MUSHROOM NEWS

JULY
2020

MUSHROOM SCIENCE

FEATURE ARTICLES

BASF
We create chemistry

Serifel® M biological fungicide.

The effective biological control you've been asking for.

Biological protection — a winning combination for mushroom growers

Mushroom growers are increasingly dealing with two common challenges:

1. Demand for sustainable products

2. Rising resistance to currently used fungicides and insecticides

Serifel® M from BASF is a protective biological fungicide based on *Bacillus amyloliquefaciens* that can effectively address these challenges.

Effective control – Serifel® M forms a shield of protection against a broad spectrum of common mushroom diseases like Green Mold-Trichoderma. Natural compounds produced by the Serifel® M spores grow on the surface of the casing soil to prevent the germination of pathogens.

Sustainability – Serifel® M is OMRI Listed® and has a positive toxicological and environmental profile, allowing for greater flexibility throughout the growing cycle. Additionally, it does not enter the mushroom or leave any chemical residue.

Resistance management – Target diseases are unlikely to develop resistance to Serifel® M due to its unique mode of action. Plus, it is compatible with the vast majority of conventional fungicides.

Ready to learn more? Contact your Sylvan representative today to learn how your operation can benefit from Serifel® M biological fungicide and Nemasys® M beneficial nematodes and to trial the products.

PREMIUM OMRI Certified

2017 Agro Awards Finalist – Best New Biological Product

Contact your Sylvan Rep to find out more about this great new product!

Sylvan CULTIVATING EXCELLENCE

SCIENCE SPAWN SUPPORT

Maximizing the Value of Growers' Crops

www.sylvaninc.com

Mushroom Science / JULY 2020

LORI HARRISON | *Mushroom News*, Editor | American Mushroom Institute | *lharrison@americanmushroom.org*

Are mushrooms the answer to what ails the world? According to Google, it sure seems like it. A recent search of "mushrooms" found articles like, "Everyone's Going Mushroom Mad—Here's Why it's Time You Ate More Too," "Why People Think Mushrooms Could Save the World," and "Mushrooms are Exciting Scientists as a Treatment for Mental Health Problems."

While the chorus of mushroom proponents continues to grow, and mushrooms are being used in a variety of ways for a variety of products, we took this issue to look at issues that touch on the science of mushrooms.

First, we have an article on bioremediation, or more specific, mycoremediation—the use of mushrooms to clean up hazardous waste, harnessing their natural ability to use enzymes to break down foreign substances. Next, with an introduction from Jan Klerken Jr. of Scelta Mushrooms, we explore umami—it's history, uses and future.

We also have an article from Carolee Bull and her team at Penn State on the idea that all viruses aren't bad, and how you can use them to control mushroom blotch disease.

We switch gears a little bit and with a report from AMI Board of Directors Chairman Joe D'Amico, To-Jo Mushrooms, who provides an overview on AMI from the recent Annual Meeting. In her *Food for Thought* column, Rachel Roberts looks at the biology of the pandemic, and in our *Safety Seconds*, we take a look at heat related illnesses. Mushroom Council unveils a recent survey about consumers and mushroom demand, and in our *People Behind the Product*, we highlight Gerardo Rico of Hillendale Services.

MUSHROOM IMPORT REPORT | MARCH 2020

Compiled from the Department of Commerce Trade Data Services / Washington, D.C.

IMPORT CLASSIFICATION	MAR 2020 KILOGRAMS	2020 YTD KILOGRAMS	MAR 2019 KILOGRAMS	2019 YTD KILOGRAMS
Fresh, *Agaricus*	6,167,284	18,244,067	5,533,032	16,122,889
Fresh, NESOI*	980,544	3,225,560	790,506	2,967,759
Total Classified by Fresh Weight	**7,147,828**	**21,469,627**	**6,323,538**	**19,090,648**
Whole < 225 g	45,397	171,193	62,621	128,671
Sliced < 225 g	305,549	1,104,637	326,344	945,751
NESOI* < 225 g	1,177,538	2,769,719	1,242,926	3,168,475
Whole > 225 g	295,376	1,150,872	290,816	746,274
Sliced > 225 g	398,877	1,243,669	299,740	940,183
NESOI* > 225 g	1,465,337	3,801,050	1,380,521	3,465,300
Total Classified by Container Weight				
< 225 g	1,528,484	4,045,549	1,631,891	4,242,897
> 225 g	2,159,590	6,195,591	1,971,077	5,151,757
Total by Container Weight:	**3,688,074**	**10,241,140**	**3,602,968**	**9,394,654**

Full import reports available at http://americanmushroom.org/industry-resources

** Not Elsewhere Specified or Indicated*

MUSHROOM NEWS

MUSHROOM SCIENCE

JULY 2020
VOLUME 68 | NUMBER 7

COVER IMAGE: Courtesy: Phillips Mushroom Farms

Letters to the editor – The *Mushroom News* welcomes letters to the editor from its readers on subjects of interest to the mushroom industry. All contributions to this department must bear the writer's signature and address and should be sent to Letters to the Editor, American Mushroom Institute, 1284 Gap Newport Pike, Suite 2, Avondale, PA 19311.

Mushroom News is published monthly by the American Mushroom Institute and can be reached at 610/268-7483. Subscription price: Association members receive a paid subscription: U.S.A. and Possessions - $300.00 for one year, third class postage. Other countries $300.00 for one year. Non U.S. deliveries at subscriber's risk. Cancellations not accepted. Remittances (U.S. Currency only and either drawn on a U.S. Bank or an international money order). To assure quick service, please enclose your mailing label when writing to us or renewing your subscription. Renewal orders must be received at least 8 weeks prior to expiration to assure continued service.

Editorial Policy: Authors should review the MUSHROOM NEWS editorial policy (Jan. 1999, 22) prior to submitting articles for publication. For copies of the policy write or call the AMI office. Manuscripts, correspondence, requests for memberships, subscription and change of address should be sent to the AMI address above. Articles appearing in *Mushroom News* represent the opinions of the authors and not necessarily the policies of the AMI.

Chairman's Message: Members Bring Strength, Relevance to AMI

JOE D'AMICO | AMI Board of Directors Chairman | To-Jo Mushrooms

Over the past year, and especially the past few months, AMI has shown its strength as an organization through its ability to draw on the support, knowledge and ideas of its members to achieve some great successes and manage changes. Earlier this spring, AMI was critical to providing information on legislative and financial guidance for businesses and industry best practices on a variety of issues that helped companies maneuver through COVID-19.

Members can access and keep up with these industry updates, resources and changes through AMI's relaunched website. This members-only site underlines the value of the decades-long institutional information created by members. The members-only section will soon include the AMI directory—prized by members old and new alike for its exclusive contact information of the industry. I encourage all of you to visit the site either on your desktop, tablet or phone. The site includes much of the information and resources from our previous site, along with new functions and information to help you in your business.

Much of what is accomplished at AMI comes from the help of our volunteer members of more than 10 committees. For about an hour or so each month, these members help drive AMI's initiatives, provide strategic input, give end-user feedback critical to evaluating innovative projects and share expertise. These efforts have helped to elevate AMI within the produce industry to solidify relationships both within and outside the industry, and to evaluate, recommend and provide resources for our businesses.

If you currently do not participate on an AMI committee, I strongly encourage you to learn more about them and get involved. The benefits far outweigh any barriers you may perceive and is a way for your staff to gain important professional development, especially under our new team. Contact AMI staff about how you can get involved, or, if you have an idea to form a new committee or revive one, please let us know.

I want to provide you an update on just some of the projects and initiatives of AMI's dedicated committees and their hard work we all benefit from. This is by no means a complete list of all the work the association is doing.

The Mushroom Employee Safety and Health Committee (or MESH), also known as the OSHA Alliance Committee, maintains a collaborative relationship with OSHA to create safer workplaces and develop and continue safety and health programs.

The MESH Committee, Front-End Loader Subcommittee and the Case Management Subcommittee continues to raise awareness across the industry about two resources on

the AMI website: the front-end loader safety video created and the incident report form in English and Spanish. AMI's HR Task Force identified the need for case management standards and best practices and will work to create a toolkit to help companies manage worker compensation claims and get employees back to work sooner. These management-focused committees represent the spirit of AMI membership and community in grappling with soft-skills techniques necessary to align the management of our industry with the human resources needs and technological advances touching our workers.

The MESH Committee also took the lead in addressing the COVID-19 crisis by quickly pulling together to develop COVID-19 Mushroom Best Practices and many educational materials for the industry to use for workers across the industry.

