INTERNATIONAL SOCIETY FOR MEDICINAL MUSHROOMS

国际药用菌学会

International Society for Medicinal Mushrooms （ISMM）was founded in Vancouver, Canada. As a global non-profit organization, ISMM promotes the development of research, education, production, transportation, marketing and cultivation of medicinal mushrooms to have people to work towards common aspirations and goals. The integration will increase the impact of the international medicinal mushroom industry and benefit the health of people in the world.

Honorable President: Prof. S.T.Chang, Prof.S.P. Wasser
President: Academician Li Yu
Executive President: Mr. Chen Hui
Secretary General: Mr. Liu Ziqiang

国际药用菌学会（International Society for Medicinal Mushrooms），简称ISMM，在加拿大温哥华注册成立，由从事药用菌产业的科研、教学、生产、流通、市场、文化及相关产业链的单位、团体和个人自愿组成的为实现共同意愿的非营利性国际组织。本学会致力于促进国际药用菌产业各个领域的融合与发展，以提升药用菌行业在全球的影响力，造福人类健康。

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NEWSLETTER OF THE INTERNATIONAL SOCIETY FOR MEDICINAL MUSHROOMS

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News Reports

Chinese Mushroom Days: Reunion - Recovery - Restart

By Greg Seymour, Acting Foreign Correspondent

Zhangzhou in Fujian Province was once again the host city of Chinese Mushroom Days (CMD) on 17-19 November 2023, following a four-year hiatus due to Covid.

The weather was perfect – warm and dry for the entire 17th edition of Chinese Mushroom Days. A new venue, the Yuanshan Fliport Hotel, was the scene for the mushroom industry conference and expo that is focused on the button mushroom industry and has become an icon on the international mushroom calendar.

'Reunion - Recovery – Restart' was the theme for this year's event which had three full days of presentations by speakers from all over the world as well as an extensive commercial exhibition on two floors of the hotel and surrounding outdoor areas.

The organizers, CFNA, reported 1500 delegates and 70 exhibitors attended this year's event which was down about 50% on the 2019 edition, the last one before Covid. While attendance was a lower than usual, the vibe was positive with many enthusiastic personal reconnections taking place on the commercial stands and during networking events.

Straw as alternative substrate

After the traditional official opening speeches, the first day's presentations got underway with a talk by Professor Li Yu from Jilin University on the better utilization of straw as an alternative substrate to produce a wide range of mushroom species. The emphasis on the need for improved environmental management could not be missed nor the importance of the role of the mushroom industry could play in enhanced environmental outcomes for China and the rest of the

world.

Li demonstrated straw substrates not only gave comparable production to traditional wood-based substrates, they can significantly contribute to a better environment by utilising vast quantities of a 'waste product' that is often burnt by wheat growers.

Minimising the burning of wheat straw after harvest reduces air pollution, CO_2 emissions, and provides an economic stimulus in regional areas by enabling another valuable crop (mushrooms) to be produced before the straw returns to the environment via animal feeds, a base product for the extraction of bio-compounds, or as fertilizer/ soil amendment.

Professor Li Yu from Jilin University held a lecture on the better utilization of straw as an alternative substrate to produce a wide range of mushroom species

The future of casing

ISMS President Greg Seymour was the next presenter and provided delegates with an introduction to the recently released 'Future of Casing' report, and an overview of the upcoming 20th ISMS Congress and North American Mushroom Conference being held between 26-29 February in Las Vegas, USA.

Delegates learnt what was in the "Future of Casing" report and that they could obtain a free copy of the report from the ISMS website www.isms.biz. After sharing the key findings of the report with delegates, Seymour shared his personal priority take-outs from the report.

He said that it was clear that there was sufficient deep dug wet peat available in existing licensed bogs around Europe to supply the mushroom industry for at least the next 20-40 years. However, disruptions to peat use were likely to come from policies and regulations adopted by governments, regulators, and retailers that prevented peat use on a national or regional basis. Seymour highlighted the proposed DEFRA policy on banning the use of peat in the mushroom industry in England by 2030 as an example and advised that the policy included a ban on the selling of imported mushrooms grown on peat.

He also pointed out that there was currently no replacement for deep dug wet peat on the horizon so continued access to this product was essential for the economic well-being of the industry until an economically viable 100% non-peat casing became a reality. Consequently, the monitoring and management of the mushroom industry's political and

operating environment will be critical to how well mushroom groups are able to counter the impact of well-resourced and experienced 'environmental and climate groups' attempting to disrupt the supply and use of peat in the mushroom industry.

World Mushroom Day?

Dr Tan Qi from the Shanghai Academy of Agricultural Sciences was the next speaker. Dr Qi began her presentation by recounting her recent visit to the FAO office in Rome to advocate for an official World Mushroom Day. FAO outlined the process the industry would need to follow, and indicated there was a good chance of success with a well-supported and professional submission.

Dr Qi then outlined the development and future trends in the specialty mushroom industry in China. Already the largest producer, the current and future industrialization of production will see China massively increase the supply of high-quality shiitake, *Pleurotus* spp., morels, and many other exotic mushrooms. The underlying challenge for producers is ensure their marketing programs are good enough to profitably sell all their extra production.

Positive panel

The afternoon session got underway with a panel session to discuss the question "What has happened in the world mushroom industry?" The panel consisted of Aleksandr Khrenov (Russian Growers Union), Jack Lemmen (GTL Europe), Ron Hegger (DMP) and Mart Christiaens (Christiaens Group) from The Netherlands, Chris Alonzo (Pietro Industries, USA), Sumio Ayusaw (Hokken, Japan) and Greg Seymour (ISMS).

Apart from providing their reflections on the situation during Covid, the group was asked what they felt about the future for the global mushroom industry. There was unanimous agreement that the future was positive but there would be some continuing pain for many in the industry for the next two to three years. This situation is likely to result in some rationalization across the sector.

Interestingly, it was reported that most growers and suppliers used the Covid period to review their businesses. This has resulted in leaner operations and lots of innovation industry wide so that as market conditions improve, the industry looks set for a relatively prosperous period.

International panel

Harvesting, marketing and Poland

Jack Lemmen from GTL Europe, based in the Netherlands, followed the panel session with an excellent presentation on improving productivity with two-handed picking. GTL now has harvesting systems in fourteen operations around the world where experience is demonstrating the use of tilting or modified traditional shelving, combined with an automated stem-cutting and mushroom packing system, makes picking up to 2.5 times faster than traditional systems. See also Mushroom Business 123 on harvesting systems.

Jack then talked about how to prepare farms for the future. He said the key tactic was to move air-handling units from the front of the growing rooms to the middle to free-up the working corridor for the installation of a mezzanine floor. Harvesters would still access rooms from the ground floor while the mezzanine floor would utilized for packing etc.

Tomasz Kuczmaszewski from Sylvan Australia was the next speaker. Tom provided delegates with an overview of the Australian mushroom industry and the efforts of its generic marketing program to increase mushroom consumption. Hanna Zielinska from Okechamp in Poland was up next and introduced her company's vertically integrated operations before providing a brief overview of the mushroom industry situation in Poland.

Spawn

The last four speakers of the day gave presentations on various aspects of edible mushroom spawn. First up, Professor Zhang Jinxia from the Chinese Academy of Agricultural Sciences in Beijing provided delegates with a picture of developments in fungal spawn in China. Next, Dr Mark Wach from Sylvan International gave a presentation on trends and developments in the global spawn business using some highlights from Sylvan's spawn research program.

Importantly, Mark said that the systems that Sylvan had successfully developed for Agaricus breeding and development were highly applicable to other exotic varieties such as Shiitake and *Plurotis* spp. Results from early work on these specialty mushrooms indicates there will be significant gains in their commercial quality and productivity performance over the next few years.

Dr Mark Wach from Sylvan International

Mr Eiichi Kimura from the Kinokkusu company in Japan then provided delegates with an insightful overview of the present situation and future challenges confronting the edible mushroom industry in Japan. The final speaker for the

day was Dr Ji Junxia from Lambert spawn who gave an overview of the specialty mushroom market in North America and the advantages of Lambert's SI product.

Night of *Agaricus bisporus*

The Button Mushroom Night dinner followed the first day's presentations. There was an exciting vibe in the air as many delegates had the chance to catch up on four years of separation over a few wines and bijous (Chinese vodka). The buffet provided a great meal while the crowd was entertained by some excellent live music. The traditional acknowledgement of sponsors took place on stage with many well-known international identities participating in a mass 'ganbei' (bottoms-up toast)!

Interestingly, a video presentation by Fuyang City and Funan Country of Anhui Province on a major vertically integrated mushroom development currently under construction got proceedings underway. The sheer scale and complex planning of the initiative was mind-boggling. It is likely that many similar government-funded mushroom developments of this scale will occur in the foreseeable future as the government seeks to diversify the economy, spread wealth, stimulate economic growth, and look after the environment - particularly in regional areas.

