

Ohio Mushroom Society



The Mushroom Log

Of Yeast and The Impossible Burger

Bob Antibus

Sometime back members of the OMS were treated to a stimulating lecture on yeasts at the Dick Grimm Memorial Banquet by Professor Nicholas Money of Miami University. If you haven't read Dr. Money's book "The Rise of Yeast", I would highly recommend it. You will be treated to a fascinating, informative and sometimes humorous look at the symbiotic relationship between humans and *Saccharomyces cerevisiae* past, present and future. As a wild mushroom forager, you might not think yeasts are too interesting beyond their role in beverages and bread. But as part of my mycorrhizal studies I've attempted many times to grow chanterelles in culture. This is accomplished by using the cleanest fruiting body you find, splitting it with a sterile scalpel and placing a tiny bit with forceps onto sterile growth medium containing antibiotics.

Typically as days pass nothing grows from the mushroom tissue, but yeasts begin to glisten on the tissue and medium. Even the freshest of mushrooms carry a fungome of yeasts. These yeasts likely impart volatile flavorings to the mushroom the way yeasts can flavor beer. Nils Fries has shown that *Rhodotorula*, a beautiful pink yeast, when sown on a medium can stimulate the germination of chanterelle spores. But what role do yeasts play in the Impossible Burger and other plant-based burgers (PBBs)?

Pat Brown founded Impossible Foods in a quest to find a plant product that might be widely accepted as a replacement for ground beef in our diet. Beef production is an important source of greenhouse gases and uses a great deal of water and land. Brown felt a PBB could serve to reduce the environmental impact of the way we eat. His work has focused on heme as an essential component of red meat. Hemes are iron containing ringed molecules found in all organisms but are very important components of oxygen binding proteins like myoglobin and hemoglobin in animals. Hemes act as catalysts and partake in complex chemical transformations during cooking adding complexity to the taste of meat.

Extensive work led Brown to a suitable plant based heme we know as leghemoglobin. This protein is similar to myoglobin but is produced in the nodules of legumes infected with nitrogen fixing symbiotic bacteria. The protein by binding oxygen protects bacterial nitrogenase from oxygen inhibition. Brown's team figured out how to extract leghemoglobin from soybean roots and thought they could supply their needs by harvesting soybean roots after the tops had been harvested from the 76 million acres grown annually in the US. This proved impractical so they switched to a strategy of producing the protein by industrial fermentation.

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Yeast, cont'd

At this point yeasts enter the story. The yeast here is *Pichia pastoris*. Of *S. cerevisiae* Dr. Money says “The trials of the climbing boys indentured to chimney sweeps in Victorian Britain come closest, perhaps, to the microscopic servitude of sugarcane yeast”. This is also true of *P. pastoris*. Removed from its natural habitat on trees, this yeast is considered superior to *S. cerevisiae* for producing proteins on an industrial scale because of its greater yields with fewer immunogenic glycans. It has become the workhorse for the metabolic expression of genes to make thousands of proteins for use in medicine, research and industry.

It turns out that *P. pastoris* delivers large amounts of exact copies of leghemoglobin in culture with few contaminants. This leghemoglobin can then be added to a PBB, and since it was the yeast and not the protein that was engineered there is no requirement to label the food as containing GMOs. With no reports of toxicity or allergenicity, leghemoglobin falls within the FDA’s GRAS (generally regarded as safe) list.

Soy leghemoglobin comprises only a small fraction, less than 1%, of PBBs that additionally incorporate various plant proteins, binders and flavoring agents. But two questions remain: do PBBs reduce environmental impact, and will people eat them?

A detailed analysis of the environmental impact of the Impossible Burger was published in PLoS (December 6, 2017). The burger turned out to be very favorable compared to beef in its carbon footprint and land and water used to produce.

Ricki Lewis, a well-known science writer and biology textbook author, compared it to other veggie burgers and rated it as the best on the market. I haven’t tried the Impossible Burger but Joanne and I have used ground Beyond Beef and found it works quite well in tacos, chili or lasagna.

Nicholas Money may be prescient in closing his book on yeast by stating “The future of

humanity depends more on this bug than any farm animal or crop plant”.

I must add that within the past week, The Center for Food Safety filed a lawsuit against the FDA for its approval of soy leghemoglobin.

ACCORDING TO A CHEF TURNED MUSHROOM SCIENTIST, WE’VE BEEN COOKING MUSHROOMS WRONG ALL THIS TIME

by *Chynna Santos*.

Reprinted from The Spore Print, newsletter of the Los Angeles Mycological Society. Issue no. 421, June 2020

*Mycologist Jim Fuller – co-founder of **Fable**, a new company making mock meat out of shiitake mushrooms– reckons you can extract loads of meaty flavor from most fungi by turning a long-standing French technique on its head.*

Don’t wash your mushrooms or get them wet. Use lots of oil or butter. High, high heat. Don’t overcrowd the pan. Cook in batches. No salt until the very end.