In support of these committees, AMI applied for and received $100,000 in funding from the PA Department of Agriculture for workforce development, including recruitment and training materials, videos and awareness.

Members of the Integrated Pest Management Committee (IPM) and Penn State University are working to update the Integrated Pest Management Manual. AMI is also working with PA Department of Agriculture to have an updated Section 18 for PHOR-EX issued for PA growers and is also working with Syngenta to safeguard the registration of Mertect.

AMI applied for and received $50,000 in funding from the PA Department of Agriculture for best practices in growing and limiting environmental impact. This grant will give AMI the opportunity to analyze issues EPA has brought to the industry and provide accurate information on behalf of growers regarding IPM methods and impact.

The Food Safety Task Force completed a draft of updates to the USDA Grades and Standards for mushrooms. The group will meet with USDA to hear feedback and receive guidance on changes and edits that will make the submission more likely to be adopted.

A Compost Working Group came together to seek "coproduct determination" for spent mushroom compost in PA, which would classify spent mushroom compost as a "coproduct" that can be transferred to farmers appropriately without each separate transfer requiring separate paperwork.

AMI applied for a grant to evaluate the carbon sequestration capacity of spent mushroom compost to further brand spent mushroom compost as a beneficial product for soil

amendment as well as revegetation and reclamation.

The *Mushroom News* Committee continues to plan content and design for the monthly industry magazine. At the beginning of the year, the delivery method of the magazine was changed to a self-mailer, eliminating the envelope and insert to save costs. The committee is evaluating the introduction of other regular features as well as expanded content, and is also evaluating the online presence of the magazine as well as overall content preferred by readers. If anyone has ideas for articles of would like to sit on the committee, contact AMI.

Nearly 40 members of the Mushroom Farmers of PA staffed the mushroom booth at the 2020 PA Farm Show. The event was a big success, thanks in large part to the Mushroom Farmers of PA member volunteers, where nearly 500,000 visitors attended the weeklong event—the largest indoor farm show in the country. The AMI booth won the Best Educational Booth at the show and the Philly Pulled Port Sandwich won best food in the food court—the operation run again by Gale Ferranto, Buona Foods.

The Research Committee continues to carry out projects, including National Institute of Food and Agriculture-funded mushroom growing innovation work and Organic Agriculture Research and Extension-funded organics supply chain research, among others. Research Committee members continue to participate in AMI grants and grant applications as advisors, and continue to provide articles and information for *Mushroom News* and government relations advocacy.

One of the core principles for AMI is to educate those outside of the mushroom community on the impact of our industry and how we fit in the larger agriculture sector. To that end, over the past year, AMI further expanded its outreach to media covering topics such as labor, sustainability, economic impact data, trade issues, and the good work of the industry in adapting to COVID-19 requirements and best practices. AMI has partnered with media that resulted in stories in trade publications like *The Packer*, PA-local publication *The Philadelphia Inquirer* and national outlets like *Forbes*, *NPR*, *CNN* online and others. AMI also accompanied growers to the White House to advocate for policies that can develop a reliable system for the industry employing mushroom workers.

As this year comes to close, I want to thank the AMI Board of Directors, staff and AMI members for their hard work, commitment and dedication to AMI and the mushroom industry. It certainly made my job easier. I have great faith that AMI is moving in the right direction and look forward to seeing how much further we can go.

AMI ANNOUNCES 2020-2021 BOARD OFFICERS & DIRECTORS

CHAIRMAN
Joe D'Amico, Jr., *Brownstone Mushroom Farms*

CHAIRMAN ELECT
Chad LaFazia, *Kaolin Mushroom Farms*

VICE CHAIRMAN/TREASURER
Scott Engelbrecht, *J-M Farms, Inc.*

SECRETARY
Geoff Price, *Giorgi Mushroom Company*

PRESIDENT
Rachel Roberts, *American Mushroom Institute*

BOARD DIRECTORS
Stephen Anania, *Amycel/SpawnMate*
Dirk Cox, *Monterey Mushrooms, Inc.*
Pat Fitz, *Fitz Fresh*
Pete Gray, *Phillips Mushroom Farms*
Meghan Klotzbach, *Mother Earth, LLC*
David Knudsen, *Ostrom Mushroom Farms*
Don Needham, *Fastrak Express, Inc.*
Mark Wach, *Sylvan BioSciences*

Bioremediation pond for soil contaminated with crude oil at an oilfield in the Ecuadorian Amazon.

Citizen Activists are Promoting Mycoremediation. Is Anyone Listening?

When wildfires burned across Northern California in October 2017, they killed at least 43 people and displaced another 100,000. The human toll alone was dire, but the fires also left behind a toxic mess. It wasn't just the record-breaking levels of air pollution. The blazes generated an untold amount of potentially dangerous ash, the remains of incinerated hazardous household waste and building materials. The charred debris of paint, pesticides, cleaning products, electronics, pressure-treated wood and propane tanks left a range of pollutants in the soil—including arsenic, asbestos, copper, hexavalent chromium, lead, and zinc.

Officials feared runoff from the toxic ash could pollute local creeks once the rainy season hit, potentially tainting the drinking water supply for the region's 700,000 residents.

In the aftermath of the fires, federal and state workers removed much of the toxic debris. But then, in Sonoma County, a coalition of fire remediation experts, local businesses, and ecological activists mobilized to cleanse the foundations of burned-out buildings with...mushrooms. The Fire Remediation Action Coalition placed more than 40 miles of wattles—straw-filled, snakelike tubes designed to prevent erosion—inoculated with oyster mushrooms around parking lots, along roads, and across hillsides.

Their plan? The tubes would provide makeshift channels, diverting runoff from sensitive waterways. The mushrooms would do the rest.

The volunteers, led by Sebastopol-based landscape professional Erik Ohlsen, are advocates for "mycoremediation," an experimental bioremediation technique that uses mushrooms to clean up hazardous waste, harnessing their natural ability to use enzymes to break down foreign substances.

In the last 15 years, mushroom enthusiasts and so-called "citizen scientists," and even the EPA have deployed mushrooms to clean up oil spills in the Amazon, boat fuel

pollution in Denmark, contaminated soil in New Zealand and polychlorinated biphenyls, more commonly known as PCBs, in Washington state's Spokane River. Research suggests mushrooms can convert pesticides and herbicides to more innocuous compounds, remove heavy metals from brownfield sites and break down plastic. They have even been used to remove and recover heavy metals from contaminated water.

The mycelium does all the work, says Daniel Reyes, founder of the Austin, Texas-based science and education company MycoAlliance.

Mycelia consume their food externally, by secreting powerful enzymes that break down molecules. In other words, they "digest" whatever substrate, or surface, they're growing on, converting it to nutrients and—depending on the substrate—edible mushrooms.

Proponents say it's a natural, more benign and potentially cheaper alternative to the "scrape-and-burn" approach to environmental cleanup, which involves digging up contaminated soil and incinerating it.

The problem with that traditional approach is that it can remove potentially fertile topsoil, says Theresa Halula, who teaches mushroom cultivation at Merritt College in Oakland, California. Mycoremediation, on the other hand, she says, can help clean up toxic sites while actually improving soil fertility.

So why isn't mycoremediation a more common practice?

One reason, Halula says, is that federal regulations require the removal of 100 percent of targeted contaminants within a short time frame. Current mycoremediation solutions simply work too slowly to be embraced on an industrial scale. "In nature, mushrooms break down all kinds of substances, and we're just beginning to look at this more closely in the lab and in field studies," she says. "But we don't yet know the speed of the breakdown, and how effective that breakdown is."

As a result, most mycoremediation projects are undertaken at the local level, like the Sonoma County project.

"Mycology is very neglected as a science, and mycoremediation is currently very site-specific," says Peter McCoy, a self-trained mycologist viewed by many of his adherents as a founder of the radical mycology movement. (His book, *Radical Mycology*: A Treatise on Seeing and *Working With Fungi*, helped give the movement its name.) McCoy says there's no one-size-fits-all method for applying mushrooms to biohazard sites. Reactions vary depending

on species of mushroom, contaminants present and local growing conditions, which means treatments must be customized and that further exploration is likely necessary.

"Hopefully, we'll develop enough anecdotal evidence for certain common pollution scenarios that we can build off-the-shelf protocols. But we're not there yet," McCoy says.

Like other subfields of bioremediation, mycoremediation has failed to attract much investment. "This is an inherent problem in the bioremediation industry," says William Mohn, a microbiologist at the University of British Columbia who specializes in microbial degradation. "We are not producing a product that people want to buy. We are producing something that companies are sometimes forced to do. It's hard to make a great business case for it. Or, quite frankly, a case for academic research."

