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Study on the mushroom species *Agaricus blazei* (Murill)

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Summary: Nowadays, *Agaricus blazei* is known all over the world as a mushroom species with unparalleled medicinal properties besides its culinary delights and therefore its regular consumption is recommended in the first place for the prevention of various cancers. For the past decade researchers have been active in the study of its therapeutic properties. Its production started only a decade ago and there are a number of questions yet to be answered. At the moment, the most widespread technique is to grow it using composts similar to those of the button mushroom. In contrast to the common button mushroom, its production differs markedly from that of the button mushroom in that it develops fruiting bodies only in light and requires that the compost temperature be high, around 25 °C, also in the fruiting period and has a much higher need for fresh air. It is also sold in fresh form but mainly as a dried product, in powdered form or as capsules or pills.

Key words: *Agaricus blazei*, polysaccharide rich, cultivation method

Historical overview

Agaricus blazei was first identified in 1945 by the American microbiologist Murrill, as a previously unknown new species, and since it was found on the land of a landowner called Blaze, the new species was named after the farmer.

Agaricus blazei has already been known for centuries in a small Brazilian village in the neighbourhood of Piedade. Local people think that the regular consumption of this mushroom species helps ensure a healthier and longer life. It was Sinden and Lambert, two members of the University of Pennsylvania of the United States, who were the first to turn their attention to this mushroom in Piedade. This was the same species that had earlier been described in Florida by Murrill. In their article published after various laboratory test, they called the attention to the therapeutic effects of *Agaricus blazei*, but then there were few who became interested in the new discovery. It is a fact that the deceased former US president Ronald Reagan, at the advice of his doctors, was a regular consumer of this mushroom species both in fresh form and in extracts in order to alleviate the symptoms of his special skin cancer, far before the attention of the Western world had known anything about the therapeutic effects of this or other mushroom species.

On the basis of the specimen collected in Brazil in 1967 the Belgian mycologist Heinermann gave the name *Agaricus blazei* MURRILL to this 'miraculous' mushroom (presently, the short name of the mushroom is simply 'ABM' all over the world) since the American mycologist was the first to describe the mushroom in 1945 as a new species.

Almost contemporarily to the research group of the University of Pennsylvania, Japanese coffee growers working in Brazil also recognised the benefits of this mushroom species and sent samples to a few research institutes where, on the one hand, its composition values were determined and on the other hand, which were pioneers in the elaboration of the growing technology. In 1978 a Japanese mushroom researcher, Iwade worked out a modern cultivation technology for *Agaricus blazei* for the first in the world. After the publication of the technology ten years had to pass even in Japan before in 1988 a larger-scale production was started for the first in the world, again in Japan.

Nowadays, we know that this mushroom species can grow in the open not only in Brazil, but also in e.g. Florida, South California or Peru. At the same time, mycologists suppose that it could be collected from the wild in many other tropical or subtropical areas but not even the places of its occurrence have been identified as yet.

Presently it is being produced in greater quantities in Brazil, China, Japan, US and South Korea and its popularity is growing. Its major market is Japan where it is one of the most expensive of the cultivated mushrooms. In the United States its production in such quantities that can already be considered greater was started during the past 5 to 6 years. Considering the tendencies of the world it seems that the production of *Agaricus bisporus* is ever more attractive also in the circle of the growers producing button mushroom already for a long period.

Nutritional values

Agaricus blazei gets to customers in fresh form or after drying in a pulverised form, in a special package in capsules, in pills or in the form of solution after extraction with hot water. The fruiting body contains 89–91% water, less than *Agaricus bisporus*. Almost 48% of total dry matter consists of crude proteins, 18% of carbon hydrates and the lipid content is 0.5%. It contains a greater amount of water-soluble polysaccharides than the button mushroom. Already, a lot of information is available nowadays on its therapeutic effect and it is known to a wide public as an exceptionally healthy food. Due to the anti-cancer effect and the immune stimulating properties, it is also used to treat those ill with AIDS.

