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Casing-material experiments with *Pleurotus eryngii*

Győrfi, J.[1] & Hajdú, Cs.[2]

[1]Corvinus University of Budapest, Faculty of Horticultural Science, Department of Vegetable and Mushroom Growing. H-1118 Budapest, Villányi út 29–43.
[2]Korona Mushroom Union. H-3396 Kerecsend, Pf. 8.

Summary: Our research led to the gathering some relevant information about the growing technology of the *Pleurotus eryngii*. In some European countries this mushroom is quiet favourable. The detail of the growing technology has not been determined in detail yet. These partial results led us to carry on with the research towards a development of covering technology. With some new series of experiments and with the use of some new covering mixtures and their application of different thickness we are hoping to clarify the details of the technology.

Key words: *Pleurotus eryngii* (King Oyster Mushroom), sterilized substratum, different casing treatments, uncovered blocks

Introduction

The oyster mushroom strains (*Pleurotus* spp.) became one of the largest scale cultivated mushrooms in the last thirty years. In the world's mushroom production the oyster mushroom strains are in third place after the white button mushroom and the shiitake. The produced amount is more than one million tones. Several oyster mushroom strains especially *Pleurotus ostreatus* hybrids are already in cultivation, but certain countries of Europe and in the United States interest is growing towards the *Pleurotus eryngii* strain (commonly known as King Oyster Mushroom).

The *Pleurotus eryngii* belongs to the family of oyster mushrooms (*Pleurotaceae*) (*Kószó*, 1996). The wild species of *Pleurotus eryngii* (*Pleurotus eryngii*/ De CANDOLLE ex FRIES) can be found in large areas of Hungary and Europe. This would be a favourable thing for mushroom collectors, but unfortunately the numbers are getting less and less. In contrast to other oyster mushroom strains the *Pleurotus eryngii* does not live of wood materials, but takes its nutrients from organic materials in the soil. This can be already decomposing wood also (*Kalmár* et al., 1989). Its natural habitat is on the dead root of the weed Eryngium campestre. Its common name originated from it also. (*Hortobágyi*, 1968) It can also be found near other umbellate weeds (*Peucedanum, Ferule* etc.) and on dry meadows and pastures (*Kószó*, 1996). It can be collected from the wild between October and December, rarely in early spring (*Albert* et al., 1995). The cap of the *Pleurotus eryngii* medium size is brown- brownish red in colour. At the beginning it has a rounded shape, than it flattens out and finally turns into a tube shape. The stem situates centrally or excentrally. The gills are white and run down deep on the stem which is also white (*Figure 1*). The cap's upper skin is thicker than the other oyster mushroom strains so it won't get flaky if the relative humidity is lower in the growing room. The advantage of this strain compare to other Pleurotus strains is that the *Pleurotus eryngii* does not produce as many spores as the other strains. This means that the grower hyper allergy in its case is does not exist (*Zadrazil* et al., 2004). At storage (+ 2 °C) *Pleurotus eryngii* keep its shelf life and marketable quality for a long time (up to 12 days), and also does not get affected by transport.

