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Introducing of ready-made and spawned compost for amateur mushroom growing

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It is almost impossible or economically unprofitable for a small grower to use modern and expensive production technology, but the primitive (extensive) one is accompanying with heavy and dirty work as well with high risk for the yield.

Introduction of ready-made, peak-heated and mix-spawned compost in plastic bags would improve the growing and labour conditions in the small mushroom houses.

Small and production experiments have been performed and much higher average yields accounted.

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Introduction

Mushroom growing on a small scale - 50 to 200 sq.m of beds in adapted rooms - is almost amateur mushroom growing. The final product is either for own household consumption or for the market. Naturally it is almost impossible or economically unprofitable for a small grower to use modern production technology with expensive machinery, steam boiler, air conditioning equipment, etc. It is also well known, how much and how heavy manual work is done in a primitive mushroom house.

Every grower has to prepare his own compost without the modern Phase II heat treatment in special heat rooms. The ready compost often contains an excess of ammonia, mushroom pests and diseases; the primitive mushroom house cannot be steamed at the end of the crop and the wooden shelves are for single use only; the manure spawn and the spot spawning, together with the compulsory low temperature in the beds result in a long cropping period, including a 70 to 100 days' picking period. All these point to the high risk involved in amateur mushroom growing.

The average yield for thousands of small growers in Bulgaria is between 60 and 80 kg of trimmed mushrooms per ton of compost with an average moisture content of 65%. Consequently, to be a successful small grower in a primitive mushroom house is a real "art". First of all, everyone must be well trained in many and different sciences.

The numerous small Bulgarian mushroom growers work for the market organized by the Central Co-operative Union.

To improve the production conditions and to diminish the risks we used international experience to grow cultivated mushroom in plastic bags and worked out a new technology for the small mushroom houses, suitable for the local conditions. Provision was made for the small growers to be supplied with ready-made and spawned compost, filled in plastic bags.

During the past 5 years both small experiments and production experiments have been performed.

Materials and methods

Corn cob compost with 30% of horse manure was used after heat treatment in big trays. The compost mixed with "Somycel 97" or "92" grain spawn in a dose of 4 kg per ton was filled into plastic bags with a diameter of 40 cm.

The bags were transported in bulk by lorries over 300 km from the composting yard to the experimental houses. Different types of houses have been used according to the final aim: home cellars, old and abandoned cow sheds and barns, plastic houses etc. In order to provide fresh mushrooms all the year round, production experiments were performed also in different locations from 200 to 1 000 m above the sea level.

Some experiments had to prove the optimal depth of the compost in the bags, the term of casing, the influence of the strain, and so on. For example, three depths of the compost were tested: 20, 30 and 40 cm, i.e. 90, 130 and 160 kg per sq. m of absolute used surface, as well four terms of casing: at the 1st, 5th, 10th and 15th day after filling the house. An absolute used surface for us is only the surface actually covered with compost. Bags arranged parallel to one another cover about 80% of the ground beds or shelves, and bags lined up in a chessboard pattern about 90%.

Results and discussion

For amateur and family mushroom growing (small-scale production) a plastic bag full of compost must not be heavier than 20-25 kg.

Bags full of spawned compost may be transported in bulk by truck over long distances and in every season. In summertime, however, it would be hazardous to keep in bulk the bags full of mixed spawned compost more than 24 hours. We have registered several occasions with temperatures of 33° C in the bags, for a short time of course and without any damage to the spawn.

Shallow bags have to be arranged on the floor or on the shelves in chessboard pattern, as well as 30 cm deep bags in winter. The 40 cm deep bags, and the 30 cm deep bags in summer, may be arranged only in parallel rows to prevent overheating during spawn -running. It is known that the small mushroom houses have no climatic installations.

Without any heating in the mushroom production room for some seasons, or with stove heating when necessary, the compost temperature during the spawn -running period varied between 18 and 20° C in the shallow (20 cm) bags and between 22 and 23° C in the deeper bags. On some occasions on the upper shelves and in summer crops higher temperatures, up to 29° C, were registered, but also for a short time and without damage to the mycelium. A small ventilator for vertical air recirculation helps well to even down the temperature. It is necessary to remember here that in all primitive mushroom houses the insufficient heating is more often quite the larger problem.