Its anti-tumour effect is provided by the contained polysaccharides (beta, alpha, xylo and galacto) and protein glucan. It is recommended, already not only by natural therapists, because of the anti-cancer effect, for the reduction of blood glucose, for the control of blood pressure, for cardiovascular problems, allergy and respiratory problems (e.g. chronic bronchitis etc.), as well as for a number of other symptoms. The analyses carried out so far have detected 15 different amino acids and different kinds of vitamins.

Morphological characterisation of the mushroom

The scientific name of the mushroom is *Agaricus blazei* MURRILL. In Brazil it is also called as the 'mushroom of the sun' or 'royal Agaricus'. In Korea the everyday language gave it the name 'simple white mushroom' or 'mushroom of God' while its name in Japan is himematsutake.

Agaricus blazei MURRILL belongs to the family Agaricaceae of the *Agaricus* genus. The fruiting body is similar to that of the button mushroom (*Agaricus bisporus*) with the difference that the stipe is wider and longer. Cap diameter is 6–12 cm, colour is light or dark brown, shape is like a hemisphere and with the increase in the size of the fruiting body the shape of the cap becomes somewhat flat. The basic colour of the cap is white but it is covered thickly by small chocolate-bronze brown scales which occur in ever greater numbers towards the edge of the cap. The cap is wavily lobed to the tip with an edge which rolls under. The stipe is 5–10 com long with a diameter of 8–15 widening slightly towards the bottom. Its colour is white which is covered transversely in a marbled pattern, resembling a belt, by small delicate woolly white scales (*Figure 1*). The young specimen are short and thick with bluntly conical caps and look like bluebells. Their colour is greyish brown. The spores are dark brown almost egg-like in shape with a size of 5–6 × 3 m.

Cultivation parameters

When examining the growing conditions, much similarity can be discovered between button mushroom and

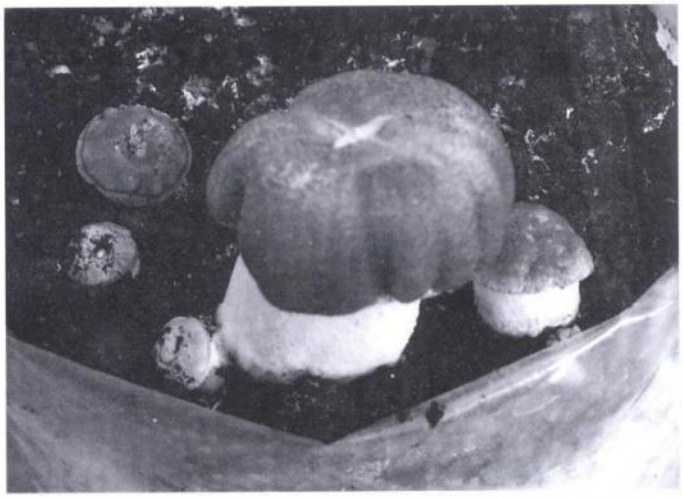

Figure 1 Fruit bodies of *Agaricus blazei* (photo by Győrfi)

Agaricus blazei, though *Agaricus blazei* requires a significantly higher temperature and more air, as well as needing light to be able to develop fruiting bodies. Due to the demand for light, for example in Japan, it is grown in glasshouses all the year round.

The mycelium of *Agaricus blazei* is capable of living between 15–40 °C and has its optimal growth between 25–30 °C. Temperatures below 20 °C or those above 35 °C will strongly slow down mycelium growth. At 45 °C the mycelium will die. *Agaricus blazei* is a saprobiontic species of the same sort as *Agaricus bisporus*, i.e. requires broken-down nutrients which are ready. The preparation of the compost is almost identical to that of the button mushroom with the difference that the compost must be neutral (pH=7) and at the same time the moisture content is also higher, 68–70%.

Similar to oyster mushrooms and shii take this species requires light from the beginning of the primordium development. Like with the production of any other mushroom species, it is a major point to select a variety (strain) having appropriate characteristics. The strains which are nowadays in production come from Brazil, on the other hand, so far it has not been possible to find anything in the literature on what kinds of strains have been bred e.g. in Japan or in the US and how.

Compost Preparation

Currently, *Agaricus blazei* is produced in media similar in composition to the compost of button mushroom.

