



**The 7<sup>th</sup> International Medicinal Mushroom Conference**

**第七届国际药用菌大会**

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**The Brazilian Medicinal Mushroom *Agaricus brasiliensis*:  
Science and Industrial Development Perspectives**

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- ***Agaricus brasiliensis* is the most promising cultivated mushroom in Brazil.**
- **The mushroom has reached the uppermost ranks among the best of all gourmet and medicinal mushrooms (Largeteau et al., 2011).**
- **It is an interesting alternative to developing countries due to its versatility being useful in the food, medicinal, and cosmetic sectors (Mendonça et al., 2005).**

LARGETEAU M, LLARENA-HERNÁNDEZ R, REGNAULT-ROGER C, SAVOIE J-M. 2011. The medicinal *Agaricus* mushroom cultivated in Brazil: biology, cultivation and non-medicinal valorisation. *Applied Microbiology and Biotechnology*, 92(5): 897-907.

MENDONÇA M de, KASUYA MC, CADORIN A., VIEIRA AJ. 2005. *Agaricus blazei* cultivation for a living in Brazil. In: *MushWorld. Mushroom grower's handbook 2, part 2*, p. 246-257.



## VERNACULAR NAMES

- In Brazil, the mushroom is known under many vernacular names such as:
  - **Piedade mushroom** (in allusion to the village where it was first found in the country and sent to Japan for its medicinal properties study),
  - **Medicinal Mushroom**,
  - **Sun Mushroom** (Cogumelo do Sol<sup>®</sup>),
  - the **Almond Portobello** (due to its fragrance and taste) and
  - **Champignon do Brasil** (proposed by Amazonas & Siqueira, 2003, in allusion to its congener *Agaricus bisporus*, the Champignon de Paris).
- In Japan, it is called **Himematsutake**, **Agarikusutake** and **Kawariharatake**.
- in China, **Ji Song Rong**
- In other countries, also as **Royal Sun Agaricus<sup>®</sup>**.



## NOMENCLATURE CORRECTION AND CONTROVERSY

- The mushroom has been incorrectly referred to as *Agaricus blazei* Murrill, a species originally described from Florida.
- The improper use of this species name is due to misidentification by the Belgium botanist Paul Heinemann who studied the fungus sent from the small village Piedade, located in the Brazilian State of São Paulo, to Japan in 1965. Heinemann only communicated his identification to the scientific community in a paper published in 1993.
- The fungus was found again in nature in Brazil in 2001 and, in a detailed comparative morphological study, Solomom Wasser and coll. demonstrated that the North American endemic species *A. blazei* ss. Murrill and the widely cultivated medicinal *A. blazei* ss. Heinem. are two different species.

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HEINEMANN, P. *Agarici* Austroamerici VIII. *Agariceae* des regions intertropicales d'Amérique du Sud. Bull. Jard. Bot. Nat. Belg., v.62, p.355-384, 1993.

WASSER SP, DIDUKH MY, AMAZONAS MAL de A, NEVO E, STAMETS, P, EIRA, AF.. Is a widely cultivated culinary-medicinal Royal Sun Agaricus (the Himema tsutake Mushroom) indeed *Agaricus blazei* Murrill? Int. J. Med. Mush., 4:267-290, 2002.



- **A new species, *Agaricus brasiliensis* Wasser, Didukh, Amazonas & Stamets, was then proposed (Wasser et al., 2002)**

*International Journal of Medicinal Mushrooms*, Vol. 4, pp. 267–290 (2002)

## Is a Widely Cultivated Culinary-Medicinal Royal Sun Agaricus (the Himematsutake Mushroom) Indeed *Agaricus blazei* Murrill?