Funding is so hard to come by, Mohn says, that he left the bioremediation field. "It's easier to find funding for other types of research," he says.

That means, as McCoy puts it, "it falls on citizen scientists and garage researchers to do the work."

Some of those citizen scientists are recruited by Tradd Cotter, a microbiologist who travels the country spreading the gospel of mycoremediation. "I tell people that the first thing we have to do is find mushrooms that break down the stuff we want to break down. And when we find mushrooms doing extraordinary things, we want to clone them," he says.

During one of his presentations, a participant said he had seen a mushroom growing on a bowling ball. Cotter asked the class, "Is this a mushroom we want to study, and why?" A young boy piped up to say, "Yes! Because it eats plastic!"

Cotter, who runs Mushroom Mountain research lab in South Carolina, says he receives packages almost every week—usually dried mushrooms along with letters describing where they were found—from people hoping to contribute to his research. "There are thousands of people out looking for mushrooms doing strange things. People really do want to help. It gives them a sense that they are contributing, even if they're not a microbiologist."

He likens effective mushrooms to janitors with giant sets of keys—enzymes—that break down molecules. "If you have one key, you might be a mushroom that will only grow on a very specific type of wood. Another mushroom from the same species could have a huge key set—perhaps it can grow on oak, plastic, or oil," Cotter says. "We want to screen the fungi with huge key sets to see what they can eat: oil, herbicides, insecticides and synthetic compounds."

Beyond the work being done in these independent labs, enthusiastic amateurs are conducting their own projects in

the field. According to Cotter's lab partner, Leif Olson, "It's happening out of necessity. People see all these environmental issues, and they want to do something about it. They hear that oyster mushroom mycelia can clean contaminated water, and they are eager to practice this knowledge."

McCoy founded the Radical Mycology Mycelial Network, an online community of so-called "mycoevangelists," in an attempt to harness that enthusiasm. Members exchange information, uploading geotagged photos of mushrooms taken in the wild for public research. While the decentralized nature of the group makes it difficult to gauge the size of the community, McCoy's Mycelial Network contact page lists groups in California, North Carolina, and Washington state; "nodes" in the U.S., Canada, and United Kingdom; and "hyphal tips" of individual mycoevangelists in 14 states. Sometimes, they even get together in person. This past summer a group of over 600 radical mycologists gathered in the hills of rural Oregon to talk mushrooms and share knowledge.

Despite their zeal, many fungi enthusiasts treat empirical design and data collection as an afterthought. In its December 2018 progress report, Fire Remediation Action Coalition's Ohlsen said that the team didn't take the time to implement scientific design principles, such as setting up control areas, measuring pretreatment toxin levels or developing and following protocols like measuring and controlling the amount of mycelia in each wattle. Furthermore, the volunteers were not trained scientists, and the coalition didn't have the resources to design and conduct a scientifically valid study.

In other words, a DIY spirit of informality pervades mycology culture, in part by disposition and in part because there is no other choice. But if the movement is going to realize its potential, its loose community of adherents may need to find ways to formalize their work.

Ohlsen expressed the hope that more scientists will bring empirical design expertise to future mycoremediation projects and encouraged nearby communities to start planning now for the next wildfire season so that data collection can be cemented into future fire remediation protocols. Unfortunately, he predicts, coming fire seasons will provide plenty of "tragic opportunities" to do so.

This article was originally published by The New Food Economy, a nonprofit newsroom covering the forces shaping how and what American's eat.

GROWING KNOWLEDGE - CULTIVATING POSSIBILITY

26

NAMC

MAY 30 - JUNE 3, 2021 VANCOUVER

20TH ISMS CONGRESS

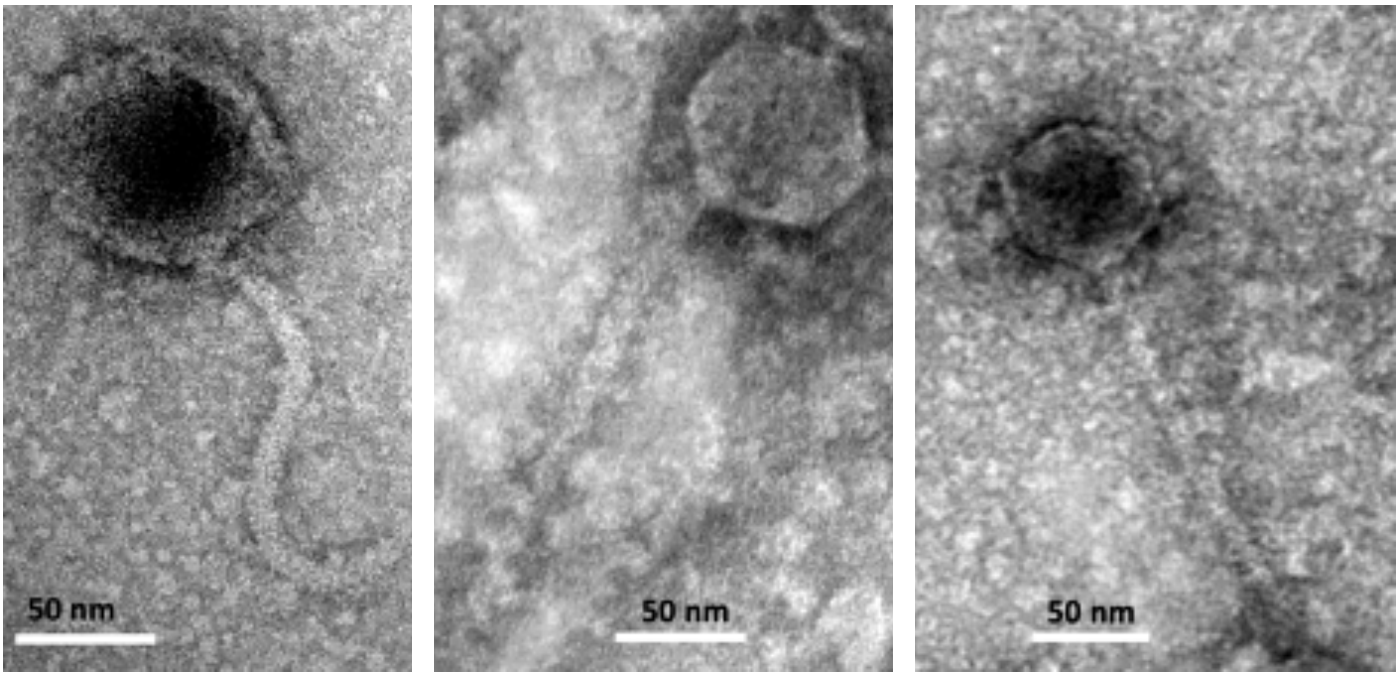
May 30 - June 3, 2021 VANCOUVER

EXPERIENCE VANCOUVER!

From colourful downtown neighbourhoods, to culturally diverse suburbs and mountainside districts, there's plenty to explore and a place for the whole family to enjoy. Come discover why Vancouver is one of the most beautiful cities in the world!

TO REGISTER, VISIT MUSHROOMCONFERENCE.ORG

REGISTER NOW!



Transmission electron micrograph of the purified phage virion. The phages have an icosahedral head and a long tail. Bar, 50 nm.

Not all Viruses are Bad: Controlling Mushroom Blotch Disease with Bacteriophages

ABDELMONIM ALI AHMAD | **KEVIN HOCKETT** | **CAROLEE T. BULL** | Department of Plant Pathology and Environmental Microbiology | Pennsylvania State University

Viruses are the most abundant and diverse biological entities on earth with about 1031 viral particles on Earth (Whitman et al., 1998). They are obligate parasites and mostly known for their aggressive and infectious nature. They work by invading the host cell, subvert its cellular machinery and releasing new viral particles that go on to infect more cells. Due to the recent pandemic caused by SARS-CoV-2 (COVID-19), we are all intimately aware of the devastating pathogenic relationship between some viruses and their human hosts. Furthermore, the mushroom industry continues to fight La France disease and Mushroom Virus X (MVX). It's true, most viruses have a pathogenic relationship and cause illnesses in their fungal, bacterial, plant, animal, or human hosts. Despite the current events, however, they're not all bad. Like many of the beneficial bacteria, many viruses are actually useful. For example, some viruses can kill bacteria, those are called Bacteriophages.

