Mushroom Biology and Mushroom Products

Proceedings of the 2nd International Conference

June 9–12, 1996 **University Park, Pennsylvania**

Edited by Daniel J. Royse

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WSMBMP

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Preface

The 2nd International Conference on Mushroom Biology and Mushroom Products offers an opportunity to share the latest developments in mushroom production technology, post harvest processing and handling, and non-food products. There is a growing consumer demand for mushrooms and their products world-wide; this increased demand substantially exceeds the rate of increase in the human population.

Sponsors
This Conference is made possible by the generous contributions of many sponsors who supported the efforts of faculty and staff at the Pennsylvania State University to make it a reality. We are especially thankful for the financial support from Giorgio Foods (USA), Franklin Mushroom Farms (USA), J-M Farms (USA), Campbell's Fresh (USA), Sylvan Spawn (USA), Unicorn (USA), Phillips Mushroom Farms (USA), Monterey Mushrooms (USA), Oakshire Mushroom Farms (USA), M.R.D. Corporation (USA), Abbott Laboratories (USA), Ostrom Farms (USA) and the International Society for Mushroom Science (ISMS). We appreciate the sponsors' generosity and encouragement for this Conference.

Secretariat
We thank the Agricultural Short Course Office, College of Agricultural Sciences, for serving as the Secretariat for this Conference. A special thanks goes to Rita Smith of the Department of Plant Pathology for sending faxes, retyping manuscripts and sending correspondence to authors.

Editorial
This volume contains the papers submitted and presented as oral presentations and posters. The papers were submitted via hard copy and/or electronically via E-mail or on 3.5" computer disks. Editing and retyping was necessary for some of the papers. Finally, we are indebted to the many contributors who so generously shared their research findings for the *Proceedings.*

Daniel J. Royse
Professor and Conference Chair

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Seventy Years of Mushroom Research at Penn State

Penn State research on cultivated mushrooms and problems related to their culture was begun in 1925. In 1928, the first mushroom research facility was built on campus and expanded in 1934 with moneys given by the Mushrooms Growers Cooperative Association of Kennett Square, Pennsylvania. The present Mushroom Research Center (MRC) was constructed in 1960 with a combination of State and Federal moneys and equipped with funds from private industry from across the U.S. and Canada. An addition, funded by the General State Authority in 1973, was integrated into the existing MRC facility providing more efficient and increased research capacity. The main building (6550 ft^2) contains a spawning-casing area, two Phase II rooms, two spawn growing rooms, 11 varying-sized production rooms, and an office-laboratory for analytical/clinical procedures. There is also a composting shed (646 ft^2) and a storage building of 1600 ft^2.

In 1969, the Mushroom Test Demonstration Facility (MTDF) was constructed constituting a systems approach to mushroom growing. The MTDF was established as an interdisciplinary research project involving four departments in the College of Agricultural Sciences: Plant Pathology, Agricultural Economics and Rural Sociology, Entomology, and Agricultural and Biological Engineering. The department of Food Science was added to the project in the early 1970's. Some of the unique features of the MTDF when it was first established included: pressurized zones or areas that provide for crop protection, specially designed cooling sources and insulating capacities to permit supplementation at casing, refined program control for phase II composting, and controlled ventilation in production rooms based on monitored gas analysis. Nearly all of these unique features have been adopted by the industry and now are in commercial use.

The MRC and MTDF are staffed by a manager, two biological technicians and part time assistants. Four faculty from the Department of Plant Pathology and at least one faculty member each from the Departments of Food Science, Entomology, and Agricultural and Biological Engineering and their respective graduate students conduct

research at these two facilities. Faculty also conduct basic and applied research at laboratories housed in Buckhout Laboratory (Plant Pathology), Borland Laboratory (Food Science), Agricultural Science Industries Building (Entomology), and Agricultural Engineering Building (Agricultural and Biological Engineering).

Penn State's diversified Extension education program utilizing demonstrations, seminars, farm walks, an annual mushroom industry short course that has averaged over 250 participants from 20 to 25 states and several foreign countries each of the past 36 years, and an annual specialty mushroom workshop has been successful in transferring research technology to commercial adoption in the past and is available, capable, and interested in continuing this role in the future.

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Foreword

The First International Conference on Mushroom Biology and Mushroom Products was held at the Chinese University of Hong Kong in August, 1993, for the purpose of bringing together scientists who had an interest in Mushroom Biology from the standpoint of any subdivision of biology and persons who had practical economic concerns with mushrooms and mushroom products. The Conference was very successful, and the published Proceedings, entitled "Mushroom Biology and Mushroom Products", has proven to be extremely useful.

At the Hong Kong Conference, a broader definition of the term mushroom was used, in that the mushroom was considered to be a macrofungus with a distinctive fruiting body that is large enough to be seen with the naked eye and to be picked up by hand. There are no limitations as to class, edibility, texture, or location of the fruiting body. As accepted by the World Society for Mushroom Biology and Mushroom Products, the mushroom need not be a Basidiomycete; it may reach maturity above ground or below ground; it may be edible, poisonous or otherwise; and it may have a texture that is fleshy or non-fleshy. With this broader definition of mushroom, it has been possible to bring together **mushroom science** (which deals with mushroom production and encompasses composting technology and environmental engineering, as well as mushroom biology) with **mushroom biotechnology** (which is concerned with mushroom products and encompasses fermentation technology, bioprocessing, marketing and management, as well as mushroom biology).

Now, three years after the 1993 Conference, we see that some of the trends that were observed at that time have continued. Mushroom production has increased in a large number of countries. In some cases this has been the result of the activities of a great many growers on relatively small farms. The huge production of *Pleurotus* in China is a direct example of this. In another case, the rise in production has involved the application of advanced mechanized growing techniques, as in the burgeoning production of *Agaricus* and *Volvariella* in Indonesia. In Fujian Province of China, specialized growing and marketing techniques have

been developed for growing *Lentinula*. Bag culture techniques for shiitake which utilize a variety of locally available substrate materials and a centrally located permanent market to which individual growers bring their mushrooms were observed at firsthand by the many mushroom specialists who attended the International Symposium on the Production and Products of *Lentinus* Mushroom held in Qingyuan, China, November, 1994. In the last two years specialized conferences have also been held on the medicinal mushroom *Ganoderma* in Korea and China.

It is evident that new techniques have evolved in mushroom science, that more edible mushrooms species are cultivated in increasing amounts, and that the interest in mushroom products for medicinal purposes is rapidly expanding. To make known and to share the information about the present status of Mushroom Biology and Mushroom Products and to explore opportunities for future research and international cooperation is the purpose of this Second International Conference on Mushroom Biology and Mushroom Products.

By having the venue of the Conference at Pennsylvania State University, the participants have been provided with the opportunity to visit one of the outstanding mushroom research centers in the world and the State of Pennsylvania which produces more mushrooms than any other state in America. The outstanding exchange of information at this Conference is due to the participants from more than twenty countries who are presenting papers in ten scientific sessions. The breadth of the subject material and the quality of the papers published in these Proceedings will indeed be a challenge for the organizers of the Third International Conference on Mushroom Biology and Mushroom Products.

June 1996

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