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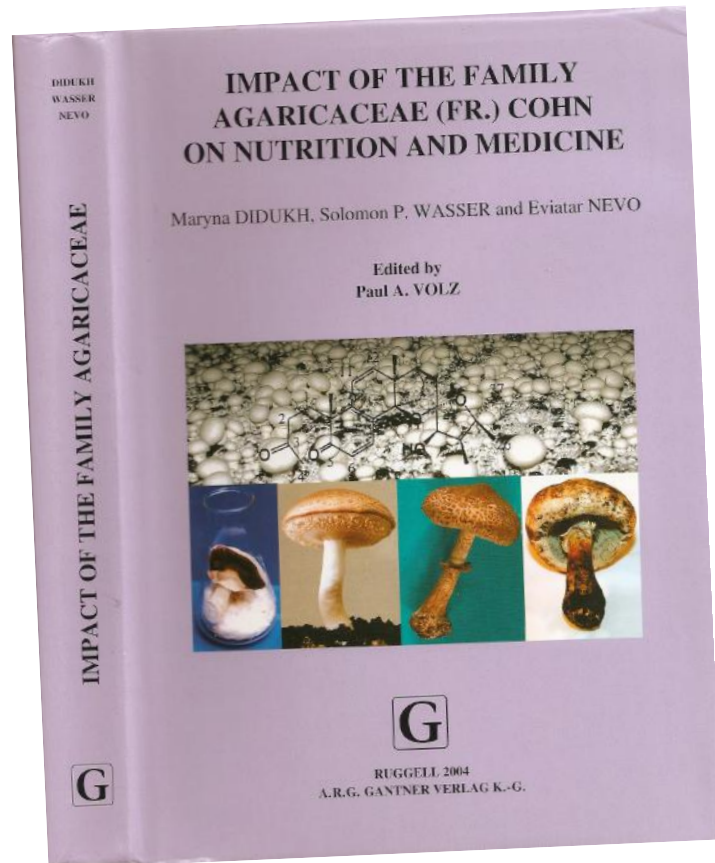
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*Agaricus brasiliensis*

Type locality: Embrapa Florestas, Colombo, Paraná State, Brazil

Latter, combining morphological with molecular and biological data, the differences between *A. blazei* and *A. brasiliensis* were proven (Didukh et al., 2004).



DIDUKH MYa, WASSER SP, NEVO E. Impact of the family Agaricaceae (Fr.) Cohn on nutrition and medicine. Volz PA, editor. Ruggell, Liechtenstein: A.R.A. Gantner Verlag K.-G.; 2004. 205 p.



*Mycologia*, 97(1), 2005, pp. 12–24.

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## ***Agaricus subrufescens*, a cultivated edible and medicinal mushroom, and its synonyms**

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*International Journal of Medicinal Mushrooms*, Vol. 7, pp. 507–511 (2005)

## **Is a Widely Cultivated Culinary–Medicinal Royal Sun Agaricus (Champignon do Brazil, or the Himematsutake Mushroom) *Agaricus brasiliensis* S.Wasser et al. Indeed a Synonym of *A. subrufescens* Peck?**

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Eviatar Nevo,<sup>1</sup> Paul Stamets,<sup>4</sup> & Augusto F. da Eira<sup>5</sup>*



## **DISCUSSION**

### **Inclusive and Exclusive Concepts of *Agaricus subrufescens* Peck: A Reply to Wasser et al.**

*Richard W. Kerrigan*

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### **Molecular Identification of Species of the Genus *Agaricus*. Why Should We Look at Morphology?**

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**Based on the previous publications (including the ones of Kerrigan), Wasser (2010) states that *A. brasiliensis*, *A. subrufescens*, and *A. blazei* are now classified with distinct morphological, molecular, biological characteristics and a different geographical distribution. The misclassification of *A. blazei* caused many problems in medicinal mushroom science but has since been corrected.**

*International Journal of Medicinal Mushrooms*, 12(1):1–16 (2010)

## **Medicinal Mushroom Science: History, Current Status, Future Trends, and Unsolved Problems**

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- In this context, a recent review by Wisitrassameewong et al. (2012) refer to the mushroom as *Agaricus subrufescens* Peck and, accordingly, attributes to this species the results of studies on mushrooms named as *A. blazei* and *A. brasiliensis*.
- However, as the authors declare, all the data concerning the medicinal properties reported are based on studies of a limited number of isolates, all or nearly all of them from the local population in Brazil.
- It is believed that the majority of the strains spread over the world most probably come from the culture originally sent from Brazil to Japan.