Sponsors on stage at the Night of Agaricus bisporus

Tradefair

The Expo was made up of the usual major international players from Europe and North America, like Hoving, Christiaens Group and DMP, but Chinese international and domestic businesses provided the bulk of the exhibitors. Delegate interest in the products and services on display in the 70 exhibition booths was high. Detailed discussions between exhibitors and potential customers were observed on many stands and sitting areas throughout the event.

Specialty mushrooms

The second day's program focused on specialty mushrooms. The morning got underway with a review and discussion of current and future production systems. This was followed by a session on the equipment available to support the various systems and mushroom types.

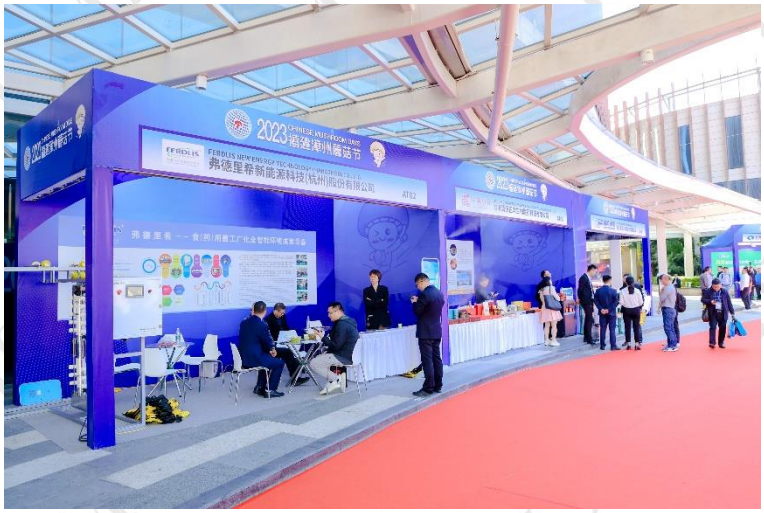
The afternoon program began with speakers talking on recent developments in the cultivation of morels (*Morchella*

spp.) and black boletes (*Phlebopus portentosus*). This was followed with a series of presentations on the status of international markets for specialty mushrooms.

The final session consisted of a panel discussion looking at issues associated with China's specialty mushroom industry going global. The day concluded with a Specialty Mushrooms dinner where guests were treated to a traditional Chinese banquet. The lively networking continued from the night before with a great deal of fervour.

The Day 3 program got underway with presentations on straw utilization for mushroom production followed a panel session on the topic. The morning session concluded with presentations on the review and discussion of production technology development for the Wine Cap mushroom (*Stropharia rugosoannulata*), the cracking Shiitake (*Lentinula edodes*), and the Bamboo or Wedding Veil mushroom (*Dictyophora rubrovolvata*).

The final session of the event provided a series of presentations and a panel session on the culinary aspects of edible mushrooms. Several of the speakers focused on developments in the 'food service' and 'prepared dishes' market segments while the panel discussed where the whole market was heading and where opportunities might lie.



Expo Stands outside the hotel.

Conclusion

Overall, the organizers can be well pleased with the 17th edition of Chinese Mushroom Days, the first since 2019 when Covid intervened. On all counts CMD 2023 was a success for delegates, exhibitors and sponsors. With next year's event back at its traditional venue and likely to attract a bigger audience as the world progresses to a 'new Normal', its easy to understand why Chinese Mushroom Days is such an important event for the global mushroom industry.

After many farewells and promises to catch-up in Las Vegas for the ISMS Congress and North American Mushroom Conference, it was time for many international guests to head for Xiamen airport to board flights for all parts of the globe or stay-on in China to travel to mushroom destinations across the country.

New Study Says Mushrooms May be Communicating More After Rain

by Kathleen St. John, Simplemost

Science nerds have been buzzing for a while about the discovery that mushrooms can communicate with each other via a network of electrical signals. But a new study listened in on a mushroom "conversation" and discovered that the fungi really start blabbing after a rainfall, so to speak.

Japanese researchers from Tohoku University, Nagaoka College and Kyoto University experimented on a cluster of mushrooms by measuring electrical activity in their fruit — the visible, above-ground portion of the fungus. They noted that the area had been dry in recent weeks, and electrical activity significantly increased after a typhoon dropped rainfall in the region. "In the beginning, the mushrooms exhibited less electrical potential, and we boiled this down to the lack of precipitation," said Yu Fukasawa, the main author of the study, in a statement. "However, the electrical potential began to fluctuate after raining, sometimes going over 100 mV."

Mushrooms connect to each other with a network of underground strands called hyphae, which together form the mycelium. Electrical signals travel along the hyphae, making a transmission of sorts. Scientists are split, however, about what those bursts of activity could mean. One researcher compared the patterns of electrical bursts to human speech and identified around 50 "words" among four species of mushroom.

Scientists believe the mushrooms could simply be signaling their presence. Or, they could be alerting other parts of the fungus gossip network to threats or attractants.

But perhaps they're not "saying" anything at all. That's what Dan Bebber, associate professor of biosciences at the University of Exeter, told The Guardian in 2022, although he agrees the electrical bursts aren't random.

"Though interesting, the interpretation as language seems somewhat overenthusiastic, and would require far more research and testing of critical hypotheses before we see 'Fungus' on Google Translate," Bebber said.

Buzzkill! Nonetheless, the Tohoku University study could be an example of mushrooms displaying something like communication — even if it's just a little small talk about the weather. The main takeaway of this study appears to be the fact that more research is needed.

Source: www.americanmushroom.org

Up-coming Events

20th ISMS Congress & 26 th NAMC

20th International Congress on the Science and Cultivation of Edible and Medicinal Mushrooms

26–29th February 2024, JW Marriot Las Vegas Resort & Spa in Las Vegas, Nevada, USA

The 20th ISMS International Congress on the Science and Cultivation of Edible and Medicinal Mushrooms (ISMSC) will be a face-to-face live event held in conjunction with the 26th North American Mushroom Conference (NAMC) in Las Vegas, USA on 26-29 February 2024.

The Congress will involve concurrent sessions of live oral presentations (12 min presentation with 3 mins for questions), dedicated poster sessions, as well as invited keynote presentations (25min presentation with 5 mins for questions) over a two-day period on the 26th and 27th of the joint event.

REGISTRATION INFORMATION

Conference registration entitles delegates to attend all four days of the combined NAMC and ISMSC event. The registration fee covers all scheduled meals, access to the Expo floor, and receptions. All authors that have had their abstract submissions accepted will need to have paid their registration fee for the event by 15 December to have their abstracts published in the Congress Book of Abstracts (see Information for Authors and Presenters section below for more details).

PRICING

ISMS Member pricing (select member price on the registration page):

- Early bird (17/03/23 to 31/07/23) $895
- General (from 01/08/23 – 30/12/23) $995
- Late booking (from 31/12/23 – 24/02/24) $1095

Standard (non-member) Registration Fees

- Early bird (17/03/23 to 31/07/23) $1395
- General (from 01/08/23 – 30/12/23) $1495
- Late booking (from 31/12/23 – 24/02/24) $1595

As an additional incentive for ISMS members, those who are students, research institutions scientists or university personnel can also use a special promotional code to receive a further $100 discount. Contact ISMS Secretariat at secretariat@isms.biz to receive the code.

Note - ISMS membership is free. Visit the ISMS website membership page to become a member.

For more information and to register for the Congress, visit https://mushroomconference.org/.

ACCOMMODATION

JW Marriot Las Vegas Resort & Spa, Address: 221 North Rampart, Boulevard, Las Vegas

The cost per night is US189/night plus tax. The hotel has limited availability of double occupancy rooms so early bookings are encouraged. For more information and to book your room, click here (https://mushroomconference.org/plan-your-trip/). There are many alternative accommodation options near the conference venue but delegates will need to research and organise these themselves.

SPONSORSHIP / EXHIBITION INQUIRIES

Expo spaces are filling up! There are a limited number of Expo spaces available, and slots are on a first-come, first-served basis. Each Expo space includes one (1) business registration worth $3,000 (for members)/$3500 (for non members), good for all four days of the Conference. Access more information at mushroomconference.org/expo/.

Expo Booths are S**old Ou**t. Contact the Mushroom Conference Planning Team for waitlist information and other options and link to info@mushroomconference.org.

AUTHOR SUBMISSION FEE

Authors are reminded that the deadline for Abstract submissions is **30 September**. The abstract submission platform is now closed. Where abstract submissions have been accepted, video and poster submission fees for the presenting authors are: ISMS member: EUR25; Non-member: EUR50.

Pay for author submission fees here
（https://isms.biz/Web/ContentAreas/Events/2024%20Congress%20Event_Display.aspx）.
An official receipt will be emailed after payment is completed.

Authors whose abstracts are accepted for an oral presentation will need to prepare a PowerPoint file and video recording of their presentation. Poster presentations will be a single page in PDF format. The deadline for submission of presentations is **12 January 2024** - see below for further details.

Authors who have been invited to present their work will need to register and pay to attend the 20th Congress by 15 December 2023 otherwise their abstract will not be included in the book of abstracts.

20TH ISMS CONGRESS PROGRAM

(subject to change without notice).

