



MUSHROOM SAFETY, FROM HARVEST TO POINT OF SALE

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FOOD SCIENCE AND TECHNOLOGY

Institute of Agriculture and Natural Resources

MUSHROOM REGULATIONS

- Most states now require some training/certification for **wild** mushroom sales
 - Iowa: Wild-Harvested Mushroom Certification: Training is good for three years, and covers eight types of mushrooms
 - Justification: Poisonous mushrooms exist, and buyers need assurance that sellers are providing **safe, wholesome, edible** mushrooms
 - Neither the average Farmer's Market customer **nor the average restaurant purchaser/chef** can be assumed to know mushroom identification; they are relying on **the collectors**
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WHAT YOU SHOULD KNOW

- Accurate identification of any mushrooms you sell
 - May include ability to identify poisonous mushrooms that could be confused with your species
- How to maintain mushroom quality
- Mushroom storage and preparation



MUSHROOMS, “WILD” MUSHROOMS, AND WILD MUSHROOMS

Commercial sales

- *Agaricus bisporus*
- Shiitake (*Lentinula edodes*)
- Oyster mushroom, enokitake, wine cap
- Lion’s mane, hen of the woods, nameko
- Chanterelle, morel, lobster mushroom, truffle
- Puffball, chicken of the woods...

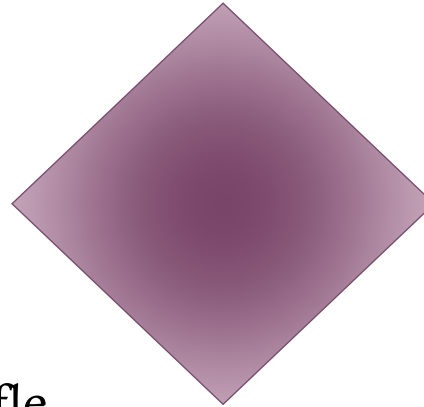
WILD!



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Ease of production



WILD!

AGARICUS BISPORUS

- Crimini, portobello, pizza mushroom; industrial scale production
- **Domesticated species**, but some wild relatives are edible



sylvaninc.eu



SHIITAKE (*LENTINULA EDODES*)



Shiitake mushrooms growing from an oak log. Photo by Stephen Hight, USDA



OYSTER MUSHROOMS (*PLEUROTUS* SPECIES)



ENOKITAKE (*FLAMMULINA VELUTIPES*)



<http://365wholefoods.blogspot.com/2013/07/enokitake-flammulina-velutipes.html>



WINE CAP (*STROPHARIA RUGOSO-ANNULATA*)



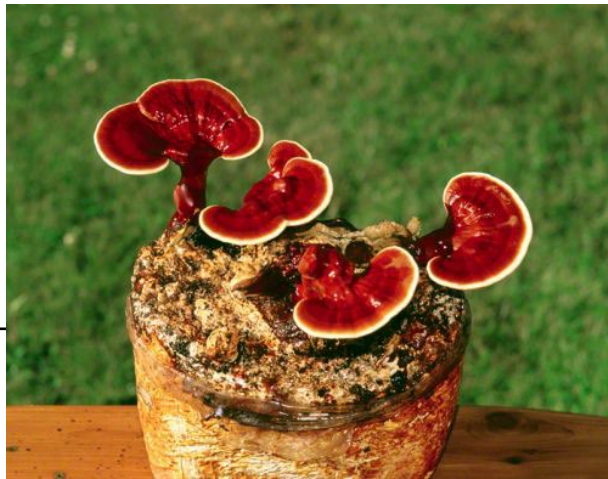
OTHER CULTIVATED SPECIES



Hen of the woods, Maitake (*Grifola frondosa*)



Lion's mane (*Hericium erinaceum*, shown with oyster mushroom)



Reishi (*Ganoderma lucidum*)
fungi.com

Pholiota nameko
fungi.com



(USUALLY) WILD COLLECTED



Morels – *Morchella* spp.



Porcini, cep, king bolete – *Boletus edulis*

http://www.mykoweb.com/CAF/species/Boletus_edulis.html



Truffles – *Tuber* spp.