Bacteriophages (commonly referred to as phages) are obligate parasites. Their infection begins when surface proteins bind to receptor proteins on the surface of the bacterial host cell, followed by replication and lysis (lytic phages), or some phages can integrate their genome into the genome of the host and remain dormant (lysogenic phages) until conditions are favorable for replication and host cell lysis. Phages have very specific targeting toward their host cells and have a great impact on the evolution of bacteria. The discovery of bacteriophages is credited to Frederick Twort (Twort, 1915) and Felix d'Herelle (d'Herelle, 1917), as they were the first to suggest this phenomenon as being viral in origin. d'Herelle discovery of bacteriophages is frequently associated with an outbreak of severe hemorrhagic dysentery among French troops stationed at Maisons- Laffitte (on the outskirts of Paris) in July-August 1915. d'Herelle was able to make bacteria-free filtrates that were able to form clear areas on agar bacterial culture, and he proposed that it was caused by a virus capable of parasitizing bacteria and he called these viruses bacteriophages. Although the early results of using bacteriophages as a control agent for bacterial pathogens were very promising, the discovery of broad-spectrum activity of antibiotics in the 1940s led to the decline of research into controlling bacterial diseases with bacteriophages (Summer, 2001). However, the appearance of antibiotic resistant bacterial strains, the rise and widespread of copper resistant bacterial strains in

agricultural fields, the lack of discovering new and effective antibiotics, as well as the environmental degradation associated with application of copper sprays and antibiotics, and our expanding knowledge based on successful phage applications, are all factors that are bringing the attention of the researchers to bacteriophage therapy in biomedical and agriculture fields (Jones et al., 2007).

Phages were first found to be associated with plant pathogenic bacteria in 1924 when Mallmann and Hemstreet (1924) reported that the filtrate of decomposed cabbage inhibited the growth of *Xanthomonas campestris pv.* campestris. Since that time phage therapy has been found to be effective for the control of a number of phytobacteria including *Xanthomonas* spp. (citrus canker, Balogh, et al., 2008; Ahmad et al., 2014), *Erwinia* spp. (fire blight, bacterial soft rot, *Svircev* et al., 2005), and *Ralstonia solanacearum* (bacterial wilt of tomato, Ahmad et al., 2017). For bacterial diseases of mushrooms, bacterial blotch was first described by Tolaas, 1915, and phages were suggested as a biological control agent to control the disease by Guillaumes et al., (1988).

As biological control agents targeting phytopathogens, phages have many advantages. First, phages are very specific to their host bacteria. Second, infection of a bacterium by a virulent phage typically results in rapid viral replication, followed by the lysis of the bacterium and the release of numerous progeny phages, which can proceed to infect new bacterial cells. Therefore, the numbers of phage will expand when target pathogens are encountered, and the therapy effects will essentially be amplified in response to the bacterial infection. Third, phages have the potential to infect antibiotic or heavy metal resistant bacteria. Fourth, phage preparation, storage and application are easy and inexpensive compared with chemical methods (Greer, 2005). Furthermore, there is also interest in the use of phage in the detection of phytopathogens (Frampton et al., 2012; Schofield et al., 2012).

Bacterial blotch of mushrooms is one of the most economically important diseases of button mushrooms, *Agaricus bisporus*, in organic mushroom production (Osdaghi et al., 2019). Blotch, a disease complex characterized by brown lesions on the surface of mushroom caps, is caused by *Pseudomonas tolaasii*, as well as at least 10 other *Pseudomonas* species (Martin, Ramos-Sepulveda, and Bull, in preparation). Several methods have been used to control the diseases including chemical treatments, however none were effective or safe for human (Sajben et al., 2010). Because of the limitations of conventional methods to control the disease, researchers developed an interest in biological

control means including the use of antagonistic bacteria (Soler-Rivas et al., 1999), and bacteriophages (Guillaumes et al.,1988; Munsch et al., 1991). In particular, bacteriophages are thought to be advantageous over conventional use of antibiotics as they have no health and environmental risks, and for their suppression of drug-resistant bacteria. Our team at Penn State is isolating phages that are able to infect blotch inciting *Pseudomonas* strains from mushroom casing samples. *Pseudomonas* species commonly isolated from diseased mushrooms at Pennsylvania were selected as hosts for phage isolation. Previous phage studies with mushroom blotch diseases has focused on *Pseudomonas toloassii* (Guillaumes et al., 1988; Munsch et al., 1991; Nguyen et al., 2012) though other causal agents had already been identified (Preece and Wong 1982; Young, 1970). However, strains that were

resistant to the phage were problematic in attempts to control the disease in large-scale experiments. These resistant strains may have been any of the 10 species of *Pseudomonas* that cause blotch. Considering this information, our goal is to develop a biological control cocktail of bacteriophage isolates that would be able to lyse not only *Pseudomonas tolaasii*, but also all other *Pseudomonas* species causing blotch disease(s). Thus far, 15 phages have been isolated and purified from Pennsylvania mushroom farms and lytic activity against a variety of individual *Pseudomonas* strains has been demonstrated. The host range of the phages with strong lytic activity were evaluated against a panel of *Pseudomonas* species. Electron microscopy observation revealed that most of isolated phages are members of the family *Siphoviridae* with an icosahedral head of about 70-80 nm in diameter, and a non-contractile tail of 150-200 nm in length, (Figure 1, page 21). It is ironic that our research evaluating the potential of using viruses to kill bacteria is currently delayed due to the risk of a lethal human virus. However, as soon as we are able to resume our research at Penn State, we will evaluate the host range of the isolated phages against other 11 *Pseudomonas* spp. before assessing the potential of using them as a biocontrol agent to control bacterial blotch of mushrooms.

REFERENCES:

Ahmad, A. A., Askora, A., Kawasaki, T., Fujie, M., and Yamada, T. (2014). The filamentous phage XacF1 causes loss of virulence in Xanthomonas axonopodis pv. citri, the causative agent of citrus canker disease. Front. Microbiol. 5:321. doi: 10.3389/fmicb.2014.00321

Balogh, B., Canteros, B. I., Stall, R. E., and Jones, J. B. (2008). Control of citrus canker and citrus bacterial spot with bacteriophages. Plant Dis. 92, 1048-1052.

D'Herelle. Summers WC. (2005). Bacteriophage research: early history. In: Kutter E, SulakvelidzeA, ed(s). Bacteriophages: Biology and Applications. Boca Raton, FL: CRC Press, 5-27.

Frampton, R. A., Pitman, A. R., and Fineran, P. C. (2012). Advances in bacteriophage-mediated control of plant pathogens. Int. J. Microbiol. 326452 10.1155/2012/326452

Greer, G. G. (2005). Bacteriophage control of foodborne bacteria. J Food Prot 68, 1102-1111.

Guillaumes J, Houdeau G, Germain R, and Oliver JM. (1998). Amelioration de la lutte biologique contre Pseudomonas tolaasii utilisation de bacteriophages. Bull OEPP/ EPPO 18, 77–82.

Jones, J. B., Jackson, L. E., Balogh, B., Obradovich, A., Iriarte, F. B., and Momol, M. T. (2007). Bacteriophages for plant disease control. Annu. Rev. Phytopathol. 45, 245-262.

Mallmann, W. L., and Hemstreet, C. J. (1924). Isolation of an inhibi- tory substance from plants. Agricultural Research. 28:599-02.

Munsch, P., Oliver, J.M., and Houdeau, G., (1991). Experimental control of bacterial blotch by bacteriophages. Balkema Pub., Rotterdam.

Nguyen et al. (2012). Characterization of bacteriophage Pto-bp6g, a novel phage

that lyses Pseudomonas tolaasii causing brown blotch disease in mushrooms. J. Microbiol Methods. 3:514-519.

Osdaghi, E., Martins, S. J., Ramos-sepulveda, L., Vieira, R., Pecchia, J. A., Beyer, D. M., Bell, T. H., Yang, Y., Hockett, K. L., and Bull, C. T., (2019). 100 Years since tolaas: bacterial blotch of mushrooms in the 21st century. Plant Dis 103:2714–2732. https://doi.org/10.1094/ PDIS-03-19-0589-FE

Preece T.F., Wong W.C., 1982. Quantitative and scanning electron microscope observations on the attachment of Pseudomonas tolaasii and other bacteria to the surface of Agaricus bisporus. Physiological Plant Pathology 21: 251-257.

Sajben, E., Manczinger, L., Nagy, A., Kredics, L., Vágvölgyi, C., 2010. Characterization of pseudomonads isolated from decaying sporocarps of oyster mushroom. Microbiol. Res. 166, 255–267.

Schofield, D.A., Bull, C.T., Rubio, I., Wechter, W.P., Westwater, C., Molineux, I.J. 2012. Development of an engineered 'bioluminescent' reporter phage for the detection of bacterial blight of crucifers. Applied and Environmental Microbiology 78:3592–3598.

