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Waste Re-Cycling using Edible Mushroom Cultivation

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ABSTRACT: Waste re-cycling through edible mushroom cultivation was investigated. Edible mushroom species used in this study include *Pleurotus tuber-regium, Pleurotus osteratus* var *florida* and *Volvariella volvacea*, while the agricultural wastes include corn cob, corn husk and poultry waste (used as an additive).Two kilogrammes of each waste/substrate was mixed with different concentrations of poultry waste, 0%, 1.5%, 2.5%, 3.5% and 2% Lime ($CaCO_3$), composted, bagged and pasteurized before being seeded with spawns of *Pleurotus tuber-regium, Pleurotus osteratus* var *florida* grown on guinea corn and *Volvariella volvacea* spawn grown on cotton waste respectively. They were incubated in high-density polypropylene bags and grown at room temperatures (27 - 30^{0c}) in a specially constructed growth chamber. The mean mushroom weight in the range (16 – 118.9) grams and the bioconversion efficiency in the range (0.09 – 0.67%) obtained from the three mushroom species are statistically different at (P=0.05). There was no statistical difference at (P=0.05) in the following parameters: Mean number of mushroom (1.4 – 18.7), the biological efficiency in the range (0.8 – 5.60%) and also the dry matter loss in the range (50 – 247.6%). The highest mushroom quality (very big) (5.0%of MNM) was obtained from *P. tuber-regium* on corn cob. *P.tuber-regium, P osteratus* var *florida*, *V.volvacea* have shown outstanding prospects in recycling huge agricultural wastes; such as corn cob, corn husk, and poultry waste in an environmental friendly manner. @JASEM

More than two thousand years ago, wild edible mushrooms were used not only as a source of food but also for their medicinal importance. The society was then divided into the Mycophilic and Mycophobic populations. The former knew the utility of the fungus and propagated it, while the latter who were unable to distinguish the edible from the non-edible dreaded the poisonous fungi and preferred to stay away from them. The classification of edible and non-edible fungi paved the way for commercial cultivation of edible fungi (Kovfeen, (1980). The many remarkable ecological advantages of cultivation of edible fungi include the efficient re-integration of agricultural plant resides (e.g. horse and chicken manure; cereal straw, bagasse, etc) fungal substrate can also be formed from industrial waste such as sawdust, sulphite liquor and residues from paper industry (Kovfeen, 1980).

In Nigeria and other developing countries of the world, tonnes of agricultural and domestic waste are generated annually which are of no economic value except when properly integrated into the soil which helps to improve the soil fertility, otherwise they constitute environmental nuisence during biodegradation. (Fasidi and Kadiri (1993). Victoria and Agina (2002) Kadiri. (1999), Banjo O. (2002)

Mushrooms are cultivated directly or indirectly on agricultural waste products or compost. This is one of the most hygienic processes to recycle animal wastes. The positive effects of such cultivation outweigh the environmental pollution i.e. increased ammonia production and bad odor. (Kovfeen, 1980). Equally according to Madan etal (1987), production of edible mushrooms with agricultural waste such as rice, wheat, corn straw, corn cob etc is a value-added process to convert these materials which are otherwise considered to be waste into human food. It therefore represents one of the most efficient biological ways by which these residues can be recycled.

Mushroom cultivation may therefore become one of the most profitable agro-businesses such as increased production of food from rice and wheat straw as well as environmentally friendly disposal of some agro-wastes (Zhang; etal (2002). In this paper corn husk and corn cob residue from corn plant which are highly available during the corn season supplemented with different concentrations of poultry waste will be tested for their ability to support the growth of three mushroom species, namely P*leurotus tuber-regium, Pleurotus osteratus* var *florida* and *Volvariella volvacea* to translate the present national interest in mushroom cultivation into practical reality.

MATERIALS AND METHODS

Corn husk and corn cob used in this investigation were reduced to smaller particle size of about 3cm x 3cm with a knife and moistened. They were supplemented with four concentrations of poultry waste; 0%, 1.5%, 2.5% and 3.5%dry weight of the substrate. Three mushroom species and two substrates represent the variable in this investigation. 2% lime ($CaCO_3$) was also added to stabilize the substrate pH. Water was mixed thoroughly to the substrate to correct the moisture content to about (50-70%). The substrate was packed into high density polyprophylen bags and punched down.