The principal starting materials for the preparation of the compost are those agricultural wastes which are rich in lignocellulose, straws in particular. Most of the growers use rye or wheat straw. Where the opportunity is given, the compost is prepared from cotton seed coat, from remains of sugar cane processing and even from hay mown on the meadow. Straw by itself would not be able to provide those nutrient sources which are necessary for production. A surplus source of nitrogen is necessary and most of the growers use horse or

chicken manure to which they add wheat or rye bran. Different amounts of nitrogen are also added to the compost. As many compost formulas, so many different fertilisers and mixes. In most cases carbamide, ammonium sulphate and calcium cyanide-amide are used. The nutrient content of the compost is also increased by adding various organic materials (soybean straw etc.) to it. The compost having a higher nitrogen level permit to achieve higher yields.

The base materials are mixed at appropriate ratios according to the formula and then either compost piles are formed following the 'traditional' compost preparation method, as already known with button mushroom or the 1st phase compost is prepared on a breathing floor and then in both cases the compost preparation is finished in the heat treatment chamber and then comes the spawning.

The presence of different micro-organisms is indispensable for the production of *Agaricus balzei*. If the compost temperature rises too high during the heat treatment (pasteurisation) production will probably be unsuccessful. The majority of the different pests, such as nematodes, insects and mites do not survive pasteurisation while useful thermophilous micro-organisms will increase in number. After the heat treatment the so-called conditioning takes approximately 7 days (last longer than in the case of the button mushroom compost). After conditioning the temperature of the compost is cooled further to 20–30 °C and spawning is carried out. For spawning, grain spawns are used, generally in an amount of 2%. 2–3 days after spawning the mycelium of the mushroom starts to colonise the compost from the grain spawns. The growth of the mycelium is very fast. During spawn run the temperature of the compost should be kept at 252 °C which should be measured often, especially on the 6th or 7th day after spawning because this time the mycelium will already produce considerable heat. The humidity of the room must also be checked constantly in order to ensure that the compost has a moisture content of about 70%. The complete spawn run takes 28–40 days (in the case of the button mushroom it is 14–20 days) then comes the casing. The thickness of the casing material is generally 3 cm. The ingredients of the casing material (mixture of peat and powdered stone, in the Far-East plain garden soil) and the pH value are identical with those of the button mushroom. When the casing is completed it is recommended to cover the surface with paper which should be continuously kept moist. Immediately after casing, the introduction of fresh air should be started because if the considerable amount of CO_2 produced by the mushroom remains in the room the fruiting bodies will not develop in the quantity and the shape desired.

The compost temperature should still be kept at 252 °C, until the mycelium will completely colonise the whole layer of the casing material. The ideal humidity is invariably 90%, therefore the surface of the paper is recommended to be sprayed with water. Once the spawn has colonised 80–90% of the casing material the paper covering the compost layer must be irrigated ever more frequently, thereby making sure that the relative humidity of the room be around 90% and ever greater amount of fresh air must be supplied because in this phase already the high CO_2 level may have harmful effect on the primordiums developing later on. The ever greater amount of fresh air means 5–7 air exchanges per hour. 7–10 days after the casing is done the mycelium will colonise the whole of the casing material and will cover the surface thickly. This is when 'napping' is carried out. The first fruiting bodies appear on the 18–24th days from the first irrigation.

Fruiting period

The temperature during the fruiting period, similarly to spawn run, is recommended to be kept at 252 °C and the relative humidity at 85% with a steady supply of fresh air.

Similarly to other cultivated mushroom species, *Agaricus blazei* fruits in flushes. Based on the production experiences gathered so far, it can be concluded that the flushes follow one another with 10 day intervals. Usually, 2 or 3 flushes are harvested. In compost substrate the second flush will yield the same quantity or often even more than the first flush. In the third flush yields will already be much lower. There is very scarce information available on yields. According to certain reports, yields are 10–12 kg per 1 m^2 in enclosed growing rooms, which are significantly lower compared to button mushroom yields.