Soler-Rivas, C., Arpin, N., Olivier, J.M., Wichers, H.J., 1999. WLIP, a lipodepsipetide of Pseudomonas 'reactans', as inhibitor of the symptoms of the brown blotch disease of Agaricus bisporus. J. Appl. Microbiol. 86, 635–641.

Summers, W. C., (2001). Bacteriophage therapy, Ann. Rev. Microbiol. 55: 437-451

Svircev, A. M., Lehman, S. M., Kim, W. S., Barszcz, E., Schneider, K. E., and Castle, A. J. (2005). Control of the fire blight pathogen with bacteriophages. pp. 259- 261) In: Zeller W, Ullrich C (eds). Proc 1st Int Symp Biol Control Bact Plant Dis, October 23–26, 2005. Berlin, Germany: Die Deutsche Bibliothek – CIP- Einheitsaufnahme.

Tolaas, A. G. (1915). A bacterial disease of cultivated mushrooms. Phytopathology 5:51-54.

Twort, F. W. (1915). An investigation on the nature of the ultra- microscopic viruses. Lancet. 189:241-3.

Whitman, W. B., Coleman, D. C., and Wiebe, W. J. (1998). Perspective prokaryotes: the unseen majority. Proc. Natl. Acad. Sci. U.S.A 95, 6578–6583. doi: 10.1073/pnas.95.12.6578.

Young J.M., 1970. Drippy gill: a bacterial disease of cultivated mushrooms caused by Pseudomonas agarici n.sp. New Zealand Journal of Agricultural Research 13: 977-990.

Performance

**"It's all based upon PERFORMANCE in the field.
In a competitive business, with very thin margins,
Lambert's PERFORMANCE is consistently the best."**

– Chester County Grower






Long Term Growth
~100 Years and Counting

Call **610-384-5031** *or visit* **lambertspawn.com**

AMI Update

Membership has its privileges. And AMI is announcing two new benefits for members.

First, **AMI has partnered with Staples Advantage** to provide members with discounted office supplies. The free account allows members access to the Staples Advantage website where you will find discounts on a variety of office and paper supplies*. Other benefits include:

- Free next day deliver
- 3% off orders of $250+
- Proactive Price Protection – when you purchase an item on the Staples Advantage site, the site automatically scans Amazon, Office Depot, Office Max and W.B. Mason for the price and will credit if less
- Dedicated account manager

To take advantage of this member benefit, you must have an email address on file with AMI and an address other than a P.O. Box. If you have not received an email from Staples Advantage inviting you to the program, contact AMI.

*Does not include technology items or furniture

AMI has also unveiled it's **Members Only website**. Here you will find additional news and resources curated specifically for members. Why Members Only? Your membership now entitles you to even more Exclusive Content, Community Collaboration Opportunities, Restricted Sharing of important industry information and an added forum to create Business to Business Connections an provide input and feedback for AMI to continually improve our services and value to your business.

* * * * * * * * * *

To log into the section, visit www.americanmushroom.org and click the Log In button on the top of the page.

* * * * * * * * * *

You'll be directed to the **Member Login** page. Enter your email. To set your password, click **Forgot My Password** and follow the prompts to set a new password. *Note, your Username is your email on file with AMI*. If you are unsure which email is on file with AMI, contact AMI.

Once you log in, you'll be directed to your **Account** page. The middle column includes links that allow you to update personal and billing information, password, email and manage lists for *Mushroom News*. You can click on any of those links and update information as needed. You will also find a Quick Links box on the right that includes links to Members Only sections within the website.

If you have any questions, contact AMI.

Food for Thought:
The Biology We Know about the Pandemic

RACHEL ROBERTS | President | American Mushroom Institute | rroberts@americanmushroom.org

Thankfully, as we continue to read today's headlines about COVID-19 and agriculture, we have hundreds of sources—from government to research—to confirm that a person cannot contract COVID-19 from food. But despite constant confirmation that COVID-19 isn't a foodborne illness, many mushroom food safety managers are managing the details of required changes. AMI has been relying of those managers in the trenches to develop plans and communications to employees, customers, health departments, you name it. Nationally, food safety professionals are asking whether adding COVID mitigation measures into Hazard Analysis Critical Control Points (HACCP) is necessary, for example, which would be in the form of staffing assurances and practices. At the same time, we are looking out for a potential new wave of the virus and attempting to prepare the industry. With so much of our lives now immersed in COVID-19 information, our Biology issue is a good time for a quick review of what is known about the virus spread at this point.

According to Graham and Donaldson in *Nature Review Microbiology* (2013, pp. 836–848), coronavirus first appeared at least 10,000 years ago. It has dozens of strains, seven of which infect humans. Several researchers this year, in "Evolutionary origins of the SARS-CoV-2 sarbecovirus lineage responsible for the COVID-19 pandemic" (Boni et al), report that the virus came through the SARS-CoV-2 virus, "which split more than 140 years ago from the closely related one seen today in pangolins." Then, sometime in the past 40–70 years, the ancestors of SARS-CoV-2 separated from the "bat version" which is believed to have jumped to humans as today's COVID-19.

In *Nature's* "Profile of a Killer: The Complex Biology Powering the Coronavirus Pandemic," David Cyranoski reports that there are researchers who predict the virus could weaken over time through mutations that adapt it to survive in humans. This way, the virus would become less deadly and spread more widely—continuing to spread should be the virus's ultimate goal because if the host dies, the virus dies. But there's no evidence of weakening yet. "The genome of COVID-19 virus is very stable, and I don't see any change of pathogenicity that is caused by virus mutation," says Guo Deyin, who researches coronaviruses at Sun Yat-sen University in Guangzhou (2020, *Nature*). Like Guo, many scientists agree that the "weakening" theory lacks evidence and that the virus doesn't need a surviving host to spread.

Klaus Stöhr, who has been studying COVID and SARS for over 20 years for the World Health Organization, looks to examples of viruses in the same family and how they have adapted in humans. He says that whether through a vaccine or having had the virus, people will still possibly get reinfected, but with minor symptoms, the way they do now from the common cold, and there will be rare examples of severe disease. In May 2020, Brian Resnick reported in *Vox* that, "Herd immunity can only be reliably built up if immunity is lasting. If immunity wanes, then it brings down the percentage of the population that's immune and lets the virus spread further."

According to Stöhr, "By far the most likely scenario is that the virus will continue to spread and infect most of the world population in a relatively short period of time," meaning one to two years. "Afterwards, the virus will continue to spread in the human population, likely forever." (2020, *Nature*). Like the four generally mild human coronaviruses ... COVID-19 ... would then circulate constantly and cause mainly mild upper respiratory tract infections."

In sum, the biology of the virus is still too much of a mystery to start predicting how the mushroom industry—or any other industry—will recover or adapt permanently. The only plan that makes sense is to plan for uncertainty.

Heat Related Illnesses & First Aid

With summer comes increased temperatures. And for those who work outdoors, several heat-related illnesses can affect them. OSHA has a "Heat Illness Prevention" campaign designed to provide guidance for worker protection focused on "Water, Rest & Shade." Employer's should develop a program with focus on employee acclimation and training and be aware of what to look for in heat related illnesses.

HEAT-RELATED ILLNESS	SYMPTOMS AND SIGNS	
HEAT STROKE	• Confusion • Seizures • Very high body temperature • Heavy sweating or hot, dry skin	• Slurred speech • Unconsciousness • Rapid heart rate
HEAT EXHAUSTION	• Fatigue • Thirst • Dizziness or lightheadedness • Elevated body temperature or fast heart rate	• Irritability • Nausea or vomiting • Heavy sweating
HEAT CRAMPS	• Muscle spasms or pain • Usually in legs, arms, or trunk	
HEAT SYNCOPE	• Fainting	• Dizziness
HEAT RASH	• Clusters of red bumps on skin • Often appears on neck, upper chest, and skin folds	
RHABDOMYOLYSIS *(muscle breakdown)*	• Muscle pain • Dark urine or reduced urine output	• Weakness

- Employers and workers should become familiar with the heat symptoms.
- When any of these symptoms is present, promptly provide first aid.
- Do not try to diagnose which illness is occurring. Diagnosis is often difficult because symptoms of multiple heat-related illnesses can occur together.
- Time is of the essence. These conditions can worsen quickly and result in fatalities.

When in doubt, cool the worker and call 911.