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WISITRASSAMEEWONG K, KARUNARATHNA SC, THONGKLANG N, ZHAO R, CALLAC P, MOUKHA S, FÉRANDON C, CHUKEATIROTE E, HYDE KD. 2012. *Agaricus subrufescens*: A review. Saudi Journal of Biological Sciences, Available online 14 January 2012, ISSN 1319-562X, 10.1016/j.sjbs.2012.01.003. Available online: <http://www.sciencedirect.com/science/article/pii/S1319562X12000046>



## COMMERCIAL IMPLICATIONS OF CHANGING THE SPECIES NAME

- Changes in a medicinal mushroom species name pose a big problem for the mushroom business because the entrepreneurs have to submit their products to the legislation of the country in order to get permission for commercialization.
- In Brazil, according to the legislation, foods presented as capsules, pills, and tablets, consisting of edible parts of fruits and vegetables submitted to process of drying or dehydration, must be evaluated as new foods.
- So far, under this category, only the names *Agaricus blazei* and *Agaricus sylvaticus* Schaeffer have been approved (ANVISA, 2008).
- This might be the main reason for most of the products from Brazil being still commercialized as *Agaricus blazei*. Only the products Cogumelo do Sol<sup>®</sup> are sold as *Agaricus sylvaticus* Schaeffer, another case of misidentification.



## A Highly Appreciated Functional Food

Many reports in literature point *Agaricus brasiliensis* as a nutritionally valuable mushroom, with a large gastronomic potential, combining:

- peculiar characteristics of taste
  - almond flavour
  - excellent texture



## A delicious health food



*Fresh mushroom*

... suitable for both salted and sweet dishes.



*Mokeca*



*Soups and broths*



*Pineapple Juice*



*Ice Tea*



*Canned mushrooms*



*Sausages*



*Croquettes*



*Puddings*



*Muffins*



*Biscuits*



*Biscuits*



## FOOD SAFETY STUDIES

- Food safety studies have shown that the human trials carried out to date suggest that the mushrooms and mushroom extracts of the *Agaricus* species tested are safe and generally well tolerated. Agaritine in cultivated *A. bisporus* has been reported in some animal model studies to be associated with potential carcinogenic effects, although this has been contradicted by other studies in the same animal models.
- A recent study has demonstrated that agaritine purified from *A. blazei* has direct anti-tumour activity against leukemic tumour cells *in vitro* [1], which is in contrast to the carcinogenic activity previously ascribed to this compound. These data provide support for the conclusion of a recently published scientific critique of studies on agaritine, which concluded that there is no scientifically substantiated data linking consumption of mushrooms to carcinogenicity in either animal models or humans [2].

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[1] AKIYAMA H, ENDO M, MATSUI T, KATSUDA I, EMI N, KAWAMOTO Y, KOIKE T, BEPPU H. 2011. Agaritine from *Agaricus blazei* Murrill induces apoptosis in the leukemic cell line U937. *Biochimica et Biophysica Acta*, v. 1810, n.5, p. 519-525.

[2] ROUPAS P, NOAKES M, MARGETTS C, KEOGH J, TAYLOR P. 2010. Mushroom and health 2010. Report prepared for The Global Initiative on Mushrooms and Health. Available online: <http://www.mushroomsandhealth.com/mushrooms-health-report-s101/>





## MEDICINAL PROPERTIES ALLEGATIONS

- Among the medicinal properties allegations attributed to *Agaricus brasiliensis*, the immunemodulator, antitumoral, antimutagenic, and anticytotoxic effects are the most widely documented.
- Other allegations include: anti-inflammatory, antiviral, antibacterial, antifungal, antiparasitic, antioxidant, hypoglycemic, antidiabetic, and hepatoprotective properties.
- Its high content of ergosterol, the vitamin D precursor, also gives him important attributes in the fight of bone diseases, as rickets and osteoporosis.



