MICOLOGIA APLICADA INTERNATIONAL, 19(2), 2007, pp. 33-34

www.micaplint.com

Editorial

MUSHROOM CULTIVATION USING THE "ZERI" PRINCIPLE: POTENTIAL FOR APPLICATION IN BRAZIL

S. T. CHANG

Emeritus Professor of Biology, Department of Biology, and Director of the Centre for International Services to Mushroom Biotechnology, The Chinese University of Hong Kong, Shatin, N. T., Hong Kong. Home Address: 3 Britton Place, McKellar, A.C.T. 2617, Australia. E-mail: scha6507@bigpond.net.au

Presented in Brasilia, Brazil, December 6, 2002, at the First International Symposium on Mushrooms in Food, Health, Technology and the Environment in Brazil

Introduction. The ZERI (Zero Emission Research and Initiatives) message, "The earth cannot produce more: Man has to do more with what the earth produces," is important to us all. Sustainable utilization of the lignocellulosic wastes found within Brazil for improvement of the quality of life, reduction of waste emissions, and value-added products should be the key elements of ZERI. It is common knowledge that lignocellulosic wastes are available in abundance in both the rural and urban areas, and are usually by-products from agriculture, forestry, and households. One of the most economically viable processes for the bioconversion of lignocellulosic wastes is the cultivation of edible mushrooms. Mushrooms provide a highly nutritious source of food and, more recently, attention has focused on a second area of exploitation following the discovery that, many of these mushrooms produce a range of metabolites of intense interest to the nutriceutical and pharmaceutical (*e.g.* anti-tumor, immunomodulation agents and hypocholesterolaemic agents) and food (*e.g.* flavour compounds) industries. It has been reported that almost all the main taxonomic families of higher fungi, and their mushroom species most, if not all, contain biologically active polysaccharides. The data demonstrated there are 660 species from 182 genera of mushrooms containing antitumor or immunostimulating polysaccharides. Fruiting bodies, submerged cultivated mycelial biomass and liquid cultivated broth are sources of the bioactive compounds.

Potential in Brazil

A. The ZERI concept. ZERI proposed a simple concept "Zero Emissions or Total Productivity". The drive towards the full use of all materials ultimately leads all material productivity. Under this condition, theoretically, there is nothing left as waste, and no adverse impact can be expected on society or the environment from unused resources. In other words, the by-products in processing the core product should be used/treated as raw materials for the production of secondary or tertiary core products, such as cereal straw, coffee pulp, coffee spent ground, coffee sawdust, bagasse and wood sawdust and chips which can be used to grow different mushrooms. After harvesting mushrooms, the spent compost can be used as feeding materials for animals or for growing earthworms. Afterward, the residues can be used as crop fertilizers. In the whole exercise, there is no waste produced. This approach is a cluster thought which should be applied to agriculture-based industry in the 21st century.

B. Review of some lignocellulosic resources of relevance to mushroom cultivation in Brazil. According to FAO, the production of cereal straws in 1999 in Brazil reached 96.3 million tons. In addition, 276.6 million tons of sugar cane bagasse , 1.5 million tons of coffee wastes, and 254 thousand tons of cotton seed hulls were produced. Certainly, a big quantity of wood sawdust chips was also produced from the wood industry. At present, an experienced mushroom grower can obtain an average biological efficiency (BE) of 60-75%. To achieve a 100% BE can be a reasonable goal for the mushroom industry. If the country can utilize one third of its lignocellulosic resources, Brazil could produce millions of tons of mushrooms for the local people and also for export.

C. Potential for application of ZERI principle in Brazil. The ZERI principle is fundamentally a productivity programme. The concept is sound, the methodology is logic. The key question is how to implement the concept. Cultivation of mushrooms using lignocellulosic wastes is an excellent case study for application of ZERI principle. When farmers realize that the residual products from their crops can be used for growing edible and medicinal mushrooms, and when the earthworms cultivated in the spent substrate produce enzymes, then the farmer is creating a platform for a cottage biotechnology industry with potential entry into the health food and mushroom nutriceutical markets, which are characterized by high growth potential. Therefore, the development strategies could be simplified as: (1)

Not highly mechanized technology on large farms as in developed countries, but cottage style enterprises in thousands of small mushroom sheds constructed of local available materials, (2) Appropriate strains of different mushrooms grown on seasonal basis, (3) Utilization of all existing organic residues and wastes from farms, forests and agro-industries, (4) Creating employment opportunities, particularly for women in rural areas and controlling pollution, (5) Short return-mushrooms, relatively fast growing organisms, can be harvested in 3 to 4 weeks after spawning - immediate benefits to a nation, and (6) Mushrooms and their products could enhance human´s immune systems and improve their quality of life.

