Mushroom Biology and Mushroom Products, Royse (ed.) © *1996 Penn State Univ. ISBN 1-883956-01-3*

Biotechnological Investigations of *Hericium erinaceum* (Bull.: Fr.) Pers. Bag-Log Cultivation to Increase Yield

Burkhard Kirchhoff
Weser-Champignon, 31840 Hessisch-Oldendorf, Germany

ABSTRACT: Fifteen strains of *Hericium erinaceum* were tested on three formulations of nutrient supplemented sawdust substrates. High yielding strains were identified but these strains produced low quality mushrooms. A substrate consisting of 80% beech sawdust supplemented with 20% corn meal gave the highest yields.

1 INTRODUCTION

Hericium erinaceum is known by the common name igelstachelbart in Germany. In other countries the name is lions mane, pom pom blanc, korallentrüffel, monkey head mushroom and yamabushitake. In Germany, wild types are found on old trees of beech and oaks, but it is not a well known mushroom. In China, *Hericium* is a well known, cultivated and expensive mushroom (Chang and Miles 1989). Not only the good taste, but also some medical potentials (Mizuno *et al.* 1992) and technical employments (Kimura *et al.* 1991) could be a marketing advantage for fruitbodies which are produced on substrate blocks.

2 MATERIALS AND METHODS

2.1 *Substrate tests*

To obtain high productive substrate we tested three substrate formulations using 2kg sterile substrate blocks with 10 replications. Beech wood sawdust was mixed with 10% wheat bran, or 20% corn meal, and the third formulation was 10% wheat bran with 5% corn meal. The moisture content was adjusted to 63%. These blocks were sterilized 2 hours at 120°C. After cooling we mixed 2% grain spawn with the strain He 1 into the

upper parts of the substrate blocks. The blocks were closed with a cellulose plug for gas exchange. After 70 days mycelial growth time at 25°C, we initiated fruitbody production in a harvest room with 95% air humidity, 18°C and less than 1200 ppm CO_2.

2.2 *Strain tests*

To select high yielding strains, we tested 15 different *Hericium erinaceum* isolates on 2 kg substrate blocks with 10 replications. We obtained the strains from Belgium, Netherlands, USA and Japan. The substrate formulation was 80% beech sawdust and 20% corn meal. Preparation and harvesting techniques were the same as described in 2.1.

2.3 *Submerged cultures*

Liquid spawn could be an advantage for the production of high yield substrate blocs (Kirchhoff 1991, Kawai 1995). To produce liquid spawn we tested 3 different nutrient solutions with strain He 1 for mycelial biomass production. One solution was 15g molasses /l H_20 (MN), the second was 20g biomalt/l H_2O (BN) and the final nutrient solution was 30g malt extract with 5g peptone in one liter water (MPN). The solutions (75 ml) were filled in 150ml Erlenmeyer flasks with 6 replications. The mycelium of He 1 was maintained at 25°C for 6 weeks at 40 rpm.

Liquid spawn production was carried out in a 12-liter batch fermenter (Braun, Melsungen) using the method described by Song and Cho (1987). For this spawn production we used a different nutrient solution and achieved good results. Substantial viable hyphal aggregates developed in the liquid spawn.

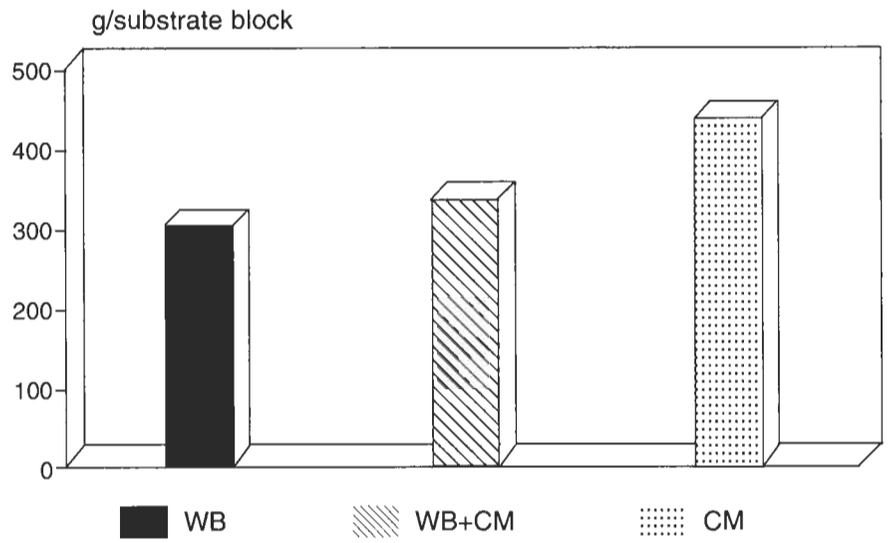

Fig. 1. Fruitbody yield of different substrate formulations with *Hericium erinaceum.*

