

Mushroom Research at the Eastern Regional Research Center

by K.B. Hicks, Research Leader, J.M. Wells, Lead Scientist, G.M. Sapers, Research Food Technologist, and J.P. Cherry, Director, Eastern Regional Research Center, ARS, USDA, Philadelphia, PA

Introduction

The Eastern Regional Research Center, located in Wyndmoor, Pennsylvania is a multidisciplinary research center operated by the Agricultural Research Service, U.S. Department of Agriculture. Applied or fundamental research is conducted at the Center to solve high-priority problems relevant to U.S. agriculture. A staff of approximately 90 Senior Scientists, 30 Post-Doctoral fellows, and 100 support scientists conduct research in nine Research Units, each of which has a commodity or disciplinary focus. In recent years, both preharvest and postharvest research on mushrooms has been performed in the Plant Science Research Unit. A general overview of this program, the major accomplishments, current opportunities for technology transfer, and potential areas for future research is presented below.

Preharvest Research

Major Accomplishments. Preharvest mushroom research was initiated in 1986 to understand more fully the regulation of fruiting body formation. We developed a system for producing mushrooms under simulated commercial conditions which permitted experimentation with various soil conditions that affected the

timing and extent of fruiting body formation. Consequently, our research confirmed the observations of previous researchers that sterile cultures of *Agaricus* did not fruit, but did form fruiting bodies or their primordia when bacteria (Park and Agnihotri, 1969) or charcoal (Long and Jacobs, 1974; Wood, 1976) were added to the cultures. Sterilization of only the casing layer also prevented fruiting body formation. Adding bacteria (dead or alive) or charcoal to the sterile soil caused a flush of mushroom production. In preliminary tests, a charcoal amendment also stimulated fruiting in older, non-productive cultures (Wells and Reveal, 1988).

Since 1988, progress has been made in identifying the soil bacteria and expanding the list of adsorbents that stimulate mushroom production. Of the 26 species of bacteria studied, the most active were spore-forming Bacilli, fluorescent Pseudomonads, as one as of yet unidentified Gram-negative and rod-shaped facultative anaerobe. The precise identification of the bacteria is nearing completion. Certain clays and diatomaceous earths stimulated fruiting body formation, however, they were not as effective as charcoal.

Technology Transfer. Once published and/or patented, the techniques developed will be available for transfer to the private sector. If an industrial R & D partner is identified, studies will be conducted to measure the effects of a custom blended charcoal-bacteria mixture on normal commercial production, on unproductive or poorly producing beds, and directly on spawn as a quick test of viability. These studies may lead to significant improvements in commercial mushroom production.



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Future Studies. With the completion of the research described above, preharvest research at ERRC will be suspended in favor of postharvest research (see below). However, much remains to be done in the preharvest area. Of real interest is the secret of what controls fruiting body production. The hypothesis of D.A. Wood appears to be viable—that vegetative mycelia produce an inhibitor under normal culture conditions. When concentrations of the inhibitor are reduced, either by natural events or by adsorbents, the culture shifts to reproductive growth. A goal for future research efforts should be to isolate and identify this inhibitor.

Postharvest Research

Major Accomplishments. Postharvest mushroom research at ERRC is relatively new and was initiated to extend several breakthroughs in parallel areas of research. The control of enzymatic browning represents a difficult problem for the mushroom industry, as well as the entire fresh fruit and vegetable industry, especially since the recently implemented restrictions in the use of sulfites to prevent discoloration. Scientists in the Plant Science Research Unit have been working on new approaches to inhibit browning in fruits and vegetables based on the applications of compounds closely related to vitamin C. One of the most promising compounds, the salt form of ascorbic acid-2-phosphate, has been shown to be an extremely effective inhibitor of browning in cut apples. This derivative reacts with the natural enzymes in plant tissue to slowly release vitamin C, a recognized browning inhibitor. Because of the timed-release effect, the derivative is substantially more effective than vitamin C alone. The new technology has been described in a recently issued U.S. Patent (Sapers et al., 1989c) and in several other publications (Sapers and Hicks, 1989; Sapers et al., 1989a; Sapers et al., 1989b).

Technology Transfer. ARS offers opportunities to private industry to purchase exclusive and non-exclusive licenses to patented technology. Currently, at least one major West Coast mushroom processor is negotiating with ARS for exclusive licensing. Possibilities exist for Cooperative R & D Agreements with private industry to further develop this technology.

Future Research. The investigators have conducted preliminary studies of browning inhibition in mushrooms, focusing on factors affecting the enzymatic reactions that determine treatment effectiveness. The goal is to develop highly effective treatments to control browning in whole and sliced mushroom. However, because of the extreme complexity of the browning-related enzymes in mushrooms (Flurkey and Ingebrigtsen, 1989), this is not expected to be a simple task. A major objective of any company interested in acquiring the ARS technology will be to obtain approval for the use of ascorbate-2-phosphate in foods. Currently the derivative is approved for use in animal feeds but not in human foodstuffs. Because of this issue, Plant Science researchers are investigating

several carbohydrate-based, food-approved compounds that have been effective in preliminary studies in fruits and vegetables. The application of these compounds to mushrooms and various other sliced fruits and vegetables will be pursued. MN



Stimulation of fruiting body formation by addition of bacteria. Flask at left (non-fruiting) is an 8-week old culture of *Agaricus* grown under sterile conditions. Flask at right (fruiting) is identical, except it was inoculated with a pure culture of a soil bacterium.

Contacts

Dr. Kevin B. Hicks, Research Leader, Plant Science Research Unit, 215-233-6579

Dr. John M. Wells, Lead Scientist, (preharvest research on mushroom fruit body formation) 215-233-6429

Dr. Gerald M. Sapers, Research Food Technologist (postharvest research on preventing enzymatic browning in mushrooms) 215-233-6417

Dr. John P. Cherry, Director, Eastern Regional Research Center, ARS/NAA/USDA, 600 E. Mermaid Lane, Philadelphia, PA 19118, 215-233-6595

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