**Mushroom nutraceuticals or dietary supplements**

## Products commercialized in Brazil with different names for the same mushroom



*Cuesta Agaricus (Agaricus blazei)*



*Gapi (Agaricus blazei)*



*Cogumelo do Sol® (Agaricus sylvaticus)*



*Aproconova (Agaricus brasiliensis)*



## USE IN COSMETICS

- **Brazil is an ideal market for cosmetic products taking into account its large population and its culture of self-image. The country's per capita spending on cosmetics and toiletries is roughly 1.7% of GDP – more than double of that in France (0.7%), triple of that in Britain (0.5%), and quadruple in the United States (0.4%) [1].**
- **Some Brazilian companies, aware of that, make use of *A. brasiliensis* as main ingredient in cosmetics as a way of diversifying their productions or even investing especially in this business sector and exporting the products worldwide.**

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[1] CASANOVA L, FRASER M. 2008. Natura – Brazilian cosmetics for the world. In: From multilatinas to global latinias: the new Latin American-based multinationals (compilation case studies). Report of the World Economic Forum, Davos, 26 January 2008, cap.8, p. 175-186. Available online: [http://brazil.willpowergroup.net/files/1004\\_Multilatinas.pdf](http://brazil.willpowergroup.net/files/1004_Multilatinas.pdf)



## Cosmetic products containing *Agaricus brasiliensis* as main active component commercialized in Brazil



Vitamega Cosmetic - Pindamonhangaba, São Paulo



Aproconova – Montes Claros, Minas Gerais



Cogumelo do Sol® - São Paulo



**Other potential uses worthwhile to be explored are discussed by Largeteau et al. (2011):**

- industrial production of lignocellulolytic enzymes in solid-state fermentation or by extraction from spent cultivation substrates;
- application of extracts of the mushroom and its spent compost in organic agriculture for the control of plant pathogens;
- use of spent compost as an alternative to chemicals to promote plant growth when considering organic production of horticultural crops and Eucalyptus growing in artificial forests;
- remediation of biocides; and
- substitution of antibiotics in chicken farming.

**Moreover, like for mushrooms in general, the cultivation of *Agaricus brasiliensis* also contributes to sustainable agriculture efforts by making use of agricultural residues.**



## RECENT REVIEWS

Some good reviews have been recently published indicating a worldwide interest in the Brazilian medicinal mushroom.

- **Hetland et al., 2011**  
From Norway, focus on its medicinal effects on tumour, infection, allergy and inflammation.
- **Largeteau et al., 2011**  
From France, deals with its biological characteristics, cultivation and non-medicinal valorisation.
- **Wisitrassameewong et al., 2012**  
From Thailand, China and France, summarizes its taxonomy, phylogeny, distribution, health benefits and current status of scientific research.



## **THE STATUS OF THE BUSINESS IN BRAZIL**

- Thanks to a great marketing strategy in Japan, the mushroom reached a high status among the medicinal natural products.
- Japan has become the greatest importer of the Brazilian production.
- Many farmers and people with no previous agricultural activity experience have realized the promise of high profits and a rapid expansion of the mushroom cultivation took place in different regions of the country.
- This had a positive effect on changing the perception of the Brazilians towards mushrooms.
- Poisonous and hallucinogenic mushrooms are usually what first come to the mind of most Brazilians when approached by someone talking about mushrooms.
- Gradually, the Brazilian medicinal mushroom and other edible mushroom species are becoming more and more popular in the country especially due to the claims of their health benefits (Dias, 2010)





## THE CRISIS TRIGGERED BY JAPAN IMPORT DECLINATION IN 2006

- The euphoria of the early times was broken in 2006, when three cases of severe hepatic dysfunction in cancer patients were reported in Japan supposedly associated with the use of *Agaricus blazei* extract products, although it was impossible to confirm this suspicion because other causative factors such as cancer chemotherapy and hepatitis virus could not be completely ruled out (Mukai et al., 2006).
- According to the Brazilian Embassy in Tokyo (SECOM 2010), as a precaution measure, the Japanese Ministry of Health, Labour and Welfare (MHLW) recommended to the manufacturers the suspension of sales and voluntary withdrawal of products from the market.
- Three products under suspicion were analysed for toxicity by the Japanese National Institute of Health Science and one of them showed cancer stimulatory effect. Although the product in question did not utilized mushrooms from Brazil origin, the Brazilian suppliers were hit hard.