Agaricus blazei, similarly to button mushroom, is harvested with a closed membrane and then it is immediately cooled down and stored at 2 °C and if sold in fresh form is transported at this temperature. It is sold also as fresh, but in the first place as a dried product or in the form of different extracts and pills.

Conclusions

A fairly high number of factors are already known on the possibilities of the cultivation of *Agaricus blazei*, yet there are many questions which are still unanswered. In the parts above, obviously without any pretence at completeness,

Table 1 Cultivation conditions required for optimal development of *Agaricus blazei* at different phases of production

Environmental requirements	Spawn run	Start of fruiting	Production period
Temperature (compost)	25±2 °C	21–24 °C	25±2 °C
Relative humidity	90–100%	85–90%	85%
Length of time	28–40 days	18–24 days	flush takes 4–8 days and app. 10 days elapse between flushes
Co_2 level	>5000 ppm	400–800 ppm	<2000ppm
Fresh air exchange	once per hour	5–7 times per hour	5–7 times per hour
Illumination	Nut necessary	100–200 lux	100–200 lux

I tried to make a summary of all those things that have so far been published on the origin, characteristics and production of this mushroom species. A production experiment has already been carried out with a few strains of this species at the Department of Vegetable and Mushroom Growing, Faculty of Horticulture, Corvinus University of Budapest. We will continue our experiments and wish to report on the results later on.

References

Chang, Shu-Ting & Miles, P. (2004): Mushrooms. Second Edition, CRC Press, Boca Raton, Florida. p. 373–375, 377–379.

Chen, Alice W., P. Stamets & Huang, N.L. (1999): Compost-substrate fermentation and crop management for successful production of *Agaricus blazei*. In Broderick, Andrew and Tan Nair (ed.)3rd International Conference on Mushroom Biology and Mushroom Products, p. 211–217.

Chen, Alice W. (2001): A Practical Guide to the Cultivation of *Agaricus blazei*: A Mushroom of Culinary and Biomedical Importance. The Mushroom Growers Newsletter, 4: 9.

Chen, Alice W. (2001): A Practical Guide to the Cultivation of *Agaricus blazei*: A Mushroom of Culinary and Biomedical Importance. The Mushroom Growers Newsletter, 4: 10.

Choi, Kyung Wha (2002): The Joy of Growing *Agaricus blazei* MURRILL- a Case of Korea (1). Newsletter from MushWorld (79th Issue, 2006)

Choi, Kyung Wha (2002): The Joy of Growing *Agaricus blazei* MURRILL- a Case of Korea (2). Newsletter from MushWorld (79th Issue, 2006).

Gonzales, R. & Rinker, D. L. (2004): Effect of Ammonia Suppressants Used in Poultry Litter on Composting and Mushroom Production. Mushroom Science XVI. (Science and Cultivation of Edible and Medicinal Fungi) The Pennsylvania State University, p. 203–212.

Iwade, I. & Mizuno, T. (1997): Cultivation of Kawariharatake (*Agaricus blazei*). Food Reviews International 13 (3): 383–390.

Kopytowski Filho, J. & Minhoni, M.T. (2004): Nitrogen Sources and C/N Ratio on Yiled of *Agaricus blazei*. Mushroom Science XVI. (Science and Cultivation of Edible and Medicinal Fungi) The Pennsylvania State University, p. 213–220.

Kwon, Hyun Jong (2001): There is Something About *Agaricus blazei* MURRILL (ABM). Newsletter from MushWorld (79th Issue, 2006)

Lahman, O. & Rinker, D. L. (2004): Mushroom Practices and Production in Latin America:1994-2002. Mushroom Science XVI. (Science and Cultivation of Edible and Medicinal Fungi) The Pennsylvania State University, p.681-686.

Lee, Ji-Hye (2001): Find the Way to Health in Mushrooms. Newsletter from MushWorld (79th Issue, 2006)

Oei, P. (2003): Mushroom cultivation. Backhuys Publishers, Leiden The Netherlands, p. 8–31.

Stamets, P. (2000): Growing Gourmet and Medicinal Mushrooms, (The Himematsutake Mushroom of the Genus Agaricus. Ten Speed Press, Berkeley, Toronto, p. 208–216.