(USUALLY) WILD COLLECTED



Chanterelles
(*Cantharellus* spp.)



Lobster mushroom
(*Hypomyces lactifluorum*
and *Russula* spp.)



GENERAL MUSHROOM SAFETY



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MUSHROOMS AND FOOD SAFETY

- Traditionally, emphasis has been almost exclusively on identification
 - Identification remains important! But recent outbreaks have revealed **consumer knowledge gaps** that we can address.
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PERCEPTIONS, AND A FALSE DICHOTOMY

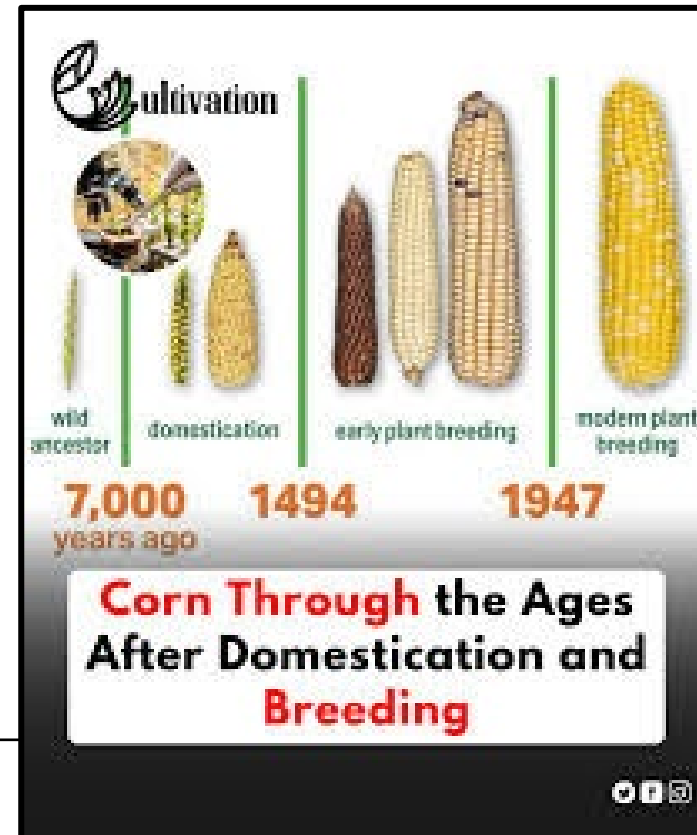
- **Wild** is potentially dangerous, needs regulation
- **Cultivated** is “just” produce; controlled; safe

WHAT IS "WILD"?

- Outside of *Agaricus bisporus* and oyster mushrooms (and *Psilocybe*), **cultivated** mushrooms have not been **domesticated**



10 000 YEARS LATER



PERCEPTIONS, AND A FALSE DICHOTOMY

- **Wild** is potentially dangerous, needs regulation
 - True insofar as wild mushroom collection requires identification skills that aren't required for growing them in culture



SAFETY - IDENTIFICATION

- **WILD** mushrooms can be poisonous!

The Sickener
(*Chlorophyllum
molybdites*) –
Severe GI irritant
(>90% of
mushroom calls
to NE Poison
Center)



Shaggy parasol
(*Chlorophyllum
brunneum*) -
Edible and
choice

C. molybdites & *C. brunneum* © Fred Stevens
Image 6 of 9

CLOSE X

MUSHROOM IDENTIFICATION

- Burden should be on producers/harvesters, **not** inspectors



This is, hands down, the commonest poisonous mushroom in Nebraska.



MUSHROOM IDENTIFICATION



Morel (*Morchella*):
Pitted cap
Hollow throughout
Fruits in **spring**



False Morel (*Gyromitra*):
Convuluted cap
Not hollow; stuffed



PERCEPTIONS, AND A FALSE DICHOTOMY

- **Wild** is potentially dangerous, needs regulation
- **Cultivated** is “just” produce; controlled; safe
 - Risk of perceiving higher level of safety than is warranted



CAUTIONARY TALE: MORELS

- 2023 outbreak in Montana: 51 sickened, 2 **dead**
- **Cultivated** morels incorporated into Special Sushi Rolls
- **All** morels need cooking; chef mistakenly thought these were safe *because they were cultivated*



'A nightmare on every end': Dave's Sushi settles lawsuits with food poisoning victims

While there have been some busier days and "Dave's continues to recover little by little," Parker said the customer flow now compared to before April 2023 is "not even close."