These are the cardinal rules we’ve heard time and again when it comes to cooking mushrooms and keeping them from turning into a sad, soggy mess.

But mycologist Jim Fuller has been studying the spongy morsels and the best ways to cook them for years, and he says conventional culinary wisdom doesn’t align with the science.

“[The current method] comes from French classical technique: because mushrooms are full of water, the idea is to get rid of as much water as possible,” he says.

“But those techniques were designed when our understanding of fungi and their

Cooking Mushrooms, cont'd.

cellular structures was too young – not necessarily flawed, but they weren't well understood."

Prior to co-founding Fable Food Co, a company that makes mushroom-based meat alternatives, Fuller studied chemical engineering in San Antonio, Texas, and also worked as a chef.

According to him, the trick isn't to keep the mushrooms dry and remove as much moisture as possible. Instead, you can use all that water to your advantage and boil the mushrooms before frying them.

Start with your mushrooms in a cold pan, add some tap water (enough to cover them), and turn the heat up high. Or you can boil some water and drop the mushrooms in.

"Adding just an extra bit of moisture into to the pan will encourage the mushrooms to release all of their own," Fuller says.

When the mushrooms are tender, let the water evaporate until the pan is pretty much dry. By the time the water has evaporated, the mushrooms will have released as much moisture as they can bleed out. This is when you add your fats (butter, oil) and aromats (thyme, garlic) and sear off the 'shrooms.

"If we put them straight into a pan with fat, the water coming out of the mushrooms would buffer the temperature of the oil and keep it low, so you won't get that Maillard reaction," Fuller says.

"This method allows you to get a silky texture without adding much fat at all. There's a fattiness and texture there due to the polysaccharides that mushrooms have ... so they have their own inherent silky creaminess," he says.

The technique – which Fuller's created a video for – is suited to most mushrooms, from the buttons and caps you can get at

supermarkets to wild-foraged varieties such as pine or slippery jack. One exception is enoki mushrooms, which Fuller says would be better dropped into soups at the last second or stir-fried for a short period.

In Fuller's eyes, a simple combination of olive oil, salt and pepper is enough to highlight the mushroom's meatiness, and it's this natural umami and depth of flavor that led him and Fable co-founders Chris McLoughlin and Michael Fox to use mushrooms in their plant-based mock meats.

Two-thirds of the product is made with shiitake mushrooms, while the rest of the nine-item ingredients list includes coconut oil, isolated soy protein, tapioca flour and seasonings.

There's only one product available for now – a "braised beef" that's a bit like a cross between pulled pork and beef brisket – though the team is also working on a burger patty. (*June 2020. Broadsheet.com.au.*)

"It is the duty of every citizen, for his own welfare, if for no other patriotic reason, to support and fight for and possibly initiate measures having to do with conservation of soil, water and forests."

Louis Bromfield

EDITORIAL MUSINGS

My first foray into yeast metabolism came while working to isolate oil degrading soil fungi on the North Slope of Alaska during construction of the Alyeska pipeline. At the time, much of what we knew came from research by Japanese scientists growing yeasts on crude oil as an inexpensive source of protein for livestock; practical because at the time as a barrel of crude was selling at \$2.00. As a grad student I subsequently learned about the central role that the “factory flora” of lipolytic yeasts plays in producing flavors in various dry fermented Italian sausages. At last count there are 43 genera and 220 species of yeast considered to be “foodborne,” so I’m guessing yeasts are part of our daily diet.

The piece about Jim Fuller mentions the Maillard reaction. This chemical process was first described in 1912 by Louis Camille Maillard and is primarily a reaction between sugars and amino acids that results in chemical changes to food during cooking. The products known as Maillard Reaction Products (MRPs) are visible in various forms like the browning of baked goods, searing of meats or roasting of coffee. MRPs are important in enhancing flavoring but the types produced are complicated by the foods involved and temperatures employed. Both beneficial and negative health effects have been associated with human consumption of MRPs. On the beneficial side they can enhance a food’s antioxidant properties, whereas in some foods MRPs, like acrylamide, are potential carcinogens.

MAN INJECTS “MAGIC” MUSHROOMS INTO BLOOD, RESULTING IN ORGAN FAILURE

Hannah Sparks

<https://nypost.com/>, Jan. 13, 2021

A man took to medical experimentation on himself when he decided to mainline “magic” mushrooms in order to kick his opioid use.

However, when the fungi started, well, mushrooming in his bloodstream, he almost kicked the bucket.