Location: JW Marriot Resort, Las Vegas NV, USA

Sunday 25 February 2024

14:00 – 16:00 Future of Casing Report Seminar [Cataluna Room]
16:00 – 19:00 Registration Opens
17:00 – 18:00 ISMS General Assembly [Cataluna Room]
18:00 – Close of Day's program

Monday 26 February 2024

07:00 – 16:30 Registration Open
08:30 – 09:00 Official Opening
09:00 – 10:00 Keynote Address - Dr Shiuan Chen
10:00 – 10:30 Morning Break
10:30 – 12:15 Scientific Presentations

Grand Ballroom

10:35 – Genetics, Breeding, Germplasm 1
10:55 – Genetics, Breeding, Germplasm 2
11:15 – Genetics, Breeding, Germplasm 3
11:35 – Genetics, Breeding, Germplasm 4
11:55 – Genetics, Breeding, Germplasm 5

Cataluna Room

10:35 – Substrate and Casing 1
10:55 – Substrate and Casing 2
11:15 –Substrate and Casing 3
11:35 – Substrate and Casing 4

11:55 – Substrate and Casing 5

12:15 – 13:40 Lunch

12:45 – 13:40 Poster session

13:45 – 15:30 Scientific Presentations

Grand Ballroom

13:50 – Genetics, Breeding, Germplasm 6

14:10 – Genetics, Breeding, Germplasm 7

14:30 – Genetics, Breeding, Germplasm 8

14:50 – Genetics, Breeding, Germplasm 9

15:10 – Training and Outreach 1

Cataluna Room

13:50 – Substrate and Casing 6

14:10 – Substrate and Casing 7

14:30 – Substrate and Casing 8

14:50 – Substrate and Casing 9

15:10 – Substrate and Casing 10

15:30 – 16:00 Afternoon Break

16:00 – 17:00 Keynote Address – Dr Eion O'Connor

17:00 – Close of Day's Program

17:00 – 19:00 Expo Opening / Welcome reception

19:00 – 23:00 Mushroom Pop-Up Bar

Tuesday 27 February 2024

07:00 – 16:30 Registrations

08:00 – 08:15 Welcome to Day 2

08:15 – 10:00 Scientific Presentations

Cataluna Room

08:20 – Substrate and Casing 11

08:40 – Substrate and Casing 12

09:00 – Substrate and Casing 13

09:20 – Pest & Disease 1

09:40 – Pest & Disease 2

10:00 – 10:30 Morning Break

10:30 – 12:15 Scientific Presentations

Grand Ballroom

10:35 – Nutrition, Bioactive Compounds, Medicinal 1

10:55 – Nutrition, Bioactive Compounds, Medicinal 2

11:15 – Nutrition, Bioactive Compounds, Medicinal 3

11:35 – Nutrition, Bioactive Compounds, Medicinal 4

11:55 – Nutrition, Bioactive Compounds, Medicinal 5

Cataluna Room

10:35 – Pest & Disease 3

10:55 – Pest & Disease 4

11:15 – Pest & Disease 5

11:35 – Pest & Disease 6

11:55 – Pest & Disease 7

12:15 – 13:25 Lunch

12:45 – 13:30 Poster session

13:30 – 15:15 Scientific Presentations

Cataluna Room

13:35 – Nutrition, Bioactive Compounds, Medicinal 6

13:55 – Mycomaterials 1

14:15 – Mycomaterials 2

14:35 – Mycomaterials 3

14:55 – Mycomaterials 4

15:15 – 15:45 Afternoon Break

15:45 – 16:45 Keynote Address - TBC

16:45 – 17:00 Closing Ceremony

17:00 – Close of ISMS Congress Program

18:00 – 19:30 NAMC Opening Reception

19:00 – 23:00 Mushroom Pop-Up Bar

The 12th International Medicinal Mushrooms Conference (IMMC12)

We are pleased to announce the 12th International Medicinal Mushrooms Conference. We invite scientists, students, mycologists, medical doctors, immunologists, contagious disease specialists, naturopaths, biochemists, and all those who are interested in studying and discussing the most current research on medicinal mushrooms and their properties.

BARI, AN UNEXPECTED MEETING POINT BETWEEN EAST AND WEST

Bari is a very charming city, the third-largest city in Southern Italy, in order of thepopulation.

It's incredible the contrast between the folkloristic old town and the cozy city center, full of branded shops and polished aristocratic buildings. Bari is highly multifaceted city, and you really need to discover every single aspect to understand its true core. Known as the "Gateway to the East" due to its long tradition of trade, this capital of Apulia is rich in history: see with your own eyes in the town of Bari Vecchia and surrounding area.

Exploring the historic centre allows us to discover its most authentic character, with signs of its past scattered through the local alleyways and endless examples of age-old traditions passed from generation to generation. Then there is the famous Bari promenade, one of the most beautiful in Italy, overlooking the clear sea and the unique charm of Bari.

Today, this dynamic city, nestled in the heart of the countryside punctuated by white dry-stone walls, is an important university hub.

But it still holds dear the memory of its seafaring exploits of the Middle Ages, as well as its precious monuments and striking churches.

The history of Bari is fascinating and turbulent. The ancient settlement dates back to the Bronze Age, passing from rule by the Peucetians to the Goths, before being fought over by the Byzantines and Lombards. Repeatedly ransacked and destroyed, medieval Bari was conquered by the Saracens and became a small independent Muslim state. It was then taken over by the Franks, before returning to the hands of the Romans, who made it the major Italian political, military and commercial centre of the Eastern Roman Empire. In 1087, with the arrival of the relics of

St Nicholas of Myra, commonly known as Santa Clause, Bari became a thriving religious centre uniting the East and West.

Norman rule in Apulia ensured a long period of prosperity for Bari, though it was still subject to conflict. Rebuilt by the Swabians, it experienced a new peak of splendour, until it declined again under the Angevins, torn apart by struggles between local squires and foreign bankers.

After going to the Aragonese and then the Dukes of Milan in 1464, it was restored to its former glory by Isabella of Aragon in 1500. In 1558, it fell into Spanish hands, experiencing numerous bloody rebellions, and in 1657 it was hit hard by plague. It then passed from Austrian to Bourbon rule, being renewed under French rule in the early 1800s with the construction of the new city.

After being returned to the Bourbons in 1815, it joined the Kingdom of Italy in 1860. This tumultuous history of dominations has left Bari with a unique artistic heritage for all to admire.

Bari is not only art, history, and ancient culture. In fact, a great social life awaits you.

WARNINGS

Bari is a relatively safe city for foreigners. Even though there are some areas to avoid (the main ones are the Libertà, Japigia, San Paolo, and Madonnelle neighborhoods), tourists should not face safety problems other than petty crime, the kind of crime you find in many cities. Use common sense and apply all usual safety precautions.

AVERAGES FOR BARI IN SEPTEMBER

This month is known as a warm month. The average maximum daytime temperature in Bari in September lies at 26.2°C (79.16°F). The average minimum temperature goes down to around 17.1°C (62.78°F) (often the minimum temperature is noted at night). Rainfall during September is moderate with an average of 66mm (2.6 inches). There are generally around 8 rainy days.

DATE AND VENUE

The conference will take place in Bari, Italy, 24-27 September 2024 at the **The Nicolaus Hotel Bari - HO Collection**. The conference will be organized in parallel sessions and poster exhibitions. The official language of the conference is English.

THEME OF THE CONFERENCE:

MEDICINAL MUSHROOMS: THE BET FOR THE FUTURE OF HUMANITY

ORGANIZED BY:

University of Bari, Department of Soil, Plant, and Food Sciences (Di.S.S.P.A.) Italian Society for Medicinal Mushrooms (SIFM)

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SCIENTIFIC PROGRAM OF CONFERENCE WILLINCLUDE:

- Keynote speeches
- Plenary lectures of invited speakers

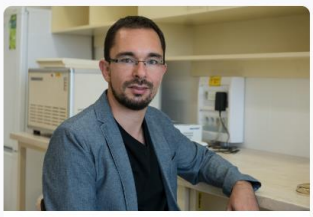
Different symposia dedicated to:

- Biodiversity, taxonomy and ecology of medicinal mushrooms;
- Medicinal mushrooms culture collections, cultivation technology and circular economy;
- Biochemistry, biotechnology and pharmacology of medicinal mushrooms;
- Use of medicinal mushrooms in animal husbandry and veterinary medicine;
- Medicinal mushrooms in human pre-clinical and clinical studies;
- Legislation, certification and safety of mushroom-based supplements;
- Medicinal mushrooms as a source of novel functional food and health benefits; Ethnomycology and the therapeutic potential of psychedelic mushrooms

KEYNOTE SPEAKERS

Dr Christoph Keßler (Germany)

Clinical experiences from the use of medicinal mushrooms in outpatient hospital settings in Germany



Dr. László Nagy (Hungary)

Basidiomycete fruiting body development: an exciting morphogenetic process and source of bioactive compounds

Prof. Robert Bruce Beelman (USA)

ERGO: A Potential Answer in Mushrooms for Healthy Aging

Dr. Tomáš Páleníček (Czech Republic)

Does the phenomenology of psilocybin experience predict long-term outcomes on mood and well-being?