The casing soil made up of 70% by volume black peat and 30% ground limestone has to be spread over the compost immediately for the shallow bags, but 5 days later for the 30 cm deep bags, and for the 40 cm deep bags between the 5th and the 10th day after filling the house. The variation with casing on the 15th day after filling the house was negative for all the three composting depths, with some exceptions. The exceptions were registered for some autumn crops,when the air humidity in the mushroom houses could easily be kept high. When the compost was contaminated with yellow moulds and in some comparatively cold houses the optimal casing term moved to the 1st day after filling the house (Table 1 a, b, c, d).

The first pin-head formation was observed at the 12th to 20th day after filling the house, depending on the season and the time of casing. It was observed that the higher the compost temperature and the earlier the casing, the earlier also the first pinning.

The first picking took place from the 20th to the 30th day after filling the house and the picking period lasted 45 days on the average.Nearly 90% of the yield was gathered in the first 35 picking days and this was very favourable when the compost was contaminated with yellow moulds.

The shortening of the cropping period, characteristic of the new technology, promotes the intensification of mushroom growing on a small scale through the repeated filling of the mushroom house in one and the same season. There was an experiment for threefold filling of a mushroom house in a field area of South Bulgaria (Table 2). The average yield obtained from all the three crops is nearly 100% higher than the common practice there.

Experiments with *Agaricus bitorquis* strains proved that some growers would be able to grow mushrooms in summertime, too, in areas where *Agaricus bisporus* strains cannot be grown because of the high temperature.

Some earlier and high yielding strains of *A. bisporus* may help also to intensify production in the small mushroom houses. The results from one experiment with 10 "Somycel" strains illustrate our statement (Table 3). If the most important purpose of the new technology would be to increase the average yield, for example up to 130 kg of trimmed mushrooms per ton of compost in the case of our example - plastic summer house without heating and filled with comparatively low quality compost - the strains 459, 22, 53 and 85 represent a good and promising possibility.

Our production experiments with 132 tons of compost, filled in 14 different types of houses, gave an average yield of 149,6 kg trimmed mushrooms per ton, with a deviation from 115 to 194 kg. Five other crops under very unfavourable conditions - cold rooms or composts contaminated with yellow moulds - gave yields from 95 to 105 kg/t. Under similar conditions the primitive technology would bring complete failure.

At the experimental conditions the deeper compost layers gave the higher yield: 20 cm deep bags 100%, 30 cm deep bags 117%, and 40 cm deep bags 135%. Naturally this result cannot have a general meaning since it was obtained first of all in connection with the poor heating in the small and primitive mushroom houses. Under these conditions the deeper bags (with more compost) kept higher temperatures during the spawn-running period.

The deeper bags economize also shelves and labour, but the optimal depth of the compost in the bags for general practice must be about 30 cm,or 130 kg compost with 65% moisture content per 1 sq. m of absolute used surface.

A negative phenomenon that may accompany the new technology is the "stroma" phenomenon in the casing layer before the first pin-head formation. At the beginning every small grower may be alarmed bebause the stroma phenomenon is not common with the old and primitive technology. However, our experience showed that it is easy to control it by a correct regime of watering, heating and ventilation of the mushroom house. One gram of fundasol (50% benomyl) per sq. m of cased surface, applied by spraying some days before the first pinning, controls the soft mildew and often helps to diminish the stroma phenomenon.

Another negative characteristic of the new technology may be considered to be that the heavier breakes of mushrooms are conducive to longer stems of the fruit-bodies. The heavier the breakes are the higher is also the labour tension for the picking,

Table 1. Relation between the casing time and the yield, kg/t. a) Compost depth 20 cm.