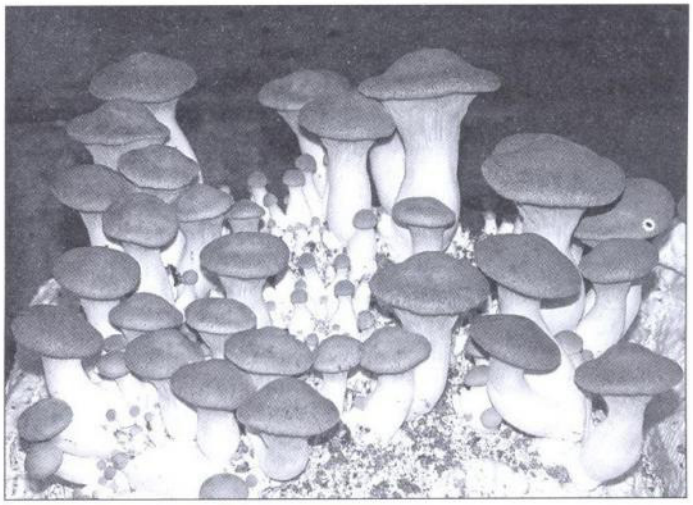

Figure 1 Fruit bodies of *Pleurotus eryngii*

Industrial growing of this strain first happened in Hungary at the end of the 1950's on the mixture of composted hay and sawdust (*Kalmár*, 1960). A few years later growing started on partially heat treated and sterilized agricultural base materials (example corn-cob) (*Véssey*, 1971). On sterilized substrate French researchers (*Cailleux & Diop*, 1974) used wheat straw with added oat. According *Szili-Véssey*, (1980) if the growing- technology of the *Pleurotus eryngii* successfully developed, that can make this strain the most demanded strain out of all the Pleurotus strains. According to *Szili* (1990), if the wheat is prepared by dry heat treatment, the additive of a nitrogen source is required. Also *Szili* (1990) suggested that *Pleurotus eryngii*

should not be grown in bags, but horizontal growing beds, example boxes, and the use of covering soil should be tried. Italy is the main producer in Europe. They grow using wheat straw. They use the procedure described by *Kószó* (1997), by means of a substrate manufacturing they use dry heat treatment and wet-heat treatment (pasteurization). The spawned substrate-similar to the procedure in Hungary- filled into plastic bags and pressed into blocks. They perforate the bags, and by the holes the fruit bodies will appear. The size and amount of the perforations has an impact on the yield. The diameter of the perforation is on average 10mm. The frequencies of the perforations are calculated on that the perforations are 5% of the total block area. The large hole size and too many perforations could result in the substrate will dry out to soon. Also the small hole size and not enough perforation could obstruct the spawn run and has an impact on the fruit body formation and also on the size of the fruit bodies. Some growers sink the blocks 25 cm deep into the soil, cut the foil of the top and cover it with casing material, 2–3 cm thick, used in white mushroom growing (mixture of peat and lime powder).The advantage of the use of casing soil is, that it's prevent the drying out of the substrate so it can result in bigger yield than perforated bags or blocks. The reason for this is that the casing can be watered, but the bags and blocks can not. The disadvantage of this procedure that soil residues can remain on the surface of the mushroom, so the product may not be favoured on the market. In Hungary (*Szarvas & Szarvas*, 2002) successful growing has been reported on sterilized substrate. They used in the experiments two Hungarian strains (Korona PEF and Korona PEL). The results show that the yields of these strains were bigger than any other oyster mushroom strain in cultivation. *Oei* (2007) reports say that on cereal – straw with added additives, the yield is 12–18 kg mushroom on 100 kg substrate. Unfortunately the base- material production cost can not be reduced because without wet or dry heat treatment the *Pleurotus eryngii's* most unpleasant disease, the bacterium –blotchiness (Pseudomonas tolaasii) appears. These bacteria can only be destroyed with steriiization above 100 °C for 2 hours, so every substrate must be sterilized. According to *Oei* (2007) the currently cultivated *Pleurotus eryngii* strains need to be exposed to a special effect before fruit body formation. This means for a week the spawn run blocks have to be kept on 5–18 °C with a relative humidity of 50–70% and with the use of ambient lighting. After that the bags can be put on shelves. The foil has to be cut off from the top of the blocks. After this overview of accessible literatures, we can state that development of the *Pleurotus eryngii's* economical growing technology we do not know all the answers just yet.

Materials and methods

The aim of our experiment was to determine the size of yield on sterilized substrate without covering and covering with several casing materials or casing mixtures. In our experiment we have used fully spawned block just before fruit body formation. We prepared these blocks in the Korona Mushroom Union's Research laboratory. The substrate composition was 60% oak wood shaving, 10% oak sawdust, 5% grinded wheat straw, 25% cooked rye. We soaked the materials for 3 hours, and then homogenized them in a mixer. For the treating of the excess water and the adjustment of the pH we used gypsum: lime powder 1:1 in 2%. We set the substrate water content to 70%, and then we filled it into heatproof bags made out of polypropylene with breathing technology (Micro Sac type bags). We put into each bags 4 kg substrate, and then sterilized them on 126 °C for 2 hours. After sterilization we inoculated the bags with 5% spawn, and completed the spawn run on 25 °C. We used for spawning the Korona PESZ strain. The spawn run took 3 weeks, than we stored the blocks at 10 °C for another 2 weeks. Then we placed the perfectly spawned run blocks into a greenhouse, in random order. One block size was 28x32 cm=896cm^2, cca. 900cm^2, the weight was an average of 4kg.