First Aid

- Take the affected worker to a cooler area (e.g., shade or air conditioning).
- Cool the worker immediately. Use active cooling techniques such as:
  - Immerse the worker in cold water or an ice bath. Create the ice bath by placing all of the available ice into a large container with water, standard practice in sports. ***This is the best method to cool workers rapidly in an emergency.***
  - Remove outer layers of clothing, especially heavy protective clothing.
  - Place ice or cold wet towels on the head, neck, trunk, armpits, and groin.
  - Use fans to circulate air around the worker.
- Never leave a worker with heat-related illness alone. The illness can rapidly become worse. Stay with the worker.
- When in doubt, call 911!

Additional resources can be found at
https://www.osha.gov/SLTC/heatstress
Source: OSHA

Enfermedades Relacionadas al Calor y Primeros Auxilios

Cuando llega el verano aumentan las temperaturas. Para aquellos que trabajan al aire libre, varias enfermedades relacionas al calor pueden afectarlos. Para proporcionar una guía en la protección de los trabajadores, OSHA tiene una campaña de "Prevención de Enfermedades por el Calor" enfocada a "Agua, Descanso y Sombra". Los empleadores deben de desarrollar un programa con atención a la aclimatación y entrenamiento de los empleados y tener cuidado en que fijarse cuando puedan ser enfermedades relacionadas al calor.

ENERMEDADES RELACIONADAS AL CALOR	SINTOMAS Y SEÑALES
GOLPE DE CALOR	• Confusión • Habla arrastrado • Convulsiones • Inconsciente • Muy altas temperaturas • Rápidas palpitaciones • Sudoración intensa o la piel caliente, piel seca
AGOTAMIENTO POR CALOR	• Agotamiento • Irritabilidad • Sed • Nausea o vómitos • Mareos o vértigos • Sudoración copiosa • Elevada temperatura del cuerpo o rápidas palpitaciones
CALAMBRE POR CALOR	• Espasmo o dolor muscular • Generalmente en las piernas, brazos o el tronco
SINCOPE DE CALOR	• Mareos • Vértigos
SARPULLIDO POR EL CALOR	• En la piel racimos de protuberancias rojas • A menudo aparecen en el cuello, parte superior del pecho y en los pliegues de la piel
RABDOMIÓLISIS *(descomposición muscular)*	• Dolor muscular • Debilidad • La orina es obscura o la cantidad que se orina es reducida

- Los empleadores y los trabajadores deben de familiarizarse con los síntomas del Calor
- Cuando se presenten algunos de estos síntomas, rápidamente dé ayuda de primeros auxilios
- No trate de diagnosticar que enfermedad es la que está ocurriendo. Es difícil el diagnosticar ya que los síntomas de múltiples enfermedades relacionadas al calor pueden presentarse simultáneamente.
- El tiempo es esencial. Estas condiciones pueden empeorarse rápidamente y resultar en fatalidades.

Cuando tenga dudas, enfríe al trabajador y llame al 911.

Primeros Auxilios

- Lleve al trabajador afectado a un área fresca, (por ejemplo a la sombra o donde haya aire acondicionado)
- Enfríe al trabajador inmediatamente. Use técnicas activas de enfriamiento, tales como:
  - Sumerja al trabajador en agua fría o en un baño de hielo. Para hacer el baño de hielo ponga todo el hielo disponible en un recipiente muy grande que tenga agua, esta es una práctica estándar en los deportes. ***En una emergencia este es el mejor método para bajar la temperatura rápidamente de los trabajadores.***
  - Quítele las capas exteriores de ropa, especialmente la ropa protectora pesada.
  - Póngale hielo o toallas frías en la cabeza, el cuello, el tronco, las axilas y las ingles.
  - Use ventiladores para que circule el aire alrededor del trabajador.
- • Nunca deje solo/a a un trabajador/a con una enfermedad relacionada al calor. Las enfermedades pueden rápidamente empeorar. Quédese con el / la trabajador/a .
- Cuando tenga dudas, ¡llame al 911!

Otros recursos adicionales se pueden encontrar en:
https://www.osha.gov/SLTC/heatstress
Fuente: OSHA

Increased Mushroom Demand Likely to Remain According to New Consumer Research

Mushroom Council's Consumer Survey Shows How Home Cooks are Using Fresh Mushrooms in Recent Months

ERIC DAVIS | Mushroom Council

Consumers will continue to use an increased amount of fresh mushrooms at home for the foreseeable future, according to a recent survey commissioned by the Mushroom Council®.

As consumer habits in the past two months have been upended, the Council sought to explore if changing consumer behaviors and usage of fresh mushrooms would have a lasting impact.

"In recent months, IRI data has consistently shown mushroom sales are increasing at around 30-35% compared to the same week last year," said Mark Lang, MBA, Ph.D., University of Tampa, who developed and conducted the survey. "Mushroom demand is high, and our new survey suggests it will continue at this pace after this crisis."

The "Fresh Mushroom Attitudes & Behaviors During COVID-19" survey of 750 shoppers conducted in April finds that 25% of consumers plan to cook more with fresh mushrooms "after things get back to normal." Another 63% plan to cook "about the same."

"While grocers are currently experiencing this increased demand, it's likely these new consumer preferences will also carry over to foodservice once restaurants reopen," Dr. Lang added.

Mushrooms' Versatility and Nutrition Driving Demand

"We also explored the many reasons why consumers are purchasing more mushrooms and what they are doing with them," said Dr. Lang. "Mushrooms' adaptability and health benefits lead the way."

As consumers increase their mushroom purchases since the health crisis began, they are including them in an array of mealtimes and dishes, including pasta (46%), pizzas (44%), salads (34%), omelets (33%) and with chicken (32%).

When asked why consumers are using more fresh mushrooms, versatility is king: 38% of respondents said they feel mushrooms "can be used in many ways" and 47% said mushrooms "go with what I'm cooking." Health is the second ranked reason with respondents saying mushrooms "provide better nutrition and health" (39%) and "help with vitamin D intake" (38%).

Their preferred varieties have remained consistent prior to March with new data showing white button (57%), portabella (36%), baby bella (26%), brown button (21%) and shiitake (17%) as the most prominent.

Mushrooms are "Interesting" and "Extend Meat Dishes"

Dr. Lang also offered open-ended questions to learn why consumers are cooking more with mushrooms. Among the top themes and responses:

- "I'm cooking more and trying to find creative dishes to cook."
- "Because me and my family love them, and they are a good source of vitamins."
- "Extend beef dishes by adding (mushrooms)."
- "Enjoy the flavor they give to my meal."

"Overall, this survey finds that mushrooms meet consumers where they are as they find themselves cooking at home more," Dr. Lang concluded. "Whether it's extending meals, boosting vitamin intake, or because a recipe calls for them, mushrooms are certainly the answer for many consumers. Increased interest and experiences with mushrooms from home cooking should also translate into increased preferences and orders for mushrooms in foodservice and restaurants as these come back online."

For a copy of the report, please email *info@mushroomcouncil.com*

Umami: On the Tip of the Tongue

Introduction by Jan Klerken Jr., Scelta Mushrooms

The way people experience food greatly depends on its shape, odor and taste. Imagine eating a strawberry: before you even bite into it, your mind is already pre-set into receiving a sweet experience with that typical strawberry aroma. All these anticipations have been built on over the course of our lifetimes, and everybody has formed his or her own library of taste markers. This is one of the reasons why flavor is so hard to define–it is not a pre-programmed association in our minds, but a collection of experiences you encounter over your life.

When it comes to tastes, though the term umami has been around almost since the beginning of time, it has only gained popularity in the last few years, earning its rightful place next to the other basic tastes–sweet, sour, salty and bitter. The umami taste is savory and is most often associated with meats such as cured ham, seafood including anchovies, some cheeses, and....mushrooms. Umami has a mild but lasting aftertaste difficult to describe. If a flavor had to be assigned to the term umami, it would be meaty and brothy with a tongue-coating savoriness that causes salivation.

Literally translated, the Japanese word umami means "delicious taste" or "pleasant savory taste" and was coined by Professor Kikunae Ikeda in 1908 when he discovered that monosodium glutamate (MSG), naturally present in some foods, reacts synergistically with some ribonucleotides, including inosinate and guanylate. Put a different way, he discovered that chemicals in some foods interact in a special way to really impress your taste buds.

Discovery of Umami

Umami has been recognized as an independent flavor for more than a hundred years in several different cultures. The Romans have actually cooked with glutamate for centuries as have the Japanese but it was just another undefined flavor to add to dishes.

As noted above, the actual attempts to define umami started in 1908 when Professor Kikunae discovered that monosodium glutamate was one of the main flavor components in dashi, an aqueous Japanese broth that's used similarly in Japanese cuisine to the way that Westerners use beef stock or bouillon. The glutamate he found in dashi came from kombu, a large brown seaweed used to make dashi.