CALL FOR PAPERS

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February 2023	Opening of the conference website
30 April 2023	Distribution of first circular
30 May 2023	Opening of registration
15 February 2024	Distribution of second circular
30 May 2024	Abstract submission deadline

15 June 2024	Notification to authors of abstract acceptance
30 June 2024	Early bird registration deadline
15 July 2024	Full paper submission deadline
31 July 2024	Closing date for registrations and accommodation
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23 September 2024	Registration desk opens
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	EARLY BIRDS (until 30 May, 2024)	**NORMAL (after 30 May, 2024)**
REGULAR ATTENDEES	500,00 €	550,00 €
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TIMETABLE

Sept 23, 2024

09:00-22:00 Conference Registration

Sept 24, 2024

07:00-09:00 Breakfast
09:00-10:00 IMMC12 Opening Ceremony
10:00-10:30 Group Photo
10:30-12:30 IMMC12 Keynote Speeches
12:30-14:00 Lunch
15:00-18:00 Session 1
19:00-21:00 Welcome Reception

Sept 25, 2024

07:00-09:00 Breakfast
09:00-12:30 Session 2
12:30-14:00 Lunch
15:00-18:30 Session 3

Sept 26, 2024

07:00-09:00 Breakfast
09:00-12:30 Session 4
12:30-14:00 Lunch
15:00-18:30 Session 5
20:00 Congress Dinner

Sept 27, 2024

07:00-09:00 Breakfast
09:00-12:30 Session 6
12:30-14:00 Lunch
15:00-16:30 Closing Ceremony

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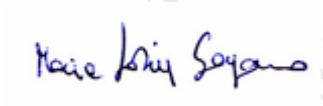

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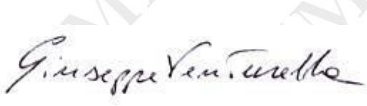

Research progress

Neurotrophic and Neuroprotective Effects of *Hericium erinaceus*

Izabela Szu´cko-Kociuba[1,2*], Alicja Trzeciak-Ryczek[1,2], Patrycja Kupnicka [3] and Dariusz Chlubek[3]

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Abstract: *Hericium erinaceus* is a valuable mushroom known for its strong bioactive properties. It shows promising potential as an excellent neuroprotective agent, capable of stimulating nerve growth factor release, regulating inflammatory processes, reducing oxidative stress, and safeguarding nerve cells from apoptosis. The active compounds in the mushroom, such as erinacines and hericenones, have been the subject of research, providing evidence of their neuroprotective effects. Further research and standardization processes for dietary supplements focused on *H. erinaceus* are essential to ensuring effectiveness and safety in protecting the nervous system. Advancements in isolation and characterization techniques, along with improved access to pure analytical standards, will play a critical role in achieving standardized, high-quality dietary supplements based on *H. erinaceus*. The aim of this study is to analyze the protective and nourishing effects of *H. erinaceus* on the nervous system and present the most up-to-date research findings related to this topic.

Keywords: lion's mane mushroom; nerve system; neurotrophins; secondary metabolites

International Journal of Molecular Sciences. 2023, 24(21), 15960; https://doi.org/10.3390/ijms242115960

Evaluating the Application Potential of a Recombinant Ganoderma Protein as Bioactive Ingredients in Cosmetics

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School of Agriculture and Biology, Engineering Research Center of Therapeutic Antibody (Ministry of Education), Shanghai Jiao Tong University, Shanghai 200240, China.

Abstract: The aim of this study was to evaluate the application potential of a recombinant fungal immunomodulatory protein from *Ganoderma lucidum* (rFIP-glu). First, a recombinant plasmid pPIC9K::FIP-glu-His was transferred into Pichia pastoris for the production of protein. The protein was then to assess its free radical scavenging abilities and the effect on the viability of both human immortalized keratinocytes (HaCaT cells) and mouse B16-F10 melanoma cells (B16 cells) in vitro, followed by the effect on the melanin synthesis of B16 cells. The results of SDS-PAGE and western blot showed that rFIP-glu was successfully expressed. Furtherly, a bioactivity assay in vitro indicated that the scavenging rate of 2,2-diphenyl-1-picrylhydrazyl (DPPH) radicals reached 84.5% at 6.0 mg/mL ($p \leq 0.0001$) of rFIP-glu, showing strong antioxidant activity. Subsequently, a safety evaluation demonstrated that rFIP-glu promoted the proliferation of HaCaT cells, with the cell viability reaching 124.3% at 48 μg/mL ($p \leq 0.01$), regarding the cell viability of B16 cells after exposure

to rFIP-glu (48 μg/mL) significantly inhibited, to 80.7% ($p \leq 0.01$). Besides, rFIP-glu inhibited the melanin synthesis of B16 cells in a dose-dependent manner from 100–1000 μg/mL, and rFIP-glu at 500 μg/mL ($p \leq 0.01$) exhibited the highest intracellular melanin amount reduction of 16.8%. Furthermore, a mechanism analysis showed that rFIP-glu inhibited tyrosinase (TYR) activity by up-regulating the expression of the microphthalmia-associated transcription factor (MITF) and down-regulating the gene expression of TYR and tyrosinase-related protein-1 (TYRP-1), thus inhibiting melanin synthesis. The data implied that rFIP-glu had significant antioxidant activity and whitening potency. It should be used as raw materials for cosmeceutical applications.

Keywords: recombinant FIP-glu (rFIP-glu); antioxidant activity; whitening potency; melanin; tyrosinase

Molecules 2023, 28(7), 3272; https://doi.org/10.3390/molecules28073272

Proteomic Study on the Mechanism of Arsenic Neurotoxicity in the Rat Cerebral Cortex and the Protective Mechanism of Dictyophora Polysaccharides against Arsenic Neurotoxicity

Xinglai Zhang [1], Hongmei Yang [2], Yi Wang [1], Jun Zhang [1], Huajie Zhang [3], Xueshan Cao [3], Ting Hu [1], Jing Lin [3], Xiaoxiao Tang [3], Xi Yan [1], Hongbing Zhuang [3], Xiaolu Chen [1], Yuxuan Liang [3], Peng Luo [1], Liming Shen [3, 4]

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Abstract: Arsenic (As) is a toxic element, and long-term exposure to As can cause neurotoxicity. The bioactive natural compound *Dictyophora* polysaccharide (DIP) from edible plants has been reported to reduce the toxicity of As. In this study, As poisoning was simulated by feeding As-containing feed, followed by proteomic analysis after one month of DIP treatment. The proteomic analysis showed that 145, 276, and 97 proteins were differentially expressed between the As-treated rats and control rats (As/Ctrl group), DIP-treated + As-treated and As-treated rats (DIP + As/As group), and DIP + As and control rats (DIP + As/Ctrl group), respectively. The differentially expressed proteins (DEPs) in the As/Ctrl and DIP + As/Ctrl groups were mainly related to apoptosis, synapses, energy metabolism, nervous system development, and mitochondria. After DIP treatment, the expression of the dysregulated proteins in the As/Ctrl group was restored or reversed, and 12 of them were reversed proteins. These results suggest that energy metabolism disorder, apoptosis, mitochondrial dysfunction, nervous system development injury, synaptic dysfunction, and oxidative stress may be the key pathological mechanisms of As-induced nerve injury in rats. DIP can restore or reverse the expression of related proteins, which may be the main mechanism of its intervention in As poisoning.

Keywords: cortex *Dictyophora* polysaccharides $NaAsO_2$ neurotoxicity SWATH

Molecules 2022, 27, 1495. https://doi.org/10.3390/molecules27051495

Anti-Cancer Potential of Edible/Medicinal Mushrooms in Breast Cancer

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Department of Biotechnology and Life Sciences (DBSV), University of Insubria, 21100 Varese, Italy.

Abstract: Edible/medicinal mushrooms have been traditionally used in Asian countries either in the cuisine or as dietary supplements and nutraceuticals. In recent decades, they have aroused increasing attention in Europe as well, due to their health and nutritional benefits. In particular, among the different pharmacological activities reported (antibacterial, anti-inflammatory, antioxidative, antiviral, immunomodulating, antidiabetic, etc.), edible/medicinal mushrooms have been shown to exert in vitro and in vivo anticancer effects on several kinds of tumors, including breast cancer. In this article, we reviewed mushrooms showing antineoplastic activity again breast cancer cells, especially focusing on the possible bioactive compounds involved and their mechanisms of action. In particular, the following mushrooms have been considered: Agaricus bisporus, Antrodia cinnamomea, Cordyceps sinensis, Cordyceps militaris, Coriolus versicolor, Ganoderma lucidum, Grifola frondosa, Lentinula edodes, and Pleurotus ostreatus. We also report insights into the relationship between dietary consumption of edible mushrooms and breast cancer risk, and the results of clinical studies and meta-analyses focusing on the effects of fungal extracts on breast cancer patients.