The bags were pasteurized for 3 hours and allowed to cool overnight before inoculation. The experiment was arranged in a completely randomized design with three replicate per treatment. The P*leurotus tuber-regium, Pleurotus osteratus* var *florida* spawn used in this experiment was obtained from a commercial grower in Rivers State Nigeria while the *Volvariella volvacea* spawn was obtained from Federal Institute of Industrial Research (FIRRO) Oshodi, Lagos State, Nigeria.

After inoculation, the substrates were incubated in a specially constructed growth chamber where temperature, ventilation and humidity could be controlled. After incubation, the bags were opened to induce fruit body production as indicated by the extent of colonization and age of the substrate. The production cycle/duration of this study was between 38 – 65 days altogether.

Two mushroom flushes were obtained; yield and quality were evaluated considering the accumulated production of the flushes. For the productivity evaluation, the following parameters were used: mean mushroom weight (w/w) (MMW), mean of number of mushroom (MNM), growth cycle, biological efficiency, bioconversion efficiency, the dry matter loss, age of the substrate at first flush.

Mean mushroom weight (w/w) (MMW): These was obtained by taking the wet weight of each flush using a scale and also taking the mean of the weight of the two flushes.

Mean number of mushrooms (MNM): The mean number of mushrooms was obtained by counting the number of fruit bodies from the two mushroom flushes and equally taking the mean.

Growth cycle: This is defined as the period from spawning to the end of incubation.

Biological efficiency. (BE): This is obtained by the mushroom wet weight per 100g of substrate used in percent.

Bioconversion efficiency. (BCE): This is the grams of dry mushroom produced per 100g of dry straw / substrate in percent.

Dry matter loss: Dry matter loss is the ratio of the substrate weight at spawning and substrate weight at the end of the production cycle in percent.

Age of the substrate at first flush and mushroom quality: Age of the substrate at first flush/fruiting was the period between spawning to the first flush harvest was recorded while the mushroom quality were evaluated by different size groups classified as follows: pileus diameter above 13cm (very big), 10-13cm (big), 5-10cm (medium) 2.5cm (small) and 0-2m very small. The substrates were lightly watered by sprinkling every day to induce further fruiting.

RESULTS AND DISCUSSIONS

The variations in the productivity parameters of the three mushroom species observed in this work are shown in table 1. the data showed that, the growth cycle of three mushroom species ranged from 20 – 37 days, with *P.osteratus* being the longest.

Productivity Evaluation: Growth cycle: Pleurotus tuber – *regium* had 100% growth/colonization after 20 days of inoculation, 100% growth/colonization was obtained from *V. volvacea* after 31 days of inoculation while the logest growth cycle was obtained from *P.osteratus var florida* which had 50% growth/colonization after 37 days of inoculation this however could be attributed to relatively high moisture content which may have hindered mycelial growth. This result is in agreement with Kleb's first principle which states that cessation of vigorous vegetative growth depends on either the exhaustion of nutrients or the accumulation of staling factors in the medium. This result shows that *P.tuber-regium* on corn cob had fastest growth but fruit body production was delayed to allow for mycelial maturation.

Age at first flush: P.tuber-regiun produced the first flush after 31 days of inoculation (ie 11 days after opening) this however is to allow for mycelial maturation. *P.osteratus var florida* had the first flush after 41 days of inoculation (ie after 4 days of opening) signifying mycelial maturation while *V.volvacea* produced the first flush after 43 days of inoculation (12 days of opening).

Mean mushroom weight: Mean mushroom weight of 118.9, 45.0 and 16.0 grams (W/W) was obtained from *P. tuber-regium* on corn cob *P. osteratus* var *florida* on corn husk and *V.volvacea* on corn husk respectively, these figures were significantly different at (P.= 0.05). *P. tuber-regium* on corn cob was statistically better than *V. volvacea* on corn husk while the other species were statistically the same.

Mean number of mushrooms: The mean number of mushroom are 1.4, 10.4 and 18.7 produced from *V.volvacea* on corn husk, *P.osteratus var florida* on corn husk and P.tuber regiun on corn cob respectively however these value were statistically the same.