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MUKAI H, WATANABE T, ANDO M, KATSUMATA N. 2006. An alternative medicine, *Agaricus blazei*, may have induced severe hepatic dysfunction in cancer patients. Japanese Journal of Clinical Oncology. Available online: <http://jjco.oxfordjournals.org/>

SECOM. 2010. Boletim de mercado o mercado de cogumelo "*Agaricus blazei* Murril" (Himematsutake) no Japão. Tokyo: Embaixada do Brasil em Tóquio, 2010. 8p. Available online: <<http://www.brasemb.or.jp/portugues/economy/pdf/Agaricus10.pdf>>.



## **THE CRISIS TRIGGERED BY JAPAN IMPORT DECLINATION IN 2006 (CONT.)**

- From 2006 to 2008, there was a cut of about 76% of the Japanese import.
- Brazil, being responsible for about 80% of the total Japanese import, was the country most affected by the new Japanese consumers perception about the benefits of the mushroom.
- This drastic declination caused a great impact on the vulnerable Brazilian mushroom growers, because 90% of their production was destined for export, almost all of it to Japan. Many growers failed to run their business and had to sour big losses.
- In 2009, the export market to Japan stabilized, with a slight recover. Although it is early to predict whether it will return to the levels of 2004, there is a new wave of optimism among the growers that managed to maintain the business directing their products to the domestic market and exporting whenever possible. There is a huge domestic potential market to be explored, which could guarantee the success of the business on a steadier basis, instead of trusting only on the high prices offered by export business.



## **INTERNATIONAL PARTNERSHIP**

- **I personally believe that international scientists and entrepreneurs partnership for the establishment of strong mushroom cultivation and processing plants, based on fair mutual benefit projections and solid partners confidence, could well be a good deal for foreign investors and the Brazilian mushroom industry development. This could also help to prevent the nasty unfair competition.**
- **Beyond the use of the medicinal and cosmetic mushroom products, with a regular supply of fresh and dried mushroom to supermarkets and restaurants throughout the year and good marketing campaigns soon the mushroom could well become much popular in Brazil and other countries as a health food.**



## THE ROLE OF THE *MUSHROOMS AND HEALTH GLOBAL INITIATIVE*

- In this context, I do believe that the expertise of the *Mushrooms and Health Global Initiative* could well be of great help.
- The first approach in this direction was done by the president of the International Society for Mushroom Science – ISMS, Greg Seymour, during the Fourth International Symposium on Mushrooms in Brazil, held in Caxias do Sul, State of Rio Grande do Sul, in 2008 (Seymour, 2008).
- As a result, a couple of mushroom growers worked hard to establish a national association. I am pleased to announce here that the Brazilian National Association of Mushroom Growers (Associação Nacional dos Produtores de Cogumelos – ANPC) was founded last year and has just become an ISMS affiliated member.

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SEYMOUR G. 2008. Science and marketing: essential partners in the development of the global mushroom industry! In: Proc. Fourth Int. Symp. on Mushrooms in Brazil, Caxias do Sul, 27-30 October 2008:19-21. Brasília: Embrapa Recursos Genéticos e Biotecnologia.



# Acknowledgement

- Many thanks to the IMMC7 organizers for inviting me to this conference. It is a great honour to be here.
- My best gratitude is due to Prof. Shu-Ting Chang who enthusiastically engaged me in the mushroom research in 1997, when he first visited Brazil. And to Prof. Solomon Wasser who, in 2001, took the challenge of reviewing the taxonomic identity of the mushroom treated here.
- I'm also grateful to Prof. Augusto Ferreira da Eira (in memoriam) for his great contribution to the Brazilian fungiculture, especially concerning to *Agaricus brasiliensis* research and development.
- An especial thanks to the mushroom growers who do not give up despite of all the adversities.
- And finally to Embrapa and my collaborators.

A photograph of three mushrooms with light brown caps and white stems growing in a container of dark brown soil. The mushrooms are arranged in a row, with the middle one being the tallest. The background is slightly blurred, showing the edges of the container.

*Thank you!*

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