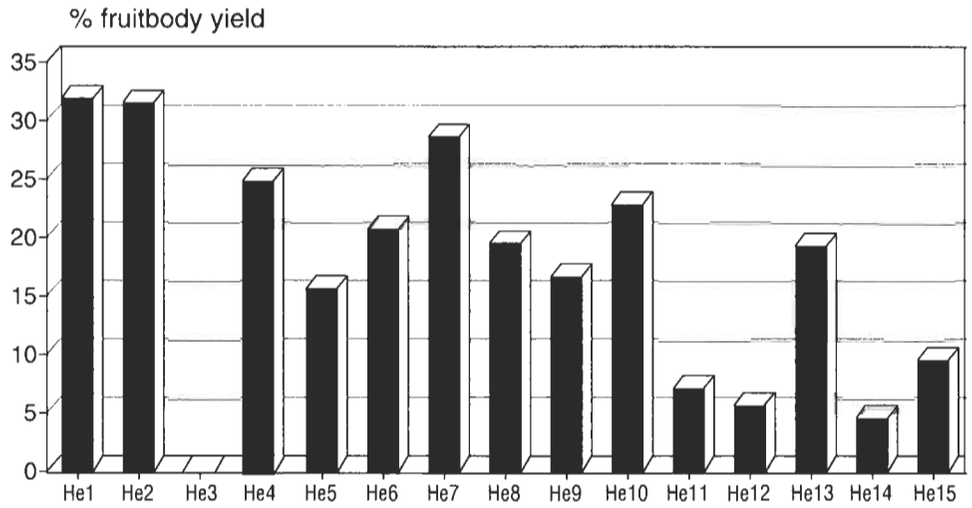

Fig. 2. Fruitbody yield of 15 *Hericium erinaceum* strains (yield as percent of the substrate weight).

3 RESULTS

3.1 *Substrate tests*

After 10 to 14 days in the harvest room the fruitbodies on the top of the substrate blocs were mature for picking. The harvest period was five weeks with two flushes. The sawdust substrate with 20% corn meal (CM) effected in higher fruitbody yields than with 10% wheat bran (WB) or 10% wheat bran and 5% corn meal (WB+CM).

At the end of the harvest period we sometimes observe green-mold infections on the substrate blocks but this was no problem for fruitbody production.

3.2 *Strain tests*

Fruitbody development began 5 to 7 days after cultivation started in the harvest room. Depending on the strain, the harvest of fruitbodies began 10 to 28 days later. We obtained considerable differences in yield, quality, color, mold resistance and fruitbody shape (Fig. 2; Table 1). Strains He 1

and He 2 produced high fruitbody yields while the strains He 6 and He 13 had good fruitbody qualities. With the use of strain He 1 we obtained early fruiting in the closed plastic bags.

Table 1: Strains, origin, and ratings of quality, color, mold resistance and fruitbody shape of *Hericium erinaceum*.

	Origin	Quality	Color	Mold infections	Fruitbody shape
He 1	Belgium	4	3	3	3
He 2	Germany	3	2	1	2
He 3	Netherlands	-	-	-	-
He 4	"	4	4	2	3
He 5	"	4	5	2	5
He 6	"	1	1	3	1
He 7	"	3	4	3	4
He 8	Japan	3	3	3	3
He 9	"	2	3	3	3
He 10	"	3	3	3	3
He 11	"	4	5	6	4
He 12	"	3	4	3	5
He 13	"	1	2	4	1
He 14	"	2	4	3	5
He 15	"	4	6	6	6

Quality: 1=good; 6=poor
Color: 1=white; 6=brown
Mold resistance: 1=no infection; 6=mold infection
Fruitbody shape: 1= well shaped; 6=misshapen

3.3 *Submerged cultures and liquid spawn*

After 42 days of mycelial growth we terminated the experiment and weighed the wet mycelial biomass (Fig. 3). With the use of liquid spawn we obtained high fruitbody yields in comparison with grain spawn. However, it seemed that the application method of the spawn also had a great influence on the yield.

4 DISCUSSION

Hericium erinaceum grows on a wide range of substrates. For good marketing not only the yield, but the quality of the fruitbodies is very important. A substrate formulation with 20% corn meal could be a good growing medium. In comparison with our results Eisenhut (1994) obtained

