Pergamon

Radiat. Phys. Chem. Vol. 52, Nos 1-6, pp. 379-382, 1998

Printed in Great Britain
PII: S0969-806X(98)00030-9
0969-806X/98 $19.00 + 0.00

PRELIMINARY INVESTIGATIONS INTO THE BIOCONVERSION OF GAMMA IRRADIATED AGRICULTURAL WASTE BY *PLEUROTUS SPP.*

Gbedemah, C. M [1]., Obodai, M [2]. and Sawyerr, L. C [2].

1. Biotech. & Nuclear Agric. Res. Inst.
Ghana Atomic Energy Commission.
P. O. Box 80, Legon-Accra.

2. National Mushroom Dev. Project,
Food Research Institute,
P. O. Box M. 20, Accra.

ABSTRACT

The application of gamma irradiation for pretreatment of lignocellulosic materials for their hydrolysis and to increase their digestibility for rumen animal have been reported in the literature. Gamma irradiation of corn stover in combination with sodium hydroxide for bioconversion of polysaccharide into protein by Pleurotus spp has also been reported.

In this study experiments were designed to find out whether gamma radiation could serve both as a decontaminating agent as well as hydrolytic agent of sawdust for the bioconversion of four varieties of Pleurotus spp.

Preliminary results indicate that a dose of 20kGy of gamma irradiation increase the yield of Pleurotus eous var ET-8 whilst decreasing the yield of other varieties.

INTRODUCTION

Pleurotus ostreatus and *P. eous* are macrofungi which utilize polysaccharides (cellulose and hemiceluloses) from various lignocelluloses to produce the popularly known oyster mushroom for human consumption [1]. *P. sajor-caju* has also been known to have the ability to degrade lignin to some extent [2].

Species of *Pleurotus* have been cultivated in a wide variety of substrates in temperate, subtropical and tropical environments. The substrates have included padi straw [3]; wheat straw [4]; banana pseudostems [5]; saw dust [6]; paper [7]; palm press fibre [8]; cotton waste [9] and coffee pulp [10].

Pretreatment of polysaccharide of lignocellulose by physical or chemical treatment has been found to be important for efficient bioconversion into more useful feed stocks [11]. Wawa sawdust and cocoa nib dust have also been found as good substrate for the growth of mushrooms in Ghana [12]. Irradiation is a physical pretreatment for the effective disruption of lignocellulose polymers thus making them more susceptible to microbial attack [13]. The flow chart of mushroom production is shown in Fig. 1. With increased interest in the mushroom industry in Ghana and the easy access to gamma radiation source, we explored the possibility of using gamma radiation to serve both as a decontaminating agent as well as a physical hydrolytic agent of sawdust for bioconversion by some varieties of *Pleurotus spp.* This physical method was compared to the conventional method of moist heat sterilization of compost prior to spawning.

MATERIALS AND METHODS

Mushroom varieties:

Two varieties each of *Pleurotus ostreatus* and *Pleurotus eous* were used in the experiments. *P.*

ostreatus var OT-3, *P. ostreatus* var OT-6, *P. eous* var EM-1, *P. eous* var ET-8 of the National Mushroom Development Project collection.

Substrate Preparation:

The spawn substrate consisted of 85-90% sawdust (wawa, *Tripochiton scleoroxylon)*; 5-10% wheat/rice bran; 1-2% lime; NPK fertilizer 1%.

The mixture was heaped to about 1.5m for 28-30 days with remixing every 4-5 days. During this period mainly bacteria and fungi helped to degrade the compost. The final product was maintained at a moisture content of 65-70%.

Bagging:

The substrate was compressed in 0.18 x 0.32m heat resistant polyethylene bags. Each bag contained approximately 1kg of substrate. For each treatment, 10 replicates were used.

Sterilization:

The bagged substrates were either sterilized with moist heat in drums at temperatures of 95-100 °C for 2.5 hours or gamma irradiated with doses of 2kGy, 5kGy, 10kGy, 20kGy and 25kGy. The dose rate in air was 131.1 Gy/hour measured by Fricke dosimetry.

Inoculation and Incubation:

The bags were inoculated with 20g of the various varieties and labelled appropriately. The compost bags were then incubated at ambient temperature (28-32^0 C) for the spawns to thicken for approximately 35 days.

From the incubation room, the bags were sent to the cropping house where the compost bags were placed on horizontal shelves. They were slit open at the neck in the cropping house where humidity of 80-85% was maintained by watering twice a day.

Harvesting:

Harvesting was done by grasping the stalk at the base with the hand and gently pulling out all the mushroom together before weighing.

RESULTS AND DISCUSSION

Figures 2a-d show the percentage of bags treated by heat or gamma irradiation prior to spawning that produced mushroom flushes during the experiment. There were clearly varietal differences in the performance of the mushroom on the substrate after the prescribed treatment. Treatment of compost with either heat or 25kGy of gamma radiation and then used as substrate for the cultivation of *P. eous* var EM-1 yielded the best results although the percentage number of bags that flushed decline with time from an initial 90% to 20-60% after 3-4 flushes (Fig. 2a .

Compost in bags seeded with spawn *of P. eous* var ET-8 performed better in terms of yield of the mushroom. There was much improvement in the percentage of bags that produced mushrooms such that by the fourth flushes 40-100% of the bags produced mushrooms depending on the dose applied (Fig. 2b). Production of mushrooms in bags spawned with *P. ostreatus* var OT-3 and OT-6 were inferior to *P. eous* var ET-8. (Fig. 2c and d).