Keywords: breast cancer; edible/medicinal mushrooms; in vitro studies; in vivo studies; clinical studies

International Journal of Molecular Sciences 2023, 24(12), 10120; https://doi.org/10.3390/ijms241210120

Detection of Mitogenic and Genotoxic Effects of the Turkey Tail Medicinal Mushroom (*Trametes versicolor*, Agaricomycetes) Extracts from Mexico on Human Lymphocyte Cultures

Letzi de Jesus Salinas-Solis, Juan Carlos Gaytan-Oyarzun, Pablo Octavio-Aguilar

Centro de Investigaciones Biológicas, Área Académica de Biología, Instituto de Ciencias Básicas e Ingeniería, Universidad Autónoma del Estado de Hidalgo, Mexico

Abstract: Diseases caused by a compromised immune system, characterized by decreased production and diversification of T lymphocytes, such as immunodeficiencies or chronic infections, are becoming increasingly prominent. These diseases lead to increased vulnerability to infections caused by parasites, viruses, bacteria, fungi, and other microorganisms. According to various articles, *Trametes versicolor* has been used as immunotherapy and cancer treatment due to its polysaccharides, which have shown their value in traditional medicine. However, most of the studies have been done with Asian samples. For this reason, the aim of this study was to evaluate the effect of samples of Mexican *T. versicolor* on human lymphoid cells. Of various extracts, the one with the best T cell proliferative response was the extract produced by maceration in water at room temperature, but all treatments in aqueous and ethanolic extracts increased the lymphocyte count, showing that extracts of Mexican *T. versicolor* also have compounds that stimulate T cells. Unfortunately, genetic damage expressed as an increment in micronuclei count was identified, so using these fungus extracts in traditional medicine would require careful control of recommended doses.

Keywords: immunology, lymphocytes, *Trametes versicolor*, immunotherapy, micronuclei, medicinal mushrooms

International Journal of Medicinal Mushrooms, Volume 25, Issue 12, 2023, pp. 33-41, DOI: 10.1615/IntJMedMushrooms.2023050464

Ganoderma lucidum Extract Promotes Tumor Cell Pyroptosis and Inhibits Metastasis in Breast Cancer

Chunlian Zhong[1,2], Yumei Li[3], Wulin Li [1,2], Shu lian[1,2], Ye Li[4], Changhui Wu[4], Kun Zhang[4], Guiyu Zhou[1,2], Weiyu Wang[1,2,5], Huo Xu[1,2], Mingqing Huang[5], Vladimir Katanaev[1,6], Lee Jia [1,2], Yusheng Lu[1,2]

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Abstract: Regulation of tumor cell death is a fundamental mechanism for tumor treatment. However, most tumors are resistant to cell death. Triggering inflammatory cell death, pyroptosis, may provide a new view of enhancing tumor cell death. Here we report a new role of *Ganoderma lucidum* extract (GLE) in pyroptotic cell death. Treatment with GLE (50–200 μg/mL) significantly elevated reactive oxygen species (ROS) levels and caused pyroptotic cell death in breast cancer cells. Mechanistically, GLE activates caspase 3 and further cleaves the gasdermin E (GSDME) protein to form pores on the cell membrane, releasing massive amounts of inflammatory factors in breast cancer cells. We also showed that GLE enhanced antitumor immune responses by substantially increasing the subsets of natural killer (NK) and CD8+T cells in the peripheral immune system and tumor microenvironment. In addition, GLE destroys multiple steps of tumor metastasis, including adhesion, migration, invasion, colonization, and angiogenesis. Collectively, these results suggest that GLE provides a potential approach for breast cancer treatment, which may complement chemotherapy or immunotherapy for cancer metastasis.

Food and Chemical Toxicology Volume 174, April 2023, 113654 https://doi.org/10.1016/j.fct.2023.113654

Systematic Arrangement Within the Family Clitocybaceae (Tricholomatineae, Agaricales): Phylogenetic and Phylogenomic Evidence, Morphological Data and Muscarine-Producing Innovation

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Abstract: The Clitocybaceae is a recently established family. Currently, the infrafamilial divisions and relationships within the family are vague due to limited sampling and genes employed for phylogenetic analysis. Some mushrooms of the family contain the neurotoxic muscarine, which has caused many severe and even deadly poisonings worldwide. However, the taxonomic distribution and evolution of the toxin within the family is largely unknown. In this study, phylogenetic analyses based on nucleotide sequences of ITS and of six molecular loci (ITS, LSU, TEF1, RPB1, RPB2 and ATP6), plus a phylogenomic analysis based on 485 single-copy orthologous genes, were performed to reconstruct the framework of Clitocybaceae. BEAST analysis was used to estimate the divergence times within the family. Additionally, biochemical analysis for muscarine was conducted of 32 representative species. Based on these analyses, an updated classification of Clitocybaceae into six genera (Clitocybe, Collybia, Dendrocollybia, Lepista, Pseudolyophyllum, and Singerocybe) is proposed. The genus Collybia is emended to accommodate four subgenera (Collybia, Crassicybe,

Leucocalocybe, and Macrosporocybe). Seventeen new Chinese species and 15 new combinations are proposed. Keys to the genera of Clitocybaceae and the subgenera of Collybia, as well as to the known species of Clitocybe and Collybia subgen. Collybia in China, are presented. In addition, muscarine was detected in 18 species, and these muscarine-containing species formed a major monophyletic clade within Collybia subgen. Collybia. Finally, our phylogenetic, phylogenomic, chemotaxonomic and molecular dating results indicate that the Clitocybaceae is a natural group estimated to have arisen some 60 million years ago, and in this family, muscarine has evolved only once circa 20 million years ago without later losses.

Fungal Diversity 123, 1–47 (2023). https://doi.org/10.1007/s13225-023-00527-2

Optimizing Straw-Rotting Cultivation for Sustainable Edible Mushroom Production: Composting Spent Mushroom Substrate with Straw Additions

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[2]*International Joint Research Center for the Creation of New Edible Mushroom Germplasm Resources, Ministry of Science and Technology, Jilin Agricultural University, Changchun 130118, China*

Abstract: In recent years, the optimization of straw-rotting formulations for cultivating edible mushrooms and the management of the resulting spent mushroom substrate have emerged as new challenges. This study aimed to investigate the composting of spent mushroom substrate produced from mushroom cultivation with various straw additions, under conditions where chicken manure was also used. Parameters measured during the composting process included temperature, pH, electrical conductivity (EC), germination index (GI), moisture, and total nitrogen content. Additionally, changes in nutrient content within the compost piles before and after composting were determined, and the variations in bacterial and fungal communities across different treatments before and after composting were analyzed using 16S rRNA and ITS sequencing. The results indicated that the spent mushroom substrate produced by adding 20% straw during mushroom cultivation was more suitable for composting treatment. The findings suggest that incorporating an appropriate amount of straw in mushroom cultivation can facilitate subsequent composting of spent mushroom substrate, providing an effective strategy for both environmental protection and cost reduction.

Keywords: SMS; biological pretreatment; microbial diversity; total humus carbon; composting

Journal of Fungi 2023, 9(9), 925; https://doi.org/10.3390/jof9090925

Bioactivities and Medicinal Value of the Fruiting Body Extracts of *Laetiporus sulphureus* and *Meripilus giganteus* Polypore Mushrooms (Agaricomycetes)

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[2]*Institute for Information Technologies, Department of Science, University of Kragujevac, Kragujevac, Serbia*

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Abstract: In the present investigation methanol and acetone extracts of basidiocarps of mushrooms *Laetiporus sulphureus* and *Meripilus giganteus* were evaluated for their antimicrobial, cytotoxic and antioxidant/prooxidant effects.

The antimicrobial potential was determined by the microdilution method against ten microorganisms. Cytotoxic effects were evaluated by MTT test, while changes of the redox status parameters (superoxide anion radical, nitrites and reduced glutathione) were determined spectrophotometrically on a human colorectal cancer cell line and human health fibroblasts cells. The results were measured 24 and 72 h after the treatment. Tested extracts exhibited moderate antimicrobial activity with MIC values from 0.004 to 20 mg/mL. The maximum antimicrobial activity was found in the methanol extracts of the M. giganteus against Bacillus subtilis, which was better than positive control. The acetone extract of M. giganteus with $IC50^{72h}$ = 13.36 μg/mL showed significant cytotoxic effect with strong cell selectivity (selectivity index = 37.42) against cancer human colorectal cancer cells. The tested extracts, especially M. giganteus acetone extract, induced an increase in oxidative stress parameters in tested cell lines, but significantly heightened it in human colorectal cancer cells. The obtained results suggest that these extracts, especially *M. giganteus* acetone extract, can be proposed as a novel source of nutraceuticals and pharmaceuticals.