The other key component in dashi is katsuobushi, dried bonito fish. In 1913, much to the surprise of many, Professor Shintaro Kodama found that it was the inosinate released from the katsoubushi that elevated the umami taste in dashi. In 1957, Akira Kininaka completed the initial round of umami discoveries when he figured out that guarylate, a compound found in dried shiitake mushrooms, was also an umami flavor contributor.

People began to suspect that these three components interacted with each other in a way that really elevates the umami flavor in many foods such as dashi. The final nail that secured umami as a fifth basic taste was the discovery in 2000 of an actual umami taste receptor in human taste buds that was dubbed taste-mGluR4. With that discovery, it was scientifically proven and umami was formally recognized as an independent basic flavor.

By itself, the taste of pure MSG is not necessarily pleasant and it has been described as salty, soapy and broth-like. But it makes a great variety of foods pleasant especially in the presence of a matching aroma within a relatively narrow concentration range. MSG in excess amounts makes the food less palatable and an optimum amount appears to be around the concentration found in many natural foods, typically 0.1–0.8% by weight.

Umami: Not Just Another Taste

One of the reasons that umami was designated as an independent flavor is because the MSG and the ribonucleotides combine to make a flavor that either ingredient alone simply doesn't contribute.

In addition to rounding out the flavors of dishes such as dashi where it's the predominant flavor, umami also elevates some of the other basic flavors, sweet and salty in particular. For example, when paired with salty flavors, the saltiness is elevated to the point that you can actually use up to 40% less salt than you typically would without negatively impacting the taste of the dish.

A 2014 Mushroom Council study from the Culinary Institute of America and University of California-Davis, published in the Journal of Food Science, explored the flavor-enhancing properties of mushrooms and found that blending finely chopped mushrooms with ground meat enhances flavor and nutrition. The study highlighted how mushrooms—with their umami—can reduce calorie, fat and sodium intake, while adding nutrients like vitamin D, potassium, b-vitamins and antioxidants, enhance the overall flavor because of double the impact of umami and maintain flavor while reducing sodium intake by 25 percent.

Umami Rich Foods

Most raw meats and vegetables contain high levels of glutamic acid (glutamate in acid form) but it is bound in proteins. Glutamic acid imparts little umami taste; whereas

the salts of glutamic acid, known as glutamates, can easily ionize and give the characteristic umami taste. Therefore, the bounded glutamic acid found in many common foods needs to be released to produce umami taste. To provide umami, most raw foods need to be processed to break down the proteins into free amino acids and the nucleic acids into free nucleotides.

According to the Mushroom Council, all mushrooms are a rich source of umami and the darker the mushroom the more umami it contains. Widely available mushrooms with the most umami:

- Shiitake
- Crimini
- Portabella
- White button

Dried mushrooms tend to have more umami than fresh ones, and cooked mushrooms are more umami-rich than raw. This means that adding mushrooms in virtually any form—raw, sautéed, whole cap garnish, even a dusting of dried powder—will add an umami lift to foods.

The Future of Umami

When it comes to mushrooms and umami, we already know that mushrooms and meat is a key combination. But can you imagine combining breads or even chocolate with mushrooms to create a strong base for building a flavor profile? Companies in and outside the industry are doing research to examine and even exploit mushrooms and their umami profile that one day can apply to the food industry.

Perhaps a 2014 New Yorker article put it best. "Umami may indeed be the fifth taste, and there may come a day when a bottle of MSG is as common in the home kitchen as the saltshaker or the sugar bowl, the simplest of flavor enhancers. But for now, as popular understanding of the concept discovered just over a hundred years ago continues to evolve, umami is more than the sum of its glutamates. It is a cultural cipher, a malleable, claimable standard of identity, innovation and taste. Umami is a badge of pride, once Japanese, now universal. A state of mind. Deliciousness."

MolecularRecipes.com contributed to this article.

People Behind the Product:
In the Driver's Seat

An integral part of the mushroom growing process, Gerardo Rico hauls peat moss and works with his crew to case mushroom beds. Gerardo has been with Hillendale Services for more than 14 years, and with the mushroom industry for 30 years.

Gerardo says he enjoys his job and the people he works with, so much so that others in his family also work for Hillendale Services. "I am proud of the fact that my son and nephews have followed in my footsteps. They also work as casing truck drivers and crew leaders."

* * * * * * * * * *

Do you have an employee or employees you would like to see highlighted in the magazine? Contact *Mushroom News* at *lharrison@americanmushroom.org*.

The closest thing to real sunlight

Enhance your mushrooms with Vitamin D using XENON Pulsed Light.

XENON's Pulsed Light system is proven to generate large amounts of Vitamin D in mushrooms, making them more nutritious and offering mushroom growers an edge on the store shelf.

Our lamps work in just seconds – not the minutes required by continuous light systems, and it's mercury free! You save energy, reduce handling time and keep your processing line moving. XENON's Pulsed Light is the closest thing to real sunlight.

Some of the world's leading mushroom producers and marketers are already using XENON's Pulsed Light. Shouldn't you?

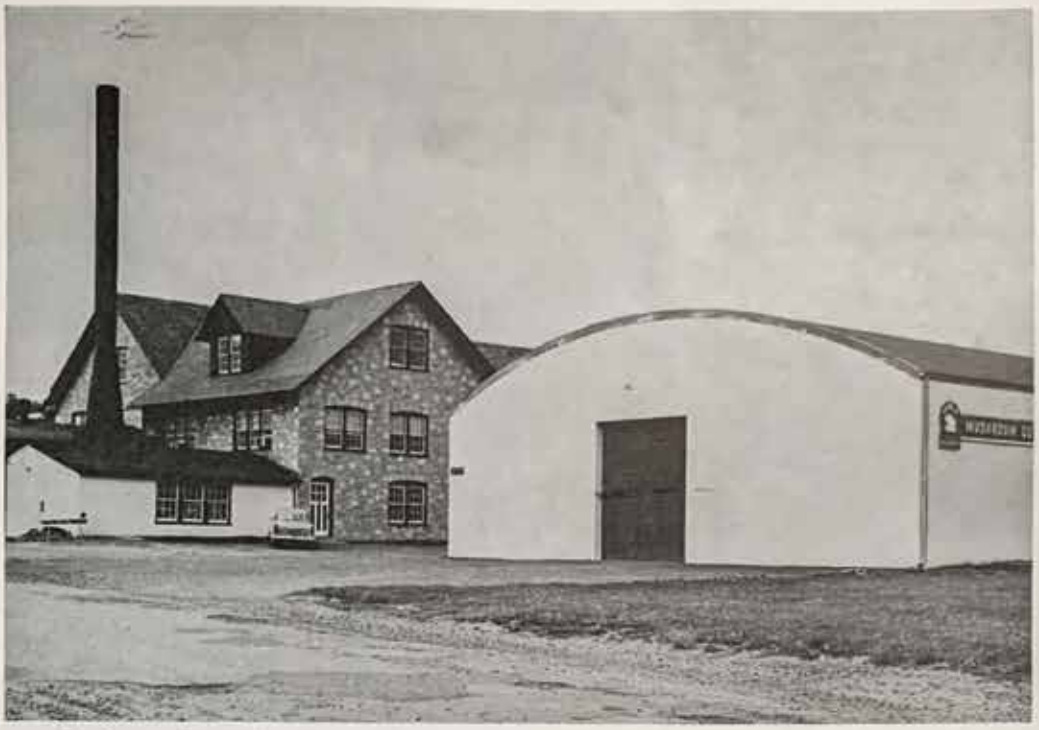
XENON™

XENON Corporation
37 Upton Drive
Wilmington, MA 01887-1018 USA

Telephone 978-661-9033
Toll Free 800-936-6695 (U.S.A. only)
Fax 978-661-9055
Email info@xenoncorp.com
Web www.xenoncorp.com

For a free report on enhancing mushrooms with Vitamin D, visit www.xenoncorp.com/mushrooms

This Month in *Mushroom News* History



Mushroom Cooperative Canning Company is one of the oldest canneries in the industry. This view shows the main plant and, in the foreground, part of the company's warehouse in Kennett Square.

Ernest Bonifacino, president and general manager, shows some mushrooms processed in the company's new freezing plant.

First Freezing Plant

Mushroom Co-op Steps into Future....

Mushroom Cooperative Canning Company, Kennett Square, has taken a giant step into the future with the construction of a large freezing plant — the first and only plant designed and built solely for the quick freezing of mushrooms and mushroom products.

After conducting a series of tests over the past five months, the company is prepared to put the freezing plant into full production in the fall. Some orders were filled on a test basis during the past season.