In each treatment we used 10 blocks. We placed them tightly next to each other, cut the foil of their tops, and then covered them with casing material or mixture 1cm thick. After covering we immediately water the blocks. The 10 blocks without covering also cut had the foil cut from the top.

Treatments:

- 100% grinded lime-powder
- 100% „traditional" casing soil
- 50% lime powder+50% „ traditional" casing soil
- Uncovered control

Lime powder= particle size an average 1mm

"Traditional" casing soil=90%peat and 10%grinded lime powder

During the experiment we daily measured the core temperatures of the blocks at different places. We also measured the minimum and maximum air temperature and the relative humidity. For the relative humidity we used an automatic humidifier. After covering and watering we set the humidifier 3 hourly for 45 minutes. Half of the with "traditional" casing soil and with casing mixture after the first watering we covered them with newspaper as used in white button mushroom growing, until the pinning has started on the top of the casing. On the newspaper covered blocks the pining started 2–3 days earlier than on the not covered ones. During flush we only watered the lime powdered covered blocks, on the other blocks we achieved the suitable water content only with humidity. The sun in the greenhouse gave enough light for the fruit body formation. In bright sunlight we used shading. The relative humidity was 85–93% during the flush, which according to literature was quiet high, but the bacterial infection only appeared at the third flush. The changes in the minimum and maximum air temperature have been affected by the outside temperature and the central heating. During flush the highest temperature was 23,3 °C and the lowest was 11 °C, but most days it was between 16–17 °C. We started the picking 14 days after covering which is a week earlier than white button mushroom. The production period lasted 5 weeks and during this we picked 3 flushes from each treatment. In each treatment we measured the yield, but also counted the fruit bodies.

Results

According to the result of our experiment the covered with 1cm depth blocks gave a bigger yield than the not covered ones (*Table 1*). The covered with 100%grinded lime powder blocks gave the biggest yield, but the 50% grinded lime powder and „traditional „ casing soil mixture gave near enough the same yield.

Table 1 The yield (kg) gown on covered blocks with different 1 cm thick casing materials and on the 10 not covered blocks

100% grinded lime powder	100% „traditional casing soil	50% lime powder and 50% casing soil	Not covered
12.06	10.01	12.04	9.08

We monitored the quality of the fruit bodies. We found that on the non covered blocks the quality was worse than on the covered blocks. The fruit bodies were mainly developing on the edge off the blocks, and their size and amount was also less than on the covered ones. The quantities of the primordiums were also less (*Figure 2*).

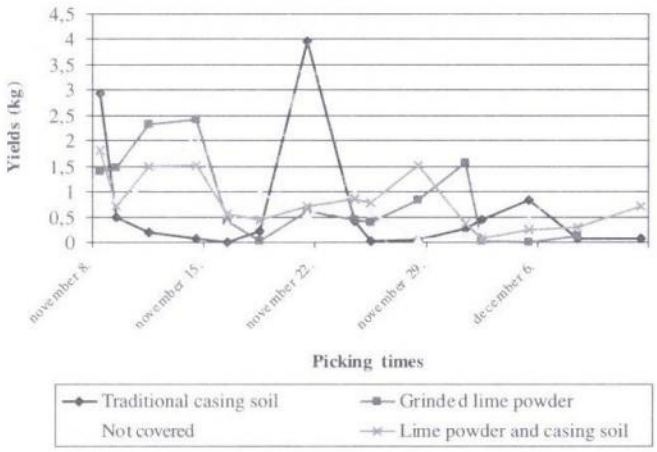

Figure 2 Flushes of the covered and the non-covered blocks

Figure 2 shows the flushes in case of the covered and the non-covered blocks. The blocks only covered with lime powder, the mycelium had difficulty to break thorough, however 70% of the total yield produced during the 1st flush, 2nd and 3rd flushes couldn't be separated. The other covered blocks, the 2nd flush gave the most production. With the use of the "traditional" casing soil 82% of the yield was produced in the first two flushes (*Figure 3*). We picked the 1st flush for 4 days and 10 days separated the 1st and 2nd flushes. The 3rd flush lasted for 18 days, and we were still picking some mushrooms at the end.