The 30-year-old, who was known to have bipolar disorder type 1, was brought into a Nebraska emergency room recently, with reports of vomiting blood, diarrhea, nausea, jaundiced appearance, confusion, and fatigue.

Upon arrival, the man spoke incoherently, doctors said in a medical journal report of the incident. Tests revealed his liver had been injured by infiltrating fungi and his kidneys were not fully functioning. In other words, he was going into organ failure.

Doctors later learned that the man had ceased taking medication for his mental illness, which prompted episodes of mania and depression.

During one such occasion, he launched a personal investigation into psilocybin-based

therapies, including those speculated as potential treatment for addiction from opioids, as well as anxiety and depression. Touted as the “safest” of all recreational drugs, ‘shrooms may have seemed like a cure-all to the patient in question, whose case study now appears in the *Journal of the Academy of Consultation-Liaison Psychiatry*.

His nearly fatal flaw, however, was the decision to inject a “tea” made of psilocybin mushrooms, rather than consume them as is customary.

Tests later revealed that actual fungus had cropped up in his blood supply, and the man spent three weeks in the hospital recovering from the ill-conceived stunt, on a ventilator and attached to a machine that could filter his blood of toxins.

After 22 days in the hospital, the man recovered and was released to his family with orders of two courses of antibiotics and one ongoing anti-fungal treatment, the case report said.

Emergence of Deadly Yeasts

Bob Antibus

When Lonelle Yoder sent me an article on the recent emergence of the pathogenic yeast *Candida auris*, I immediately recognized one of the authors: Arturo Casadevall.

Doctor Casadevall is a professor of medicine at John Hopkins, a scholar, and unconventional thinker familiar to mycologists. Casadevall and colleagues have, for example, proposed that mycelial fungi growing in the demolished and entombed Chernobyl reactor might be obtaining all or part of their energy from the high energy particles of radioactive decay. If this is true, it represents a process unknown elsewhere in biology. Their work has stimulated the study of fungal-derived melanin pigments as a potential radiation shielding material for astronauts on long-term space flights.

Another one of Casadevall's ideas is known as the fungal-mammalian emergence hypothesis. Biologists know that it's far more energetically expensive to be warm blooded (endothermic) than cold blooded (ectothermic), so the researchers asked why mammals, rather than reptiles, dominated Earth following the Cretaceous-Tertiary extinction. They suggest that a compost earth existed following an asteroid impact, and it's atmosphere would be laden with fungal spores. The pervasiveness of fungal diseases would act as a strong

selective agent on recolonizing animals. Because mammals have a body temperature above the temperature optima of most fungi, they would be favored in this environment and less susceptible than reptiles to fungal diseases. The contemporary global losses of reptiles and amphibians to fungal agents demonstrates their susceptibility to fungi. Meanwhile, bats get white nose disease when in torpor during hibernation, but can recover if allowed to warm to normal body temperature.

Casadevall has applied this logic to the sudden appearance of *C. auris* with three distinct clades, each with resistance to multiple azole antifungals, appearing simultaneously in widely geographically isolated regions. Interestingly, the antifungal resistance was acquired prior to strains developing pathogenicity. They argue that the rising of global temperatures, especially in urban areas, has been shown to increase fungal thermotolerance. This selection is part of the reason that fungi, in this case *C. auris*, will potentially gain the ability to overcome the thermal barrier presented by mammalian body temperature. They present an interesting argument for how this yeast, originally isolated from human ears, became a dangerous pathogen.

Odd and Ends

Bob Antibus

I must admit to having been fooled by walnut shells when looking for morels in the spring and often finding more spent shotgun shells than mushrooms on collecting trips, but a Czech mushroom hunter takes the prize. The Czechs are renowned mushroom hunters; it's estimated that the average Czech family consumes over 8 kilos of foraged mushrooms per year. Roman Novak was foraging after a rain this Fall near his home when he observed a shiny object. What he then excavated was an elaborately decorated bronze sword as well as an axe. The sword is estimated to be 3,330 years old, and is of a style and metallurgical make up similar to swords found near Vaspy in Sweden.

States have all sorts of symbols, Wisconsin has a state bacterium—it's used in cheese making. Ohio's state fossil is *Isotelus* a Trilobite. I believe only two states have state mushrooms with several considering adding them. The state mushroom of Minnesota is the morel and Oregon has a chanterelle; Oregon's state microbe is brewer's yeast. Drop me an email if you have an idea for Ohio's state mushroom.

New Member/Membership Renewal Form

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Enclosed please find check or money order for (check one):

____\$15.00 annual family membership (newsletter via email and website only)

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Would you like to be an OMS volunteer? In what way? _____

How did you hear about our group? _____

OMS will not share your information with any other group, business or individual, ever.

