International Journal of Horticultural Science 2006, 12 (4): 7–9
Agroinform Publishing House, Budapest, Printed in Hungary
ISSN 1585-0404

Enrichment trials with straw substrate to produce *Agaricus bisporus* (Lge., Sing.)

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Summary: Everywhere in the world button mushroom is cultivated on heat-treated horse manure or on a compost mixture of straw, horse manure and chicken manure. In the ZKI trials continued on straw which seemed to be a simple and cheap substrate. To improve yield the N-content of the straw was increased by mixing it with wheat bran, alfalfa flour and ProMycel. Enriching agents were added to the dry heat-treated straw (100 °C) at 1, 2, 3 weight per cent. All the 3 agents increased yield as related to control. The highest yield was obtained with ProMycel.

Key words: *Agaricus bisporus*, dry heat-treatment, enrichment, fruit body yield.

Introduction

In Hungary, as elsewhere in the world, cultivated or button mushrooms are cultivated on composted and heat-treated horse manure and on a compost mixture of straw, horse manure and chicken manure, respectively. Composting takes, in general, 3 weeks. In the Vegetable Crops Research Institute trials aimed at finding other kinds of substrates in order to increase yield. A substrate could be found the preparation of which is much simpler than that of the manure compost and, in the same time, it is also adapted to oyster and other mushrooms. On straw button mushroom yield was always lower than on the usual manure compost (*Balázs & Kovácsné Gyenes*, 1989). Low yield may be explained by the low N-content of the straw.

Attempts were made to increase the N-content of straw substrates. The question to be answered was whether the low N-content was responsible for low yield and how and by what means N-content could be increased. The enriching agents we chose (wheat bran, alfalfa flour, ProMycel) are generally used in mushroom production.

Materials and methods

The basic wheat straw substrate was chopped (20–40 mm) in a hammer mill. The dry substrate was heat-treated by steam at 100 °C for 60 minutes and then wetted to 70% humidity. To protect it against moulds 0.01% benomyl (Fundazol 50 WP) was mixed with the wetting water. The enriching agents were heat-treated in the same manner and mixed into the heat-treated straw.

The enriching agents included – as mentioned above – wheat bran, alfalfa flour and ProMycel, mixed at 1, 2 and 3 weight per cent into the wet straw. Samples were taken from the mixture for labor tests. Substrate humidity, N-content and pH values were evaluated. Tests included Agaricus bisporus, button mushroom. Grain spawn was prepared in the ZKI Mushroom Laboratory. It was mixed into the substrate at 3% of wet substrate weight. The heat-treated and spawned substrate was filled into bags without perforation (2 kg/bag) and sealed. Some small holes were made in the upper third part of the bags to satisfy the air requirement of the mycelia. The trial was repeated twice.

Incubation took place in a plastic mushroom growing house and during harvest bags were kept in a cellar. During incubation substrate temperature was kept at 25 °C and the rel. air humidity between 80–90%.

Results

Mycelia colonized the enriched substrate in 17 days in every treatment. There was no difference in incubation time. After incubation bags were placed in a cellar. Prior to casing, the plastic cover was opened and pulled down to the floor. The substrate was cased 5–6 cm deep. After casing temperature was kept at 22 °C with 85–90% rel. humidity. One week after casing the surface was scraped. Even after scraping high rel. humidity and 22 °C air temperature were kept so that mycelia could grow vigorously and rapidly into the casing soil. The first fruit bodies appeared in 30–35 days after casing.

Yield evolution is represented in *Figure 1*. Accordingly, the 3 enriching agents increased yield in all the 3 doses. Yield was considerably higher in relation to straw substrate. The highest yield was obtained with ProMycel. The per cent increase of the mixture ratio also increased yield. The increase could be explained by the high N-content due to enrichment (*Table 1*).