Keywords: *Laetiporus sulphureus*, *Meripilus giganteus*, antimicrobials, cytotoxicity, mushrooms extracts, oxidative stress, medicinal mushrooms

International Journal of Medicinal Mushrooms, Volume 26, Issue 1, 2024, pp. 17-26 , DOI: 10.1615/IntJMedMushrooms.2023051297

Primary Exploration of Mushroom Protein Hydrolysis and Cooking Impact on the Protein Amino Acid Profiles of *Agaricus bisporus* and *Lentinula edodes* Mushrooms

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Abstract: Compared to free amino acids, protein amino acids in mushroom have gained little attention. No studies have investigated mushroom protein hydrolysis kinetics; moreover, investigation into cooking impact on protein amino acids is scarce. This study aimed to 1) examine the hydrolysis time-scheme of mushroom protein amino acids in order to investigate the hydrolysis method using a mushroom matrix; and 2) investigate the impact of cooking on protein amino acids within two groups: white and crimini mushrooms with a roasting cooking method and portobello and shiitake mushrooms with sautéing and roasting methods. For Aim 1, mushroom powder was hydrolyzed at 2, 4, 12, 24, 48, 72, and 96 h. The results showed logical hydrolysis progression. For Aim 2, whole mushroom samples were hydrolyzed with the traditional 24 h 6N acid hydrolysis. Protein amino acids in the hydrolysates were then quantified via EZ:Faast derivatization and ensuing GC-MS analysis. Significant cooking method and mushroom type interactions were observed for 66.7–81.8% of the 21–22 amino acids detected, confounding direct comparison of the two cooking methods. All total and most (66.7–100%) individual protein amino acids significantly decreased upon cooking for all samples. Met was the most limiting essential amino acid in all samples, but it was subject to oxidation-induced variance. The second most limiting amino acid, His, did not significantly differ between sautéing and roasting cooking methods. This study adds knowledge regarding mushroom's protein amino acid profile and how cooking methods affect the profile.

International Journal of Gastronomy and Food Science Volume 32, June 2023, 100710 https://doi.org/10.1016/j.ijgfs.2023.100710

International Journal of Medicinal Mushrooms Call for Papers

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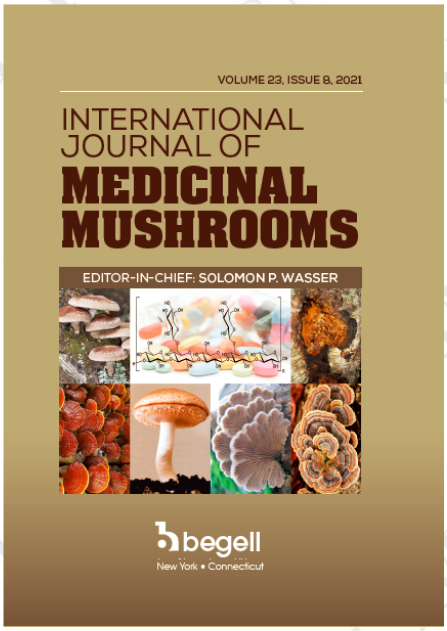

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Points and Reviews

Relationship between Components, Intestinal Microbiota, and Mechanism of Hypoglycemic Effect of the Saggy Ink Cap Medicinal Mushroom (*Coprinus comatus*, Agaricomycetes): A Review

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ABSTRACT: *Coprinus comatus* is rich in a variety of nutrients, which has been reported to display a good hypoglycemic effect. However, there is no consensus on the hypoglycemic mechanism of this mushroom. Intestinal microbiota, a complex and intrinsic system, is closely related to metabolism. In this review, we discussed the potential relationship between certain components of *C. comatus* and intestinal microbiota to illustrate the possible hypoglycemic mechanism of *C. comatus* through intestinal microbiota. It will provide a new perspective for the study of hypoglycemic mechanism of *C. comatus* and promote the development and utilization of this mushroom.

KEY WORDS: *Coprinus comatus*, nutrients, intestinal microbiota, diabetes mellitus, medicinal mushrooms

ABBREVIATIONS: DPPH, 2,2-diphenyl-1-picrylhydrazyl; **FFAR2**, SCFA receptor; **GLP-1**, glucagon like peptide-1; **Nnt**, nicotinamide nucleotide transhydrogenase; **25(OH)D**, 25-(hydroxy)-vitamin D; **PTS-Crp axis**, phosphotransferase system-cAMP receptor protein axis; **SCFAs**, short chain fatty acids

I. INTRODUCTION

The shaggy ink cap medicinal mushroom *Coprinus comatus* (O. F. Mull.: Fr.) Pers. (Agaricaceae, Agaricomycetes) is becoming a research "star" in Basidiomycetes, not only because of its chemical composition, but also for its sanitarian functions. A variety of pharmacological effects of this mushroom are constantly being discovered with the deepening of *C. comatus* research, such as immunomodulatory, oxidation resistance and antibacterial capability etc.[1–5] (Table 1). Among them, one of the functions that have attracted our attention is lowering blood sugar.[4,5] However, the

mechanism of hypoglycemia is not very uniform at present. As we all know, diabetes is a common metabolic disease. Recently, some studies reported that the pathogenesis of diabetes may be related to intestinal microbiota.[6–8] In other words, the varieties and activities of intestinal microbiota may affect the occurrence of diabetes.

Intestinal microbiota, an intricate system existed normal microorganisms in the human gastrointestinal tract, plays a crucial role in human homeostasis. *Bacteroidetes*, *Eubacterium*, *Bifidabacterium*, *Fusobacterium*, and *Peptostreptococcus* are the main species, and among which, over 90% are *Bacteroides* and *Firmicutes*.[9] When the microecological balance between human and intestinal microbiota is broken, some diseases may appear in the body. And some studies about mice and humans all indicated that intestinal microbiota had a casual role in insulin resistance, which was the primary alteration observed in the type 2 diabetes.[9] Therefore, it inspired us that we could look for a food to improve diabetes by regulating the gut microbiota. *C. comatus* is delicious and rich in nutritional value, which contains many components, such as polysaccharides, dietary fiber, amino acids, vitamins and so on.[10] Some of these components may affect the activity of intestinal microbiota. Therefore, this review speculated that the one of the hypoglycemic mechanisms of *C. comatus* might be achieved by affecting intestinal microbiota to promote the commercial development of *C. comatus* and illustrate a new healthy way to ameliorate diabetes.

TABLE 1: Common components, contents, and biological activity of *C. comatus*

Components		Biological activity	Ref.
Polysaccharides	4.11	Immunomodulatory activities, antioxidant,	1,4,5,10
Amino acids	Unclear		
Crude fiber	2.78	Hypoglycemic	10
Vitamin B	2.05		
Vitamin C	3.69		
Phenolic	Unclear	Antioxidant	61,62

II. *C. COMATUS* AND INTESTINAL MICROBIOTA

A. Polysaccharides

Polysaccharides, an active biopolymer, has been extensively studied ascribed to its antioxidant properties, hypoglycemic activities and hypolipidemic functions, etc.[2,4,12] From the perspective of *C. comatus*, the polysaccharides content is 4.11%,[11] which is a potent biomacromolecule attributing to immunomodulatory activities, hypoglycemic effects and antioxidant capacity etc.[1,2,4,5] As so now, the polysaccharides of *C. comatus* were widely prepared by water extraction and alcohol precipitation. Three polysaccharides, CC30, CC60, CC90, can be obtained by changing the concentration of alcohol. Moreover, CC60 was proved to be the most effective fraction for lowering blood glucose.[4] In terms of hypoglycemic mechanism, it was generally accepted that it was related to immune intervention.[4,10] However, since both diabetes and intestinal microbiota were related to metabolism, it was necessary to explore whether *C. comatus* polysaccharides could affect the intestinal microbiota and interfere with the process of diabetes successively. It was illustrated that patients with type 2 diabetes existed mild dysbiosis of intestinal microbiota, such as the decreasing of butyrate (a type of short chain fatty acids)-producing bacteria and increasing of some harmful bacteria.[13] Successively, alternation of gut microbiota could induce inflammation. Admittedly, a myriad of immune cells was presented in the intestine, or their secretions were attached to the intestinal mucosa. Under normal conditions, these immune factors would not damage the symbiotic gut microbiota in the body. Similarly, gastrointestinal microbiota would not stimulate

the immune cells. However, gut homeostasis would be broken when the microbiota was abnormal. Subsequently, the fluctuation of microbiota would increase the permeability of the mucosa, affect the differentiation of immune cells, cause systemic inflammation ultimately.[14] Simultaneously, inflammation would facilitate the resistance of insulin.[15] Inulin is a kind of polysaccharides, which could improve certain symptoms of diabetes. Li et al. elucidated that inulin can improve diabetes at different stages. The abundance of *Deferribacteres* and *Tenericutes* were positively correlated with interleukin-6 and tumor necrosis factor-α, while Cyanobacteria and Bacteroides were correlated with interleukin-6, tumor necrosis factor-α, interleukin-17A or interleukin-10. After 6 weeks of oral inulin, the secretion of these cykotines upregulated or reduced corresponding to the changes of gut microbiota, accompanied with the mitigation of diabetes in db/db mice.[16] The polysaccharides from *C. comatus* has been demonstrated to have an effect of reducing plasma glucose.[4] Moreover, its antibacterial (such as *Escherichia coli*) activities have also been proven by spectrophotometry.[17] However, whether *C. comatus* polysaccharides could ameliorate diabetes by regulating the intestinal microbiota remains to be equivocal. It was evident that the basic units of polysaccharides were monosaccharides. Furthermore, these basic units were connected by glycosidic bonds to form different spatial structures. These analogous preliminary structural characterizations provided the possibility for this hypothetical pathway.

