than 50% of commonly isolated *Penicillium* species produce one or more genuinely toxic compounds (5).

Of the mycotoxins produced by *Penicillium* species, only OA appears likely to be carcinogenic. Most concern about *Penicillium* toxins lies with their acute toxicity and, in some cases, teratogenicity. Citreoviridin, citrinin, OA, patulin, and penitrem A have all been shown to exist in significant amounts in the natural environment and to have influenced the health of humans or other animals. Moreover, the other compounds listed are also genuinely toxic, and the species producing them are mostly widespread in foods.

The involvement of *Penicillium* toxins in human nephritis in northern Europe is highly probable, and in endemic nephropathy in eastern Europe, likely. Much more research is needed into both these disease syndromes.

Evaluation of the significance of low concentrations of specific *Penicillium* mycotoxins in human or animal health is also urgently needed. Information about many *Penicillium* toxins is still fragmentary at best. Reasons include low overt toxicity (i.e., a lack of readily recognized symptoms) and the paucity of routine analytical methods, both mycological and chemical, suitable for foods, feeds, and animal tissues. Despite this, it appears certain that animal health at least is affected by low level ingestion of *Penicillium* toxins, resulting in reduced fertility, increased susceptibility to infectious diseases, reduced feed conversion, and ill thrift. The potential involvement of mycotoxins produced by *Penicillium* species in low level disease in humans undoubtedly warrants continued research.

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by BEN \((n = 239,000)\), indicated a 10-fold difference in the incidence of cancers of the kidney, pelvis, ureters, and urinary bladder. Taking the unaffected population as the reference group, populations in the high and very high incidence areas of BEN showed an adjusted relative risk for cancers of the kidney and ureters of 8–29 in men and 27–34 in women. For cancers of the urinary bladder, the relative risks were 2–4 in men and 6–11 in women. The geographic correlation observed between BEN and UTT in this study strongly suggested a common etiology with OA was a relevant factor. In addition to the fact that exposure to OA was well documented, UTT tumors are rare enough so that a 10-fold excess paired with strong geographic clustering is difficult to attribute to misclassification/underdiagnosis biases or to chance.

However, the implication of OA as sole risk factor for BEN and/or UTT has not been proven. The following factors should be considered (Castagnaro et al., 1990):

1. No direct epidemiological proof for a causal relationship between mycotoxins and BEN has yet been presented. Complex exposures to mycotoxins usually occur in conjunction with other poorly characterized environmental agents. Epidemiological studies at the individual level are required; both these and future laboratory studies should take into consideration the involvement of multiple risk factors.

2. In some studies, data collected on environmental contamination relate to periods after the time when the disease was likely to have begun.

3. It is not clear how differences in food storage or other dietary practices, as opposed to or in combination with individual susceptibility, can explain the unusual clustering of BEN and UTT. Villages afflicted in the past continue to be afflicted today, while nonendemic villages, sometimes located in close proximity to afflicted villages, have remained free of BEN.

4. BEN may be caused by long-term exposure to polycyclic aromatic hydrocarbons and other toxic organic compounds leaching into the well drinking water from low-rank coal underlying or proximal to the endemic settlements. These organic compounds have been observed in well water in endemic villages, but not in nonendemic villages. (Tatu et al., 1998).

5. A viral etiology for BEN is unlikely, but has not been ruled out. For example, there may be a relationship between Bolivian hemorrhagic fever, an arenaviral hemorrhagic fever disease spread by rodents, and BEN (Tatu et al., 1998).

6. Phenotypic and genotypic differences in a number of activating and detoxifying enzymes have frequently been linked to individualized susceptibility to certain forms of cancer: the association between the efficiency of oxidative metabolism of debrisoquine and the risk for developing BEN and/or UTT, individuals suspected of having BEN, health controls from the endemic regions, and healthy controls from nonendemic regions. The extensive metabolizer phenotype was encountered in most of the BEN cases and subjects with BEN and UTT (Tatu et al., 1998).