The yield, estimated by weight of mushroom after 8 weeks cropping, was influenced by type of pre-treatment of the compost and the variety of mushroom used in spawning the compost (Fig. 3). Duncan Multiple Range Test ($p \leq 0.05$) showed that the yield of *P. eous* var EM-1 was lowest at all treatments compared to *P. ostreatus* var OT-3, *P. ostreatus* var OT-6 and *P. eous* var ET-8 (Fig. 3). Moist heat sterilization was statistically ($p \leq 0.05$) superior to 2 kGy gamma irradiation in all varieties tested but the yield was improved with increasing radiation dose up to 20 kGy.

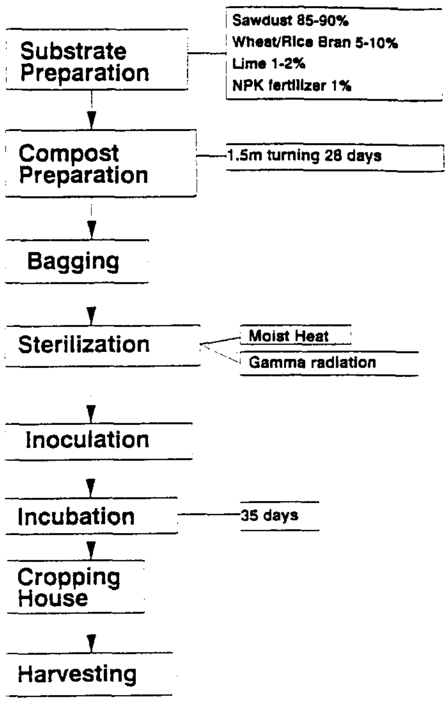


Fig. 1. Flow Chart For Mushroom Production

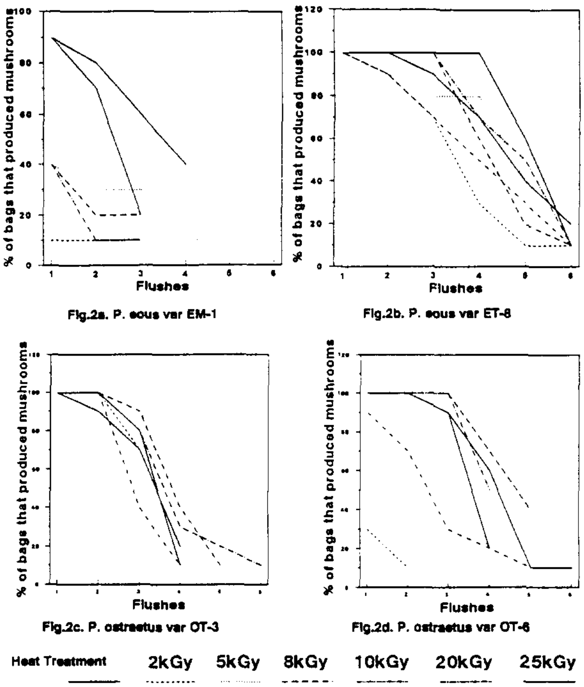
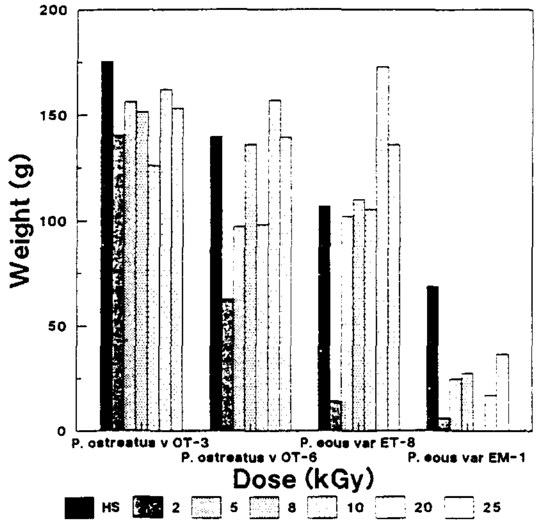


Fig. 2 Comparative effect of heating and gamma radiation pretreatments of sawdust on the production of fruiting by the indicated Pleurotus species at 28-30°C.



HS-Heat Sterilization.

Fig. 3

Average of 8 Weeks Cropping

The economic value of mushroom cultivation is the ability of these fungi in transforming inedible agricultural waste to edible biomass which is generally accepted as food of high quality, flavour and nutritive value [14]. After the heat/radiation treatment, sucession of the residual microorganism in the compost could influence the bioconversion of the substrate to utilizable nutrients for the mushroom development. Presumably the environmental and the nutritional condition created during composting selectively favoured growth of *P. oeus* var ET-8 on compost treated with 20 kGy of gamma radiation resulting in the highest yield of mushroom during all the six flushes. *P. ostreatus* var OT-3 comes next in terms of potential of using gamma irradiated compost for cultivation of mushrooms in Ghana. In future studies, sucession of residual microorganisms after the prescribed treatment will be followed in order to obtain data to explain why some mushroom species were inhibited.

CONCLUSION

P. eous var ET-8 grew best on compost treated with 20kGy of gamma radiation. *P. eous var ET-8* also produced mushrooms during all the six flushes when grown on gamma irradiated compost whilst other varieties in the experiment did not. This advantage could be exploited in areas where preservation limits production. *P. ostreatus var OT-3* can also be used in the same manner when cultivated on sawdust pretreated with 20kGy of gamma radiation.

ACKNOWLEDGEMENT

Our special gratitude goes to Mr. C. F. S. Edmunson for his immense technical assistance during the work.

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