B. Dietary Fiber

Dietary fiber is an essential component in *C. comatus*. Wherein, the contents of dietary fiber vary with different parts, the content of the pileus is 8.80% while the content of the stipe is 7.18%.[18] As of now, the common hyperglycemic mechanisms with respect to dietary fiber were described as follows: a) reducing postprandial glucose, b) facilitating gastrointestinal movement, c) accelerating insulin response, d) producing satiety etc.[19–21] Meanwhile, the effects of short chain fatty acids (SCFAs, mainly composed of acetate, propionate and butyrate etc.) on the progress of diabetes had been researched.[22–25] SCFAs were one of the fermentation products of the intestinal microbiota.[25] In view of this, there were several explanations about the intestinal microbiota could improve diabetes. During fermentation of dietary fiber, gut bacteria released SCFAs, and these productions could affect hepatic insulin sensitivity.[26] SCFAs promote glucagon like peptide-1 (GLP-1) secretion by intestinal L cells through their receptors (FFAR2). Successively, this incretin could promote the homeostasis of insulin and glucagon in the body and ameliorate diabetes.[24] Moreover, SCFAs could play an anti-inflammatory role ascribed to influencing the differentiation of immune cells and the release of inflammatory factors.[25] Therefore, they may improve glucose homeostasis by inhibiting the inflammation pathway. Meanwhile, high dietary fiber diets could reduce Gram-negative bacterial content and body weight synergistically.[27] The abundance of aerobic bacteria was decreased, so that the anaerobic/ aerobic ratio would increase with intake of dietary fiber was increased.[28] Wherein, the genera *Prevotella* and *Xylanibacter* were closely related to SCFAs.[29] Dietary fiber is the main active component of Konjac flour, the results of 16S rRNA showed that the abundance of the intestinal microbiota was improved-both α and β-diversity increased. Among them, the levels from phylum to species had considerable changes, such as Firmicutes, Clostridiales, Enterobacteriaceae, and Lachnospiraceae etc. corresponding to amelioration of inflammation and weight loss etc.[30] Since dietary fiber was not digested in the intestine, sufficient time was guaranteed to interplay with the intestinal microbiota. However, most of the current research was cereal dietary fiber, while fruit fiber and vegetable fiber were rarely involved.[31] Nevertheless, the diabetes could be controlled by the medication, appropriate dietary fiber intervention should still be considered for patients. Undoubtedly, the

mechanism of hypoglycemic about the fungus of *C. comatus* still needs to be further investigated.

C. Amino Acids

C. comatus is enriched in essential amino acids (e.g., leucine, lysine, arginine, valine etc.) and nonessential amino acids (e.g., glutamic acid, tyrosine, glycine, cysteic acid etc.).[10] Current studies provided a potential link between amino acids absorption and glycaemic control.[32–35] As major nutrients, amino acids are not only the basic components of peptides and proteins, but also play a pivotal role in maintaining intestinal homeostasis. Intestinal microorganisms have a strong ability of amino acids metabolism due to their abundant genes related to amino acids metabolism.[36] In this regard, we can speculate that amino acids play the role in controlling glycaemic by regulating gut microbiota. The pertinent literature reported that the number of gut bacteria, which was used to dissimilate amino acids, were less than 1% of the total gut microorganisms in the intestine of normal human,[37] but it has profound implications. Intestinal microorganisms can utilize dietary amino acids as raw materials for microbial protein synthesis to support the growth of bacteria, or they can obtain energy from the catabolism of amino acids.[38] Accumulating studies demonstrated that the species and abundance of gut microbiota varied with amino acids consumption. In turn, the species of gut bacteria also influence the distribution of the amino acids. To address this issue, Abdallah et al. sorted out different species of intestinal microbiota of the main metabolic amino acids in the intestinal tract of humans and animals. For example, *Clostridium bifermentans* and *Peptostreptococcus* spp. could utilize leucine.[39] Meanwhile, Ren et al.[40] found that the ratio of Firmicutes/Bacteroidetes varied with supplementation of arginine. In the small intestine of mice, when 0.5% arginine was provided, the quantities of *Firmicutes* decreased, while the quantities of *Streptococcus*, *Lactobacillus*, and Bacteroidetes increased.[40] *In vitro* experiments on pig small intestine bacteria have shown that histidine, arginine or glutamate was added to the medium, the number of *Escherichia coli* and *Acidaminococcus* fermenting increased.[41] Based on recent researches, we hypothesized that the amino acids in the *C. comatus* are responsible for glycemic control through the following mechanisms: a) one of the fermentation products of amino acids is short chain fatty acids,[37] as mentioned above, it can improve diabetes by increasing insulin sensitivity. b) Branched-chain amino acids (including leucine, phenylalanine, tyrosine etc.)-enriched mixture could increase the number of *Akkermansia* genus to 0.27%, while the proportion of this genus is only 0.01% in control group.[42] Specially, Everard et al. indicated that changes in *Akkermansia* genus could reverse insulin resistance.[43] c) Compared with the germ-free mice group, the expression of nicotinamide nucleotide transhydrogenase (Nnt) was significantly higher in the conventionally raised mice because of the limited availability of glycine. Meanwhile, the expression of Nnt is associated to insulin sensitivity.[44] Accordingly, amino acids are one of the potential candidates for the function of regulating glycemic stability of *C. comatus* attributing to its abundant varieties.

D. Proteins

Protein, an important nutrient, is abundant in *C. comatus*. Pertinent literature has shown that the protein content can reach 24.45% in dried mushroom.[11] Mounting evidence showed that *C. comatus* could improve the diabetes, but the mechanism was not unanimous. Nakatani et al.[45] found that the mung bean protein could reduce the mice weight induced by high-fat dietary. Meanwhile, the plasma glucose level was lower than the control group, but this phenomenon did not occur in the group of germ-free mice. Therefore, it could be speculated that one of the

hypoglycemic mechanisms was achieved by intestinal microbiota. Meanwhile, there is a reciprocal regulatory relationship between proteins and intestinal microbiota. For instance, the concentrations and sources of protein may influence the gut microbiota.[46] And the variation of intestinal microbiota could influence the metabolism of protein.[47,48] For example, it was demonstrated that the different proportion of protein could change the composition of intestinal microbiota by using Illumina Miseq sequencing. Except for unrecognized intestinal microbiota, some bacteria changed significantly when the proportion of crude protein decreased from 16% to10%. There was a positive correlation between the abundance of bacteria and the proportion of crude protein, such as *Firmicutes*, *Actinobacteria* and Colostridiaceae_1, etc. However, the *Proteobacteria* and Enterobacteriaceae increased with the proportion of crude protein decreased. Meanwhile, the concentration of intestinal SCFAs would also change accordingly. For example, when the crude protein decreased from 16% to 10%, the acetate and valerate also declined. This may have an impact on the health of the host.[49] However, different types of protein have different effects. Take the proteins of different duck products as an example, when the rats are fed wine-cured duck protein for 30 days, the species of bacteria such as *Allobaculum* and *Lactobacillus* will increase, but if it were water-boiled salted duck protein, the diversity of intestinal microbiota would decline.[50] However the proteins from Tartary buckwheat could ameliorate the dysbiosis of intestinal microbiota attributing to inhibition the *Bacaeroides* and improvement the *Lactobacillus* and *Bifidabacterium*, etc.[51] Some researchers have also found that differences of age can cause the same protein to have different effects on gut microbiota. Two groups of rats, young and middle-aged, were given 17.7% chicken protein for two weeks. The results showed that some bacteria showed opposite trends in the two groups. For example, the number of Firmicutes decreased in the middle-aged rat's group, while increased in the young rats group. Simultaneously, the trend of Bacteroidetes was just opposite to that of Firmicutes.[52] Specially, the ratio of the Firmicutes to the *Bacteroidetes* could be associated with obesity.[53] This inspired that it is possible to choose the appropriate proportion of protein according to age to change the proportion of certain intestinal microbiota, to prevent obesity and reduce the risk of diabetes. The problems are that the pathogenesis of diabetes is often not single, and the effect of protein on intestinal microbiota is also multifaceted. *C. comatus* has great distinctive research prospects ascribed to the feasibility of intestinal microbiota regulating by proteins.