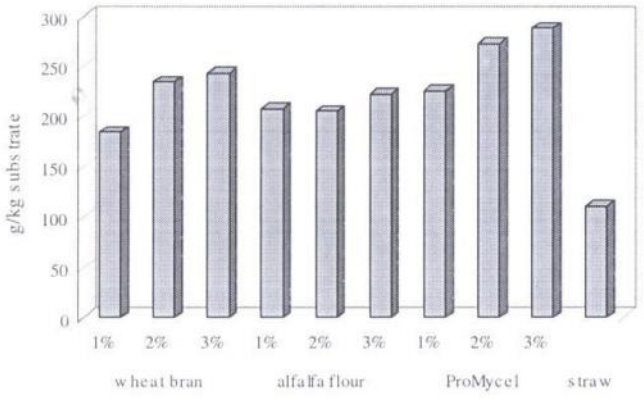

Figure 1. Agaricus bisporus yield on dry heat-treated straw

Table 1. Data of wheat straw substrate with enrichment

Substrate	Humidity m/m%	Nitrogen m/m% (in dry matter)	pH
wheat bran 1%	71.3	1.02	7.75
wheat bran 2%	70.5	1.03	7.29
wheat bran 3%	70.1	1.14	7.27
alfalfa flour 1%	71.4	0.9	8.18
alfalfa flour 2%	71.2	1.05	8.22
alfalfa flour 3%	69.1	1.12	8.08
ProMycel 1%	72.9	1.14	8.15
ProMycel 2%	71.9	1.51	7.88
ProMycel 3%	70.3	1.53	7.90
straw	71.4	0.96	8.08

The N-content of the substrate increased considerably as influenced by ProMycel in relation to control. The same trend could be observed with wheat bran. Alfalfa flour influenced yield less than the two other enriching agents.

In mushroom production trends in yield flushes are always very important. In our trials fruiting began somewhat earlier in the 3 treatments as compared to control. Increased alfalfa flour and wheat bran doses advanced harvest (*Figures 2* and *3*). The change in ProMycel doses did not affect earliness (*Figure 4*). On straw the second and third flush was more vigorous than the first one.

Trends in yield and fruiting as influenced by enrichment can be seen in *Figures 5–7*. *Figure 5* shows that 3% ProMycel resulted in the highest yield during the shortest time, followed by 2% and 1% ProMycel. Differences were considerable in relation to wheat straw.

Alfalfa flour dose did not cause any difference on the 20th day of harvest. On the 45th day yield was the same at 1% and 2% doses. Somewhat higher results were obtained at 3% dose. As related to control treatment improved yield considerably (*Figure 6*).

At 2% and 1% bran enrichment accumulated yield was almost the same on the 15th day of harvest. A small difference was found at 3% dose on the 45th day. Changes due to 1% dose were also considerable as related to wheat straw (*Figure 7*)