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Foodborne Disease and Mycotoxins


Five years ago we noticed six areas in the study of interactions between mycotoxins that needed further research. At this point these can be refined to four areas that need additional study. Many of these observations also occur when the interactions between a mycotoxin and another treatment are examined. First, there can be striking differences between male and female animals. Generally the mycotoxin interaction is more toxic to male animals (215). Second, the order of exposure is important. The interaction of a mycotoxin with another treatment may be synergistic or antagonistic depending on whether the treatments were sequential or simultaneous (190).

Third, research needs to expand and include the interactions of mycotoxins with other fungal metabolites and the interactions with more complex combinations. Based on this work and the previous work (6), most mycotoxin combinations have zero interaction. However, under field conditions with additional stress factors, the toxicity of these mycotoxins could be altered to adversely affect health and performance. This must be understood before we relax our concern of the deleterious interactions that can occur between mycotoxins. Fourth, inorganic sorbents are effective in reducing aflatoxosis. However, their effectiveness in combination with other treatments that increase aflatoxosis needs to be determined. For example, there needs to be a study to investigate the effectiveness of the inorganic sorbents in reducing the carcinogenicity of aflatoxin in high-protein diets or with exposure to HBV.

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Mycotoxicoses


Mycotoxicoses


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kits have been developed, but these are only mentioned to give the reader an idea of other techniques available that would suggest mycotoxin contamination.

Within the last decade, immunological techniques involving monoclonal and polyclonal antibodies, radioimmunoassay, and ELISA have gained wide acceptance with varying degrees of success depending on cross-reactivity and/or specificity of reactants and analytes, and a detailed prospectus is given in another chapter.

The natural occurrence of saprophytic, parasitic, and endophytic plant fungi (both localized and systemic) and their evolutionary processes directed at species survival more than suggest an ecological justification for the production of previously referred to secondary metabolites or mycotoxins. Survival mechanisms (i.e., physiological, reproductive, defensive, etc.) among these species, their economic significance to production, and their role in human and animal health underscores the importance of definitive analytical methodology for mycotoxins in our food and feed products. Environmental concerns to reduce the volume of herbicides and fungicides have precipitated a movement toward eliminating these practices and going to a no-till agricultural system. Subsequently, fungal infection and mycotoxin contamination of cereal grains, stored grain products, agricultural commodities, field crops, forages, and pasture grasses is a story without an end. However, with the continued judicious development of new analytical technology, advances in mycotoxin research (i.e., the chemical isolation and identification and toxicology investigations) should provide avenues for understanding fungal-plant growth interactions and contribute to the development of safer and more nutritious products for a global economy.

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Analytical Methodology for Mycotoxins


sensor areas (255), immunoassays for mycotoxins will be advanced to another new era. I hope that this review will not only provide some general principles for different immunoassay protocols but also help to generate more interest in using immunochemical methods in the analytical, diagnostic, and possibly therapeutic areas. I also hope that it will stimulate additional research in this rapidly progressing area to improve the methodology, to simplify the assay procedures, and to increase the sensitivity and specificity of the assays to alleviate matrix interference problems.

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Mycotoxin Analysis


4. Scleroderma (Earthballs)

These mushrooms are generally puffball-shaped and -sized. When cut from the top to the bottom, the insides will first appear white, but over the course of a few minutes will change to greenish, brown, or purplish-black (56). The skin of the earthball is much thicker than that of a puffball and has only one layer. Earthballs are generally considered either inedible or potentially poisonous. Earthballs are commonly found partially underground (28).

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The clinical significance of these compounds in normal consumption has yet to be determined (262–266).

Ling-Zhi (*Ganoderma lucidum*) contains various water-soluble compounds that inhibit the growth of sarcoma 180 or fibrosarcoma and Lewis lung carcinoma when tested in mice (267). Chinese traditional medicine practitioners have used Ling-Zhi as an antitumor agent (268).