E. Vitamins

Although the demand for vitamins is very small, vitamins play a pivotal role in the regulation of body health. Moreover, certain vitamins can not be synthesized by the human body, which can only be ingested through food. It has been reported that *C. comatus* contains vitamins, such as vitamin B1, vitamin B2, vitamin C, etc.[11] Taking the highest content of vitamin C (3.69%) as an example,[11] studies have shown that vitamin C has a good effect on blood glucose control. It is well known that the content of vitamin C in kiwifruit is high. To determine the effect of vitamin C, the researchers asked the participants to eat two SunGold kiwifruit a day for 12 weeks, then measured some indicators and used 16 sRNA to determine fecal microbiota. The results showed that the content of vitamin C in blood was significantly increased and the control ability of blood glucose was improved, but the changes of glycated hemoglobin and fasting glucose were not significant in clinic. At the same time, vitamin C content was negatively correlated with insulin resistance.[54] This was consistent with the discovery that metformin and vitamin C are more effective in reducing glycated hemoglobin and diabetic complications.[55] The results of molecular analysis showed that the variation of α diversity was not significant in this study, but the number of Coriobacteriaceae, which was belong to the bacterial phylum *Actinobacteria*, increased

significantly.[54] In the *in vitro* experiment, the *Bacteroides* spp., *Parabacteroides* spp. and *Bifidabacterium* spp. increased with the kiwifruit cultures.[56] Unfortunately, the paper did not explore that the relationship between the fluctuation of the microorganisms and diabetes. At present, there are many studies on the relationship between vitamin D mediated by intestinal microbiota and obesity or metabolic balance. For example, Firmicutes increased while Verrucomicrobia and Bacteroidetes decreased statistically significant in healthy and untreated mice which were feed by vitamin D deficient diet.[57] We can establish the connection of vitamin D-intestinal microbiota-diabetes. There is a viewpoint that inflammation is one of the mechanisms that trigger diabetes at present.[15] Simultaneously, the changes in intestinal microbiota can cause inflammation. Lipopolysaccharide is a component of the outer layer of Gram-negative bacteria, which can promote the occurrence of inflammation, and then inflammation will lead to the occurrence of type 2 diabetes mellitus.[58] In mice, the deficiency of vitamin D led to a decrease in the abundance of *Bacteroides* and *Prevotella* and an increase in serum lipopolysaccharide concentration, which increased the risk of diabetes accompanied.[59] This result is consistent with the decrease of lipopolysaccharide caused by the increase of 25-(hydroxy)-vitamin D (25(OH)D) content. Another explanation for the mechanism is that vitamin D deficiency can lead to an increase in inflammatory cytokines. In this experimental model, the C-reactive protein and E-selectin (inflammatory markers) were contrary to the dosage of vitamin D. When the vitamin D intake in the experiment was the largest, *Prevotella* tended to become the dominant microbiota.[60] Therefore, the types and contents of vitamins in *C. comatus* and the mechanism of vitamins modulating plasma glucose are promising research directions.

F. Phenolic Compounds

Phenols are one of the active constituents in the *C. comatus*, which are found in fruiting body and fermentations.[61] In terms of the fruiting body, the total phenols in extracts from cap were more than the extracts from stipe.[62] Admittedly, phenolic compounds from *C. comatus* were regarded as the active components possessing antioxidant properties.[61,62] After oral administration entry into the gastrointestinal tract, the bioavailability of phenolic compounds is very low, therefore most of the phenolic compounds will remain in the gastrointestinal tract in direct contact with intestinal microbiota.[63] Additionally, there might be a potential implication between intestinal microbiota and antioxidant capability. For example, *Bifidabacterium* facilitated the capability of antioxidant (indicated by hydroxyl radical and 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging ability etc.).[64] Moreover, the increase of probiotics such as *Lactobacillus* and *Lactococcus* etc. were related to the improvement of antioxidant capacity has been reported already.[65] As we all know, it was important for diabetes to inhibit of oxidative stress.[66] In view of this, we can hypothesize that phenolic compounds from *C. comatus* carry out its antioxidant capacity by modulating intestinal microbiota, mitigate diabetes ultimately. *Dendrobium* polyphenols, an active component which is extracted from *D. loddigesii*, has the effect on diabetes. And the literature demonstrated that the mechanism of hypoglycemic was achieved by affecting intestinal microbiota and then regulating inflammatory factors (such as interleukin-6 and tumor necrosis factor-α etc.). Compared with the control group, when *Dendrobium* polyphenols were administered at 50 or 100 mg/kg for 7 weeks in diabetic mice, insulin levels were significantly increased, and the expression of inflammatory factors was significantly decreased in the 100 mg/kg group. Meanwhile, operational taxonomic units in the metformin treatment diabetes db/db mice group with a dose of 130 mg/kg were like that in the *Dendrobium* polyphenols group with a dose of 100 mg/kg. Moreover, *Dendrobium* polyphenols reversed the ratio between *Bacteroidetes* and *Firmicutes* in diabetes. The change of beneficial bacteria-*Akkermansia muciniphila*-was similar between metformin treatment group at adose of 130

mg/kg and *Dendrobium* polyphenols group at a dose of 100 mg/kg.[67] However, no obvious mechanisms of phenolic compounds from *C. comatus* for hypoglycemic effect have been reported.

III. CONCLUSIONS

With the deepening of research and the progress of science and technology, the role of intestinal microbiota has attracted more and more attention. It's even been described as the "human organ" in the gut. Moreover, it can be used as an early warning sign of some metabolic diseases. In other words, if the gastrointestinal microbiota was disrupted, your body would change accordingly. For instance, based on the available means of observation, the abundance of *Akkermansia muciniphila* would influence metabolic equilibrium of human. Compared to the heat-killed *A. muciniphila* group, the normal group demonstrated that the plasma glucose level decreased significantly.[43] As we all know, the metformin is a universal drug for type 2 diabetes mellitus. Its therapeutic effects are partly associated with gut microbiota, especially *Escherichia*. Recently, it has been identified as a potential life-extending drug. Bacterial phosphotransferase system-cAMP receptor protein axis (PTS-Crp axis) can control the effects of metformin on host. Meanwhile, the Crp strongly influences the metabolic response of *Escherichia coli* to metformin. For instance, overexpressing Crp in *E. coli* increased the *Drosophila* lifespan. The paper also reported that agmatine which was mainly produced by the bacteria from the genera *Escherichia*, *Bacteroides*, *Enterobacter*, and *Citrobacter*, could increase the lifespan of type 2 diabetes patients with metformin treated. Moreover, this regulatory effect could also be affected by nutrients.[68] According to the literature, the relationship between intestinal microbiota and diabetes through diets can be established. *C. comatus* is a kind of healthy and delicious Basidiomycetes, which contains a variety of nutrients. In this review, we elucidated the possible relationship between certain components of the *C. comatus* and intestinal microbiota. Among them, the relevant possible mechanisms are shown in Fig. 1. *C. comatus* has been proved to have a good hypoglycemic effect, but the mechanism of hypoglycemic is not uniform at present. We could look for the relationship between *C. comatus*, intestinal microbiota and diabetes mellitus according to the functions of intestinal microbiota with signing metabolic balance. However, due to the large and complex gastrointestinal microbiota, diets often have multiple impacts on a variety of bacteria. Therefore, the ultimate impact on the body may be a superimposed effect. We should establish a systematic and complete system, carry out rigorous *in vitro* and *in vivo* experiments to verify the universality of this hypothesis, to expand the scope of application of *C. comatus* and verify its hypoglycemia mechanism.

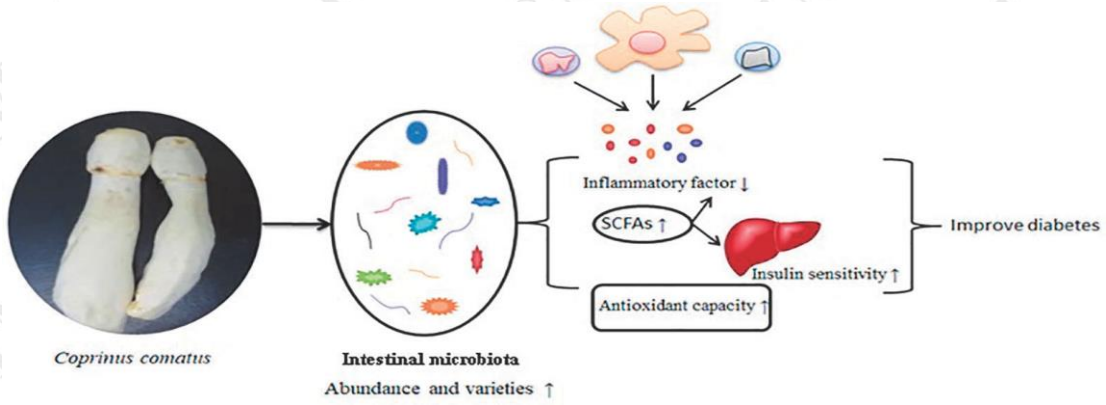

FIG. 1: Schematic of a potential hypoglycemic mechanism of *C. comatus*. Up arrows represent an increase in number or capability, and down arrows represent a decrease in quantity. Small circles with different colors represent inflammatory factors.

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Aiming to build the relationship between the members and the Society, the publication of the newsletters was proposed before the launching of the Society. The newsletters represent one of the key official publications from the Society. Contents of the newsletters will include notifications of the decisions made by the committee board, reviews or comments contributed by ISMM committee members, conferences or activities to be organized, and the status updated in research, industrialization, and marketing for medicinal mushrooms. The newsletters will be released quarterly, by the first Monday of every January, April, July, and October, with possible supplementary issues as well. The Newsletter is open to organizations or professionals to submit news, comments, or scientific papers relating to medicinal mushroom research, marketing, or industry.

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