Brazil produces 96.3 million tons of cereal straws and 278.4 million tons of other lignocellulosic materials excluded the wood by-products and natural grass resources. Annual production of mushrooms in Brazil has been estimated in 7,000 tonnes, accounting for less than 0.01% of the total world production of cultivated mushrooms. If the country could use its one third of those materials, *i.e.* 96.3+278.4/3= 125.6 million tons, the country could produce around 84 million tons of fresh mushrooms, based on an average of 67.5% BE. This can easily give us an idea of how many new jobs, and how much income could be generated by mushroom cultivation annually in Brazil. Therefore, I consider that this approach will address the human health challenge, the poverty challenge, and the environment challenge. This is in view of the fact that the world market for mushrooms and their nutriceutical products is very lucrative.

Problems in tropical regions. In practical application, cultivation of *Agaricus* mushrooms in developed countries has become a high technology industry and in fundamental research, it has become a branch of science, which is derived from the disciplines of microbiology, fermentation and environmental engineering. In the last two decades, millions of dollars have been spent in western countries to develop the industry. The mushroom farms are usually furnished with well-advanced equipment. The support from industry and governments for *Agaricus* mushroom research is equally impressive in some developed countries, such as in U.S.A., U.K. and The Netherlands.

By contrast, cultivation of mushrooms, particularly tropical mushrooms, in tropical/subtropical countries, is still primitive. There are several reasons/problems, which may be related to the slow development of mushroom cultivation in tropical regions, such as: (a) High prices of mushrooms in comparison with most common vegetables; (b) The lack of government and industrial support for research; (c) The lack of interest on the part of academic scientists in the fundamental biological studies of edible mushrooms; (d) The shortage of technical expertise; (e) The lack of regional conferences and cooperation; (f) The lack of constant marketing; and (g) In practice, the yield of mushrooms produced in these regions is still generally low and unpredictable due to the hot and humid climate.

Prospects

(a) Mushrooms can convert waste materials into human food. The tropical regions have a wet and warm climate and have an abundant supply of agricultural wastes. (b) Mushrooms are relatively fast growing organisms. Some tropical mushrooms can be harvested and consumed within 10 days after spawning. (c) Mushroom cultivation is labour intensive, however, this may not be a problem in tropical regions. (d) While land availability is usually a limiting factor in most types of primary production, mushroom culture requires little space because they can be stacked using the tray culture. (e) Mushrooms have been accepted as human food from time immemorial and can immediatly supply additional protein to human food. Other sophisticated and unconventional sources of food protein, such as yeast, algal cultures and single-cell proteins have relatively more complicated requirements and need to be processed before they can be consumed. (f) Mushrooms should be treated as vegetables. After improving the culture techniques, they should be cultivated as widely and cheaply as other common vegetables. (g) In view of their pleasing flavour, adequate protein and health value, mushrooms no doubt represent one of the world´s greatest untapped resources of nutritious and palatable food, as well as medicinal effective nutriceuticals/dietary supplements for human welfare in the future.

Continuous production of successful and stable crops requires both practical experience and scientific knowledge. It is the time that humankind should make every endeavour to maximize the use of their existing resources as the ZERI message stated, "The earth cannot produce more: Man has to do more with what the earth produces." Therefore, we should make a concerted effort in research and development on mushroom cultivation in order to use lignocellulosic resources more effectively and efficiently. It is equally important to promote the concept that mushrooms are not a luxury food but a national necessity. In spite of the many problems existing in the cultivation of mushrooms in tropical regions, I foresee a new possibility of using mushrooms in a more important role as a source of protein to enrich human diets in these regions where the shortage of protein is more marked than in temperate regions. I also see no reason why both rural and urban areas cannot share in this new possibility and prospect. But we should face continuing challenge to introduce new technology to maximize mushroom production per unit area with minimum costs in order to provide a cheap source of food protein, as well as an affordable price of nutriceuticals/dietary supplements from already available biomass waste materials for the people in tropical regions.