The blocks covered 50% "traditional" and 50% lime powder mixture, the 1st flush lasted for 10 days, and that gave 64% of the total yields. The 2nd flush lasted for a longer period of time in this case (*Figure 4*).

The 1st flush of the non covered blocks gave 52% of the total yield. After that we can not talk about separate flushes. The growing period finished a week earlier than the covered blocks. The yields of the different treatments calculated on 100kg substrate, can bee seen in *Figure 5*. Our findings were that the non-covered blocks yield was the smallest, and the yields of the other treatments were similar to each other.

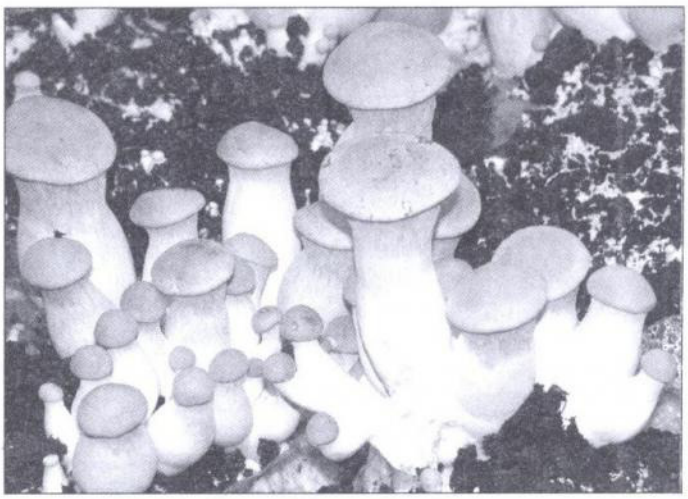

Figure 3 Fruit bodies of the traditional casing soil

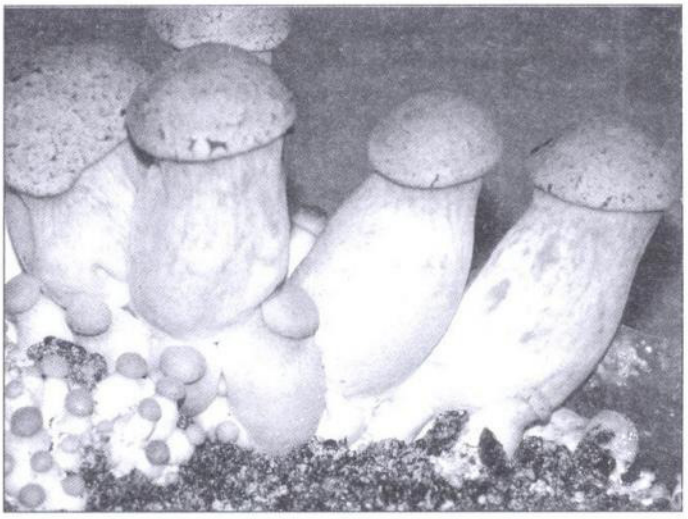

Figure 4 Fruit bodies of the 50% traditional + 50% grinded lime powder

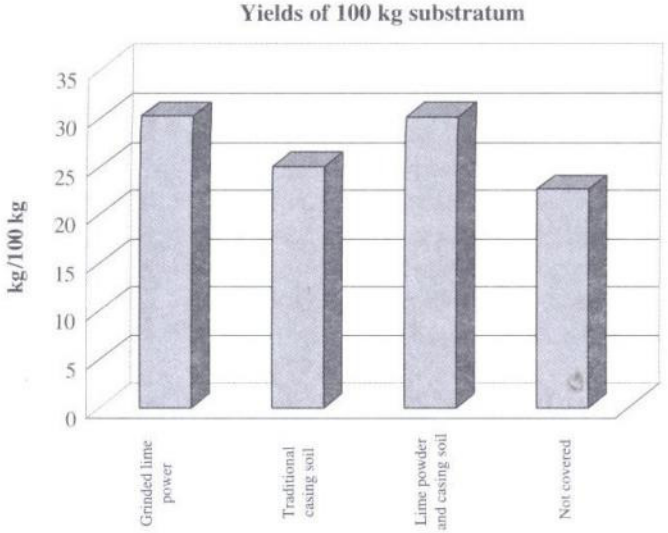

Figure 5 Yields of the different treatments calculated on 100kg substrate