Biological efficiency: The biological efficiencies obtained from *P. tuber-regium* on corn cob, *P. osteratus* var *flordia* and *V. volvacea* were respectively 5.7%, 2.4%, and 0.8%. These figures were not statistically different at (P=0.05). The low biological efficiency obtained from this study however could be attributed to the short duration/production cycle of between (38 – 65) days

Table 1: Variations in the productivity parameters of the three mushroom species on corn cob and husk

Productivity Parameters	Mushroom Species			L S D
	P-tuber-regium on corn cob	P. osteratus var florida on corn husk	V. volvacea on corn husk	
Growth cycle (days)	20(++)	37 (+)	31(++)	
Age at first flush (Days)	31	40	43	
MMW (g)	$118.9^{(a)}$	$45^{(a)b}$	16^{b}	77.1
MNM^{A}	18.7^{a}	10.4^{a}	1.4^{a}	22.1
BE. (%)	5.66^{ns}	2.44^{ns}	0.8^{ns}	
B.C.E. (%)	0.67^{a}	0.36^{b}	0.09^{c}	0.12
Dry matter loss (%)	247.6^{ns}	50.0^{ns}	54.0^{ns}	

(++) - 100% colonization / growth: + - 50% colonization/growth: LSD - Least significant difference; ^{A} Mean values: (a-c) Mean values within the same row with no common superscript letter differ (P=0.05); ns - Mean values within the same row are not statistically different: MMW - mean mushroom weight: MNM – mean number of mushrooms: BE – Biological efficiency: B.C.E – bioconversion efficiency.

Bioconversion efficiency: Bioconversion efficiency of 0.67%, 0.36% and 0.09% were obtained from *P.tuber-regium* on corn cob*, P.osteratus var florida on corn husk and V. volvacea on* corn husk respectively which are not statistically different at (P=0.05). The low biological efficiency and Bioconversion Efficiency are in agreement with the low yield obtained from this study due to a relatively short production cycle. *Dry matter loss:* The dry matter loss of 247.6%, 50% and 54% obtained from *P.tuber-regium* on corn cob, *P osteratus* var *florida* on corn husk and *V. volvacea* on corn husk respectively were not statistically different at (P= 0.05). This relatively high dry matter loss is not in agreement with the low yield as more of the dry matter are lost due to mushroom respiration than in fruit body production. According to Zhang, etal (2002) the dry matter loss was partly assimilated into the mushrooms fruitbodies and partly lost into the atmosphere as carbon dioxide due to mushroom respiration

Mushroom Quality: The mushroom quality is shown graphically in Figure 1. *Pleurotus tuber-regium* on corn cob produced the highest quality (very big category) in terms of marketable mushrooms which represent 5.0% of total mushroom fruit body harvested (MNM).

Conclusion: The major findings of this study are summarized as follows: *Pleurotus tuber-regium* on corn cob is the best in terms of rate of growth/colonization, age at first flush, mean mushroom weight. The minimum time for fruit body production is 31 days for *P- tuber-regium* on corn cob, 41 days for *Pleurotus osteratus* var *florida* on corn husk and 43 days after inoculation for *V. volvacea* on corn husk. *P. tuber-regium, P. osteratus and V.volvacae* have shown outstanding prospects in the recycling of the huge agricultural wastes like corn cob and corn husk and poultry manure in an environmentally friendly manner and also in the improvement of food production.

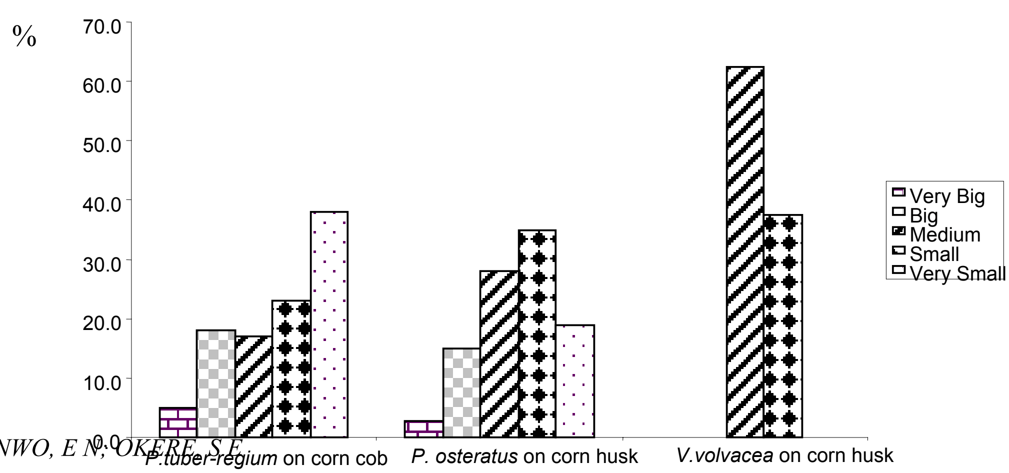

Fig. 1: Variation in the mushroom quality of the three mushroom species on corn cob and husk evaluated by different size groups**.**

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