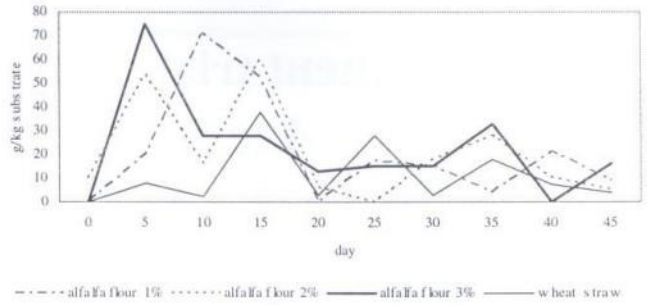

Figure 2. Effect of alfalfa flour on yield flushes

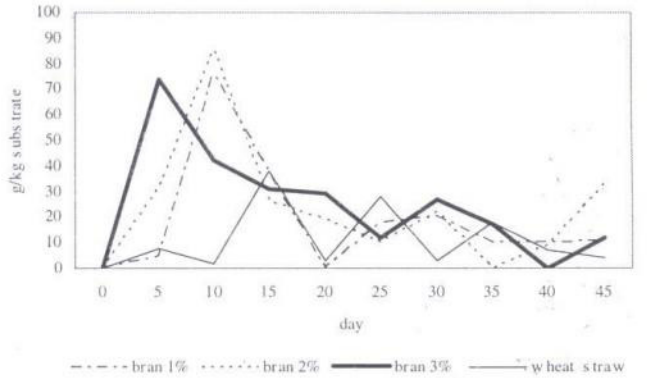

Figure 3. Effect of wheat bran on yield flushes

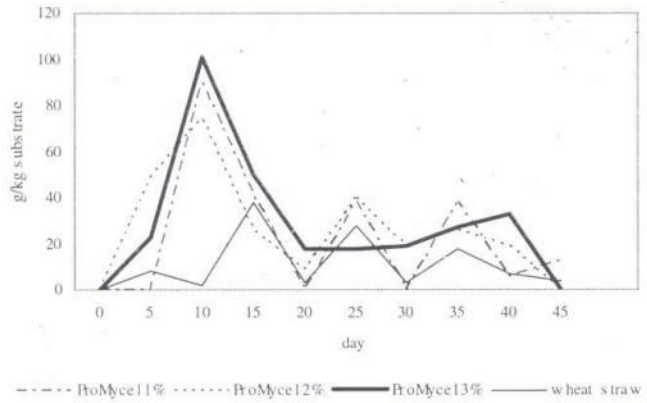

Figure 4. Effect of ProMycel on yield flushes

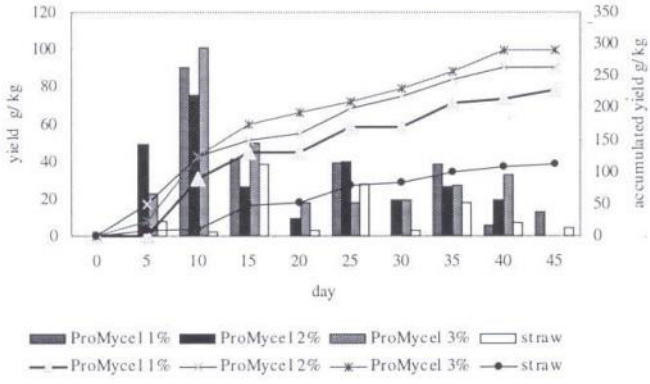

Figure 5. Yield and harvest trends as influenced by ProMycel enrichment (dry heat-treatment)

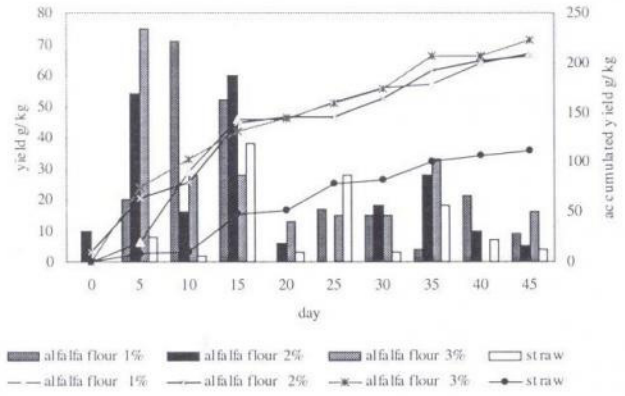

Figure 6. Yield and harvest trends as influenced by alfalfa flour (dry heat-treatment)

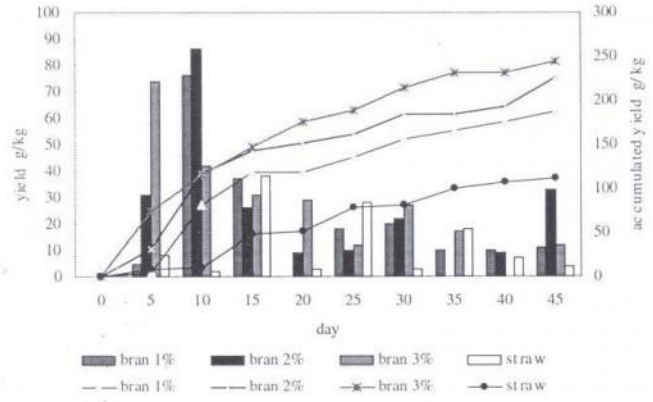

Figure 7. Yield and harvest trends as influenced by bran (dry heat-treatment)

Discussion

Button mushroom is cultivated on horse manure and synthetic substrates, respectively. Composting takes about 3 weeks. *Till* (1961) prepared wheat straw and peat bran compost without composting. He sterilized the substrate. The process is too expensive and requires sterile conditions during cultivation.

Huhnke & Sengbusch (1968) improved the method by shortening the sterile phase. After sterilization the substrate was inoculated with a bacterium group to prevent the occurrence of competetive organisms. No sterile condition was necessary in further cultivation.

Cultivation on straw requires no horse manure, no composting and treatments only take a short time. The process is environment friendly because no ammonia is produced. In former straw substrate trials yield was very low. Present day enrichment agents can improve yield considerably. Trials will continue using large bags generally accepted in production.

Acknowledgements

The study was sponsored by OTKA (T0422648).

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