LIABILITY RELEASE AND PROMISE NOT TO SUE:

I understand that participating in the activities of a mushroom club involves a moderate amount of risk. This includes all of the risks of being away from home, risks associated with moving about in fields and woods, risks of encountering inclement weather, risks involved in eating wild mushrooms, risks of losing personal property by theft or misplacement, and all other expected and unexpected risks, including illness or injury. While a member of the Ohio Mushroom Society; or as a non-member attending any event hosted by the Ohio Mushroom Society, I agree to assume total responsibility for my own safety and well-being; and that of any minor children under my care, and for the protection of my and their personal property. I release the Ohio Mushroom Society, its board members, club members, contractors, and any and all entities such as parks or preserves, or any private property owner who may host an Ohio Mushroom Society event, and all other persons assisting in the planning and presentation of any Ohio Mushroom Society event, from liability for any sickness, injury, or loss I or any minor children under my care may suffer during any event or as a result of attending or participating. I further promise not to file a lawsuit or make a claim against any of the persons or entities set forth above, even if they negligently cause me or my minor children injury or loss. I agree to hold the Ohio Mushroom Society harmless from any liability they may incur as a result of any damages to any property I may cause. This release and promise is part of the consideration I give in order to be a member of the Ohio Mushroom Society, or to attend any event which they host or attend, whether a member or a non-member. I understand this affects my legal rights. I intend it to apply not only to me but to anyone who may have the right to make a claim on my behalf.

Signature: _____ **Date:** _____

Return form and check or money order to: Ohio Mushroom Society,
c/o Jerry Pepera, 8915 Knotty Pine Lane, Chardon, OH 44024

Good News for 2021

Here's some good news for the New Year: this year's membership is free! If you were a current member in good standing in 2020, your membership will automatically be renewed for 2021. Folks wishing to join OMS for the first time this year will need to pay at the normal levels, but with no increase in dues (starting at \$15 for an electronic family membership). Also, remember that OMS membership gives you a \$5 discount on North American Mycological Association (NAMA) membership dues. See namyco.org/join for more information.

If you're looking for more good news, look to the woods! Time in nature is calming, therapeutic, and time well spent. Even a walk around your neighborhood is a healthy tonic. You never know what happy surprises await you in unexpected places.... About a month ago I discovered a large colony of a short-stemmed gilled mushroom in the mulch under some planted evergreens in a yard. Though I still haven't identified it yet, I'm using it as an opportunity to practice my identification skills before the "real" field season begins.

We're all anxious to get out there for group discovery and learning again. Your volunteer board members are, too! We hope to put together a (limited) calendar of activities covering at least part of the year, subject to change as always. Keep an eye on the website and the March/April newsletter for dates. Until then, be well, seek good news, and discover the nature near you!

-Debra Shankland, OMS Chairperson

CALL FOR SUBMISSIONS: Have you read or written something interesting and fungus-related that you think other members would enjoy? Please send it in (to editor Bob Antibus, below) for consideration for future newsletters! We welcome any submissions, from anecdotes to scientific reports.

2020 Ohio Mushroom Society Volunteers

Chairperson

Debra Shankland
(440) 253-2152
deb.shankland@yahoo.com

Treasurer/Membership/Circulation

Jerry Pepera
membership@ohiomushroom.org

Jack-of-All-Trades

Dick Doyle
(513) 541-1581
rdoyle55@gmail.com

Newsletter Editor

Bob Antibus
antibusr@gmail.com

Mushroom Guru

Walt Sturgeon
(330) 426-9833
mycowalt@comcast.net

Foray Organizer

Martha Bishop
mycena@icloud.com
Hospitality Chair

Sharon Greenberg

(330) 457-2345
d.greenberg@att.net

Web Manager

Lonelle Yoder
(614) 216-1769
lonelley@yahoo.com

Other Board Members:

Shirley McClelland
(740) 215-5883
shirleymccllelland@msn.com

Bryan Lewis & Laura Wilson

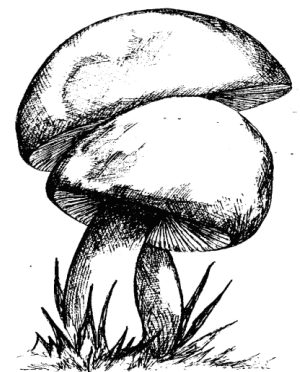
(917) 475-6130
bwaynelewis@gmail.com

Pete Richards

(440) 775-3412

Dave Miller

(440) 935-0239 or
(216) 400-7364
dmiller@oberlin.edu



Ohio Mushroom Society
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Circulation and Membership
Jerry Pepera,
8915 Knotty Pine Lane
Chardon, OH 44024

Editor
Bob Antibus

www.ohiomushroom.org

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