CAUTIONARY TALE: MORELS

- Montana Food Code regulated sale and serving of **wild** mushrooms – but not “cultivated mushrooms from a controlled environment”



CAUTIONARY TALE: ENOKITAKE

- Enoki is cultivated in dense clusters in low light to produce the “stringy” form
- **Many** recalls and multiple outbreaks over past ~8 years for *Listeria monocytogenes*
- Studies show *Listeria* persistence in growth media, growing environment



SAFETY – POST-HARVEST

- Fresh mushrooms are highly perishable and can spoil quickly
 - Sell or preserve in a timely fashion
 - Allow airflow; plastic traps heat and moisture and speeds decomposition
 - Dried mushrooms can be stable over time
 - Dry sufficiently to prevent mold growth
 - Will not destroy foodborne bacteria or morel toxin(s) – reconstituted mushrooms still need cooking
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SAFETY – POST-HARVEST

- Mushrooms are low acid – **BOTULISM RISK!**
 - Canned
 - Soup
 - Preserved in oil

Human & Experimental Toxicology (2006) 25: 273–278
www.hetjournal.com

A botulism outbreak from roasted canned mushrooms

Melike Cengiz*, Murat Yilmaz, Levent Dosemeci and Atilla Ramazanoglu

Department of Anesthesiology and Intensive Care, Faculty of Medicine, Akdeniz University, Antalya, Turkey



SAFETY - PREPARATION

- **Most** mushrooms should not be eaten raw – can cause GI distress if not thoroughly cooked
- Not in Food Code, no labeling requirements (yet!) but we're trying to increase awareness

These guys are especially egregious!



“UNKNOWN UNKNOWNNS”

- The consumer doesn't know what they don't know
 - I buy something called “morel mushrooms” and my prior experience is with *Agaricus* – do I know that there's anything different about morels? Do I know enough to ask about preparation?
 - If I “know that I don't know” and seek information, will I find it?

NOT in: *The Joy of Cooking* (2006 edition)

Better Homes and Gardens 100th Anniversary New Cookbook (2022)

Cooks Illustrated Cookbook (2011)

The Joy of Cooking (2006 edition)

How to Cook Everything, 20th Anniversary Edition (2019)

Cooking Like a Master Chef (2015)

On Food and Cooking (2004 edition)

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 - If I “know that I don't know” and seek information, will I find it?
- **You** are the expert – share your knowledge!
 - Don't assume someone buying morels (or lion's manes, or oyster mushrooms) knows what they're doing – be ready with cooking suggestions, maybe a recipe or two...



COOKING SUGGESTIONS

- At date, the best science can offer is “cook thoroughly”
 - **Especially important for morels**
 - Frying, to the point where you see browning and crisping, is a good idea
 - **Many consumers (including chefs) want to treat mushrooms like vegetables, and cook lightly, if at all. I advise people with little mushroom experience to cook mushrooms longer and hotter than they think they should**
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HELPFUL INFORMATION TO PROVIDE WITH MUSHROOMS

- Name (common and scientific) of mushroom
 - See MushroomExpert.com or e-mail me at hhallen-adams2@unl.edu if you need guidance
 - Some mushrooms (especially morels!) have Muddy Taxonomy; do the best you can.
 - *Morchella americana* is the common yellow morel in Nebraska
 - *Morchella punctipes* is the half-free morel
 - Your contact information
 - Date of harvest
 - **Cooking information is not legally required but is *strongly* encouraged!**
 - **One or two sentences could save a life!**
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RESOURCES

- Fungal cultivation and supplies
 - Field and Forest Products: www.fieldforest.net
 - Prairie States Mushroom Club
 - <http://www.iowamushroom.org/>
 - Iowa wild-harvested mushroom certification
 - <https://naturalresources.extension.iastate.edu/programs/mushroom-certification>
 - General information, US Midwest
 - www.mushroomexpert.com
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