*Gyromitra esculenta* is known to contain up to 0.3% acetaldehyde methylformaldehydezone, which has had some carcinogenicity when tested in laboratory animals. Various other gyromitrins have also been studied for carcinogenic potential (269, 270). When Swiss mice were given intragastric weekly doses of 100 μg/g of gyromitrin G for a year, they developed lung, clitoral, forestomach, and prepubertal tumors (272). Both hydrazine and monomethylhydrazine, constituents of some of the *Gyromitra* species, have been shown to be carcinogenic in test animals (273, 274).

Various *Lactarius* species have been shown to have mutagenic potential. *L. deliciosus* and *L. deterrimus* contain lactaroviolin II and deterrol, substances that have been shown in the Ames test (275) to have mutagenic activity (17). *L. rufus* and *L. helvus* have shown mild mutagenicity in the Ames test (276).

*Lentinus edodes*, the edible shiitake mushroom, has been shown to contain a mitogenic lectin. Cases of mutagenicity in humans or animals have not been reported (277).

The species *Lycophyllum connatum* has been shown to contain a potentially mutagenic azoxy compound (17). No human cases of mutagenicity have been reported.

### III. SUMMARY

Diagnosis of mushroom poisoning is often through a combination of history, symptom presentation, and physical evidence. Identification using various macroscopic and microscopic characteristics is important in predicting outcome. Once it has been determined that a mushroom has been ingested, the symptom complex, combined with the time of onset, can aid in determining the type of mushroom ingested. Most treatments should start with decontamination with good supportive care. There are few actual antidotes.

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Tree Oyster: See *Pleurotus ostreatus*.

Truffles: Some species of truffles have been attributed with aphrodisiac powers. The Czech folk name for these truffles means "lamb’s testicles." Early English medicine used some truffles in a formula to induce pregnancy (5).

Tsuchi-maitake: See *Polyporus umbellatus*.

*Tulostoma brumale* (*T. pedunculatum*) and *Tulostoma campestre*: The Ramah Navajo Indians used this puffball in infusions or poultices for healing sheep leg-bone breaks (46, 48).

Umbrella Polypore: See *Polyporus umbellatus*.

*Ustilago maydis*: Commonly called corn smut, the fungus that grows on corn silk was at one time recommended for treatment of lung hemorrhage, bowel hemorrhage, and as an emmenagogue (42).

Volvariella volvacea: A protein with immunomodulatory activity has been purified from this edible mushroom. The active agent is a polypeptide. In an in vitro study measuring blast formation stimulatory activity this protein maximally stimulated human peripheral blood lymphocytes at a concentration of 5 μg/ml. The mechanism of action appears to be via cytokine regulation (49).

Wild Boar’s Dung Maitake: See *Polyporus umbellatus*.

Winter Mushroom: See *Flammulina velutipes*.

Wood Ear: See *Auricularia polytricha*.

Yamabiko Hon-shimeji: See *Hypsizygus tessulatus*.

Yamabushi-take: See *Hericium erinaceus*.

Yuhuangmo: See *Pleurotus citrinopileatus*.

Yuki-motase: See *Flammulina velutipes*.

Yung Ngo: Chinese name, See *Auricularia polytricha*.

Zhu Ling: See *Polyporus umbellatus*.

C. Combination Products

The "tension-easing pill" is a combination of mushrooms used to treat numb hands and feet, and problems with veins, tendons, and limb tetany. The mushrooms included are *Amanita agglutinata*, *Boletus edulis*, *Lactarius insulsus*, *Lactarius pinicinus*, *Lactarius piperatus*, *Lactarius vellereus*, *Lenzites betulina*, *Panus conchatus*, *Pulveroboletus ravenelii*, *Russula alutacea*, *Russula densifolia*, *Russula foetens*, *Russula integrans*, *Russula nigrians*, and *Thelephora vialis* (38).

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