"This is indeed a giant step for our company," Ernest Bonifacino, president and general manager, told Mushroom News. "Our cannery is the only cannery in the mushroom industry with a freezing plant located directly on the premises.

"The significance of this point," he said, "might be lost unless you think in terms of quality control. The fact that we do not have to transport mushrooms to a freezing plant at some distant point means that we can supply our customers with products of higher quality. Considering the perishability of mushrooms, even the nearest freezing plant is too far away.

"Then, too, it must be remembered that all the presently available processing equipment and freezing facilities were designed for products other than mushrooms. Our plant was designed specifically for mushrooms."

Mr. Bonifacino places great stress on Mushroom Cooperative's quality control.

"Quality control," he said, "extends all the way down to the mushroom growing houses. Our 20 grower owners are among the very finest mushroom growers in the world. We're starting out with mushrooms of top quality and maintain control over quality throughout our processing operation. Now we have extended it to our new line of products.

"Keep in mind, too, that all mushrooms coming into our plant are inspected by Federal-State inspectors. This service has greatly increased the quality of mushrooms and assures our customers the very best mushrooms and mushroom products."

One of the oldest mushroom canneries in the industry, Mushroom Cooperative was founded in 1931 and functioned as a part of Mushroom Growers Cooperative Association for many years. Under the guidance of Walter W. Maule, who served as secretary and general manager of the cannery and MGA until his retirement in 1958, Mushroom Cooperative gained a sound reputation as a packer of quality canned products.

The company's decision to enter the frozen mushroom field was influenced primarily by the impact of cheap canned mushrooms from Formosa. After an analysis of the market and the

(Continued on Page 8)

Frozen mushrooms join Mushroom Cooperative's line of products. The company has been marketing MGA brand canned mushrooms for 33 years.

July 1964

An important part of Mushroom Cooperative's freezing plant equipment is a grader (seen in background) that can grade in five size ranges with a tolerance of ¼ inch.

(Cotinued from Page 7)
trends in the food field, the company came to the conclusion that freezing was the most promising of the practical methods of processing mushrooms.

Mushroom Cooperative explored the possible use of nearby freezing facilities, but one fact was apparent: even the nearest freezing plant of adequate capacity and equipment was so located that the perishable mushroom could not be delivered fast enough to assure a product of the highest quality. Then, too, the equipment and facilities were designed for products other than mushrooms.

Mushroom Cooperative's freezing plant was designed as an addition to the established plant on Birch Street in Kennett Square. The addition consists of a cinder block structure housing the pre-freeze process equipment. By cutting through the thick fieldstone walls of the building, the company made this area practically a part of the old plant.

Extending from this area are two pre-fabricated coldroom structures. One is a raw mushroom storage room with its own cooling plant designed for a working temperature of 32 to 35 degrees. The second is a frozen product storage room with the temperature controlled at -10 degrees. This room is designed for palletized handling of frozen packages products. Its refrigeration is generated by the same equipment used in the actual freeze tunnel.

Both coldroom structures are of modern metal-bonded plywood construction with Fiberglass insulation ranging from four to ten inches in thickness. The actual freezing of the product takes place in a freeze tunnel located in the process room. The tunnel is a large, heavily insulated box structure through which passes a four-foot stainless steel belt upon which the mushrooms ride.

Very low temperatures are generated in the tunnel. A battery of powerful fans directs the cold air over the product with hurricane force. Just as anyone feels colder on a windy day, this combination of cold air and wind brings about the quick freezing of the mushrooms to a desired temperature. It also results in what is known as IQF — "Individually Quick Frozen." Instead of being frozen into a solid block, the mushrooms remain separated.

In addition to the belt freezing area, the tunnel contains room for freezing of packaged products on trays.

The capacity of the present equipment is 1,500 pounds per hour. This can be doubled simply by installing additional refrigeration machinery.

Besides Ernest Bonifacino, Mushroom Cooperative's officers are Walter Walton, vice president; James Yeatman, secretary, and C. F. McVaugh, treasurer. Other members of the board of directors are Herman Ferraro, Norman Gregg, and Vico Bertogli, who is plant superintendent.

James Yeatman, secretary of the Cooperative, feeds mushrooms onto secondary inspection conveyor where (below) mushrooms not meeting high standards of quality are removed.

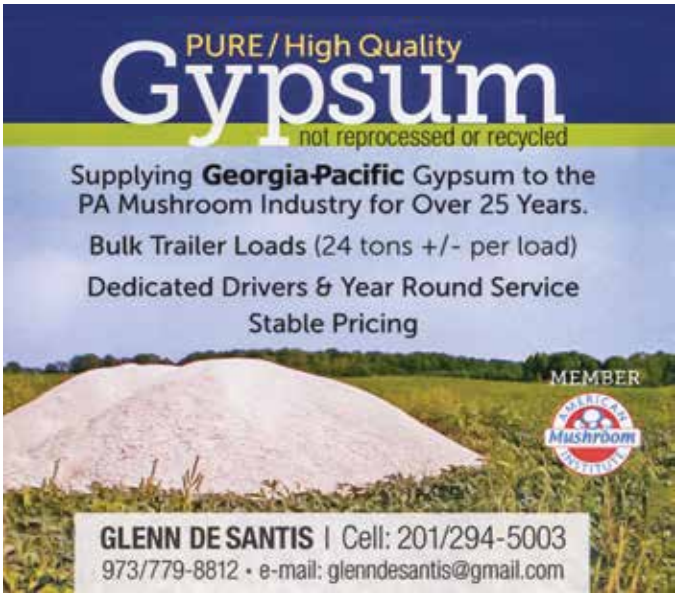
Classifieds

FOR SALE New, never used horse manure hopper; 1-year-old, dipped galvanized stainless steel. Set up and ready to run. Box is 117" high x 116" wide. 162" tall from back to the ground. 116" tall from front. Please call 610/268-3278 with any questions or to set up at time to come take a look. $70,000 OBO.

HELP WANTED Giorgi Mushroom Company, a large, integrated farm in Berks County, PA, with Phase I bunkers and Phase II tunnels, is seeking applicants for grower and management positions. Ideal candidates would have both growing experience and a strong management background. We offer competitive salaries and a comprehensive benefits package. Applicants may forward a letter of interest and resume to Joe Caldwell, Giorgi Mushroom Co., P.O. Box 96, Temple, PA 19560 or e-mail them to *jcaldwell@giorgimush.com*.

Completed Ballots 2021-2023 Term

The ballots are in and have been tabulated. Background forms are being sent to those that are eligible for appointment to the Council. Once the completed forms are received, they will be sent to the USDA Secretary of Agriculture for the appointments to the Council which will be announced in November or December.



ADVERTISER'S INDEX

BENTLEY

Truck Services, Inc.

Committed to Excellence

- New and Used Truck Sales
- Full Service Leasing
- Commercial Truck Rental
- Parts and Service

ISUZU TRUCK
GAS / DIESEL

FUSO

HINO TRUCKS
A Toyota Group Company

OEM's listed may not be available at all Bentley Locations

Contact: Jim Hawthorne
Cell: 609-501-8011
Office: 302-328-4600
244 Quigley Blvd.,
New Castle, DE 19720

American Mushroom Institute

ABC Associated Builders and Contractors, Inc. Delaware Chapter

American Mushroom Institute
1284 Gap Newport Pike, Suite 2
Avondale, PA 19311

DELTA FORCE

OUR STRAINS YOUR GAINS

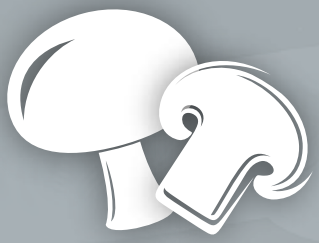
TOP PERFORMER REGARDLESS OF COMPOST QUALITY

ALLOWS FOR HIGH PERCENTAGE OF LARGE MUSHROOMS

CREATES IDEAL STAGGER INCREASING HARVESTING EFFICIENCY

Amycel, Your Partner in Growing Success

Delta is one of our most popular strains worldwide, and performs well in a wide variety of compost conditions. Delta can be tailored to produce a wide variety of size mixes, and is well suited for growers looking to produce superior quality mushrooms to compete in the fresh market. Control you crop variables, grow Delta.



LEARN MORE AT AMYCEL.COM

INNOVATION IS IN OUR SPORES

People, Products & Performance
You Can Trust

Amycel. Spawn Mate.

AMYCEL.COM

USA EASTERN 800.795.1657 WESTERN 800.995.4269

CANADA EASTERN 877.821.1684 WESTERN 888.856.4124