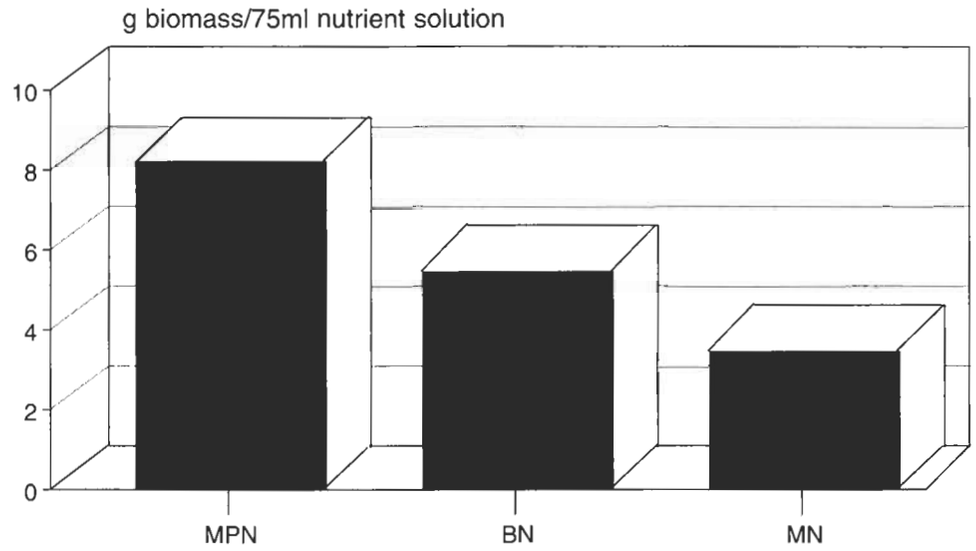

Fig. 3. Mycelial biomass production of *Hericium erinaceum* with different nutrient solutions.

comparable yields when she used a substrate formulation with 20% wheat bran. In other regions the substrate formulation depends on the price for the ingredients, yield and the marketing situation. Eisenhut (1995) furthermore observed that, with the use of ash-wood sawdust, there were no greenmold infections on the blocks.

We found some high yielding strains (He 1 and He 2) and also strains with good fruitbody quality (He 6 and He 13). A desirable strain is one with a fast mycelial growth, high yield, good fruitbody quality, well shaped fruitbodies, and greenmold resistance. Until now we have not obtained this strain in our culture collection.

Grain spawn is one of the most widely used spawn for *Hericium* production in Europe (Hirt *et al.* 1994). High production costs of liquid spawn are only suitable for greater fruitbody production but the market is still limited. Furthermore, there is the danger of genetic degeneration of the mycelium in the liquid spawn production process. In the future, smaller amounts of modified liquid spawn for the production and continuous testing of genetic degeneration will be necessary.

A summary of problems associated with *Hericium* is as follows:
— Low yield is associated with high quality strains
— Misshapen fruitbodies
— There is a danger of genetic degeneration associated with liquid spawn
— Mold infection may present a problem during the harvest period

— Rapid, post-harvest quality decline in cold storage or in the marketplace
— Small market for product

Oei (1991) states that the cultivation of *Hericium erinaceum* is relatively easy in Taiwan but marketing of this product will be more difficult. Up to now there is no market for this mushroom in Germany and we agree with his opinion. A specific combination of high yielding substrates, good quality and high yield strains, modified spawns and their application methods, well adapted cultivation conditions and a good marketing strategy will lead to an economically successful, continuous production process for this mushroom in Europe.

REFERENCES

Chang, S.-T. and P.G. Miles 1989. Edible mushrooms and their cultivation. CRC Press, Inc. Bocca Raton, Florida.

Eisenhut, R. 1994. Untersuchungen zur Anbautechnologie und zum ernährungsphysiologischen Wert des Speisepilzes *Hericium erinaceus* (Bull.:Fr.) Pers., Dissertation.

Eisenhut, R. and D. Fritz 1995. Ein neuer Speisepilz? Untersuchungen zum Myzelwachstum und zur Anbautechnologie von *Hericium erinaceus*, Der Champignon 1/95:24-29.

Hirt, A. and W. Schnitzler 1994. Myzelwachstum von *Hericium erinaceus* und *Ganoderma lucidum* auf Brutsubstraten, Der Champignon 1/94:17-21.

Kawai, G. *et al.* 1995. Liquid culture induces early fruiting in shiitake (*Lentinula edodes*). Mushroom Sci. 14:825-832.

Kimura, Y. *et al.* 1991. Hericerin, a new pollen growth inhibitor from the mushroom *Hericium erinaceum*. Agric. Biol. Chem. 55:2673-2674.

Kirchhoff, B. 1991. Investigations of shiitake (*Lentinus edodes* (Berk.) Sing.) bag-log cultivation to increase the yield in Germany. Mushroom Science 13:509-516.

Mizuno, T. et al. 1992. Antitumor-active polysaccharides isolated from the fruitbody of *Hericium erinaceum* and medicinal mushroom called yamabushitake or houtou. Biosci. Biotech. Biochem. 56:347-348.

Oei, P. 1991. Manual on mushroom cultivation, TOOL Foundation, Amsterdam.

Song, C.H. and K. Cho 1987. A synthetic medium for the production of submerged cultures of *Lentinus edodes*. Mycologia 79:866-876.