Variation Crop; type of house	Days after filling of house 1	5	10	15
Late spring; cellar; shelves	130.0	122.8	131.8	118.6
Spring; mountain plastic house; shelves; yellow moulds; 1st crop	113.2	102.1	104.8	103.3
Summer; mountain plastic house; 2nd crop in same house	165.9	137.0	147.6	118.7
Autumn; cellar; shelves	187.8	184.4	157.4	-
Average of the 4 crops	149.2	136.5	135.4	113.5

b) Compost depth 30 cm.

Late spring; common room; shelves	125.4	136.2	143.7	139.1
Summer; mountain plastic house; shelves	114.8	128.0	130.0	121.9
Autumn; common room; shelves	175.7	179.4	168.7	154.8
Winter; cellar; shelves	115.3	117.1	129.0	109.3
Average of the 4 crops	132.8	140.2	142.9	131.3
Summer; mountain plastic house; shelves; yellow moulds	131.5	106.9	90.9	95.0

c) Compost depth 40 cm.

Spring; common room; shelves	145.8	152.3	159.2	130.2
Spring; cellar; shelves	159.3	170.6	163.7	167.6
Autumn; common room; shelves	168.0	190.7	193.4	172.4
Autumn; plastic house; floor bags	261.9	248.1	205.9	190.4
Average of the 4 crops	183.8	190.4	181.8	165.2
Summer; mountain plastic house; shelves; yellow moulds	107.3	91.4	86.8	96.1
Winter; cellar; shelves; yellow moulds	126.3	124.1	117.5	117.2
Average of the 2 crops	116.8	107.8	102.2	106.7

d) Mushroom houses with favourable high air humidity.

Autumn; common room; shelves; compost depth 20 cm	164.5	167.0	175.4	156.2
Autumn; cellar; shelves; compost depth 30 cm	168.1	174.1	174.0	179.5
Autumn; cellar; shelves; compost depth 40 cm	196.0	186.8	193.3	196.9

but the large families of the small growers do not miss the right moment for picking.

The new technology has an advantage also as to mushroom flies. In winter crops chemical treatment often is not necessary at all, but in summertime a reduced number of the treatments are only needed.

Conclucions

The introduction of mushroom production in plastic bags with heat-treated and mixed-spawned compost has a very favourable effect on the small-scale amateur mushroom growing, above all in achieving a higher yield and diminishing the risk of failure.

The shorter cropping period provides a possibility to fill one and the same small mushroom house several times during the suitable seasons. This intensifies the primitive mushroom growing.

The new technology offers better working conditions - the "dirty" processes of composting can be avoided and the number of shelf floors reduced.

The plastic bags improve the hygienic regime in mushroom houses and filling, emptying, cleaning and disinfection are also much easier.

The main difficulties accompanying the new technology are: the risk of overheating in the compost during the spawn-running period, the stroma phenomenon

before the first pin-head formation, and the higher labour tension during the picking period.

Table 2. Threefold filling of one and the same mushroom house in autumn-winter, winter and winter-spring seasons in a field area, i.e. an area with hot summer.

Index	Crop		
	Autumn	Winter	Spring[x]
Filling-date	Sept. 9, 1976	Dec. 16, 1976	Apr.6,1977
Compost-tons	15.5	13.4	10.5
Picking period-days	63	43	34
Yield-kg/t compost	176.7	123.6[xx]	152.5
Average of the 3 crops		152.2	

x The mushroom house was empty on March 15.

xx The compost was not very qualitative; first phase of composting was on open wharf and in cold rainy weather.

Table 3. Relation between the strain, yield and the picking period.

Strain Somycel No.	Yield for 35 days kg/t	Part of total yield %	Total yield in 50 days kg/t	Comparison with control Somycel 97-%
459	140.6	90.2	155.8	152
22	139.4	92.1	151.4	148
53	133.7	91.1	146.7	143
85	130.4	89.6	145.5	142
97	97.3	94.8	102.6	100
24	97.1	94.5	102.8	100
56	92.9	78.5	118.4	115
665	89.9	86.4	104.0	101
11	80.7	94.7	85.2	83
92	61.3	76.6	80.0	78