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Reactions of Different Supplement on the Yield and Nutritional Constituents of Oyster Mushroom (*Pleurotus sajor-caju*) Cultivated on Sawdust

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Abstract
Mushroom is an enlarged complex aboveground fleshy fruiting body of a fungus (such as a *basidiomycete*) that consists typically of a stem bearing a pileus especially one that is edible. Wheat bran, lime and sugar were used which serves as supplements and added to the sawdust; these were varied into five treatments. The treatment (T1) consist of wheat bran, lime and sugar, treatment (T2) consist of wheat bran and lime, treatment (T3) wheat bran only, treatment (T4) lime only and fifth treatment (T5) wheat bran and sugar. One kilogram of substrate was used per bag. The protein content ranged from 25.12- 30.72% from the five treatments, while the moisture content in percentage obtained ranged from 73.42-79.35%. In terms of ramification of the bag placed in the dark room, all five treatments attained full ramification stage (100%) at fourth week. The analysis of variance carried out showed significant difference ($P \leq 0.05$) in yield (g/kg) of mushroom. Hence, T1 had the highest yield, followed by T2, T4, T3 and T5, with mean yield values of 141.65±7.86, 92.56±4.71, 86.96±3.45, 64.08±2.22 and 52.11±2.04 (g/kg) respectively. Range of 31.79-84.61% biological efficiency (BE) was obtained across the five treatments.

Keywords: Biological Efficiency, Proximate, Mycelia, Supplement, Ramification

Introduction

Macro fungi are an intrinsic part of forest ecosystems and a critical constituent for their existence and restoration. A great diversity and diverse ecological functions of the macro fungi species in nature are the basis of ecological stability in the forest communities. Greater attention has recently been paid to their participation in forest development, silviculture, forest regeneration, and forest protection (Pavlík and Pavlík 2013). About 25 species of more than 2000 edible fungi are widely accepted for human consumption but only a few of them are cultivated commercially (Chang, S.T., *et al*. 1992) . Mushroom is a food of high quality flavor and nutrition value, with high content of protein, low content of fat, vitamins (B1, B2, C, niacin, biotin etc), minerals (P, K , Na, Ca) and high content of fibres and carbohydrates (Peter, 1991 and Ekpo *et al*., 2002). Mushrooms are known as healthy foods throughout the world with proteins, vitamins, minerals, chitin, essential amino acids and low fat and calories (Valverde *et al.,* 2015). The nutritional value of mushroom is comparable to foodstuffs such as corn, soybeans or beans. They are especially important foods because of the basic amino acids they contain. Within the mushrooms, there are proteins at levels ranging from 5-49% of dry weight, in addition to protein, dietary fibers, minerals, such as potassium, phosphorus iron, and vitamins and carbohydrates (Valverde *et al.,* 2015). Mushrooms are used for treatment of chronic catarrh, diseases of the breast and hinges, they lower the cholesterol level of blood, improve circulation, serve as remedy for night sweating in tuberculosis, rheumatism, jaundice, dropsy, intestinal worms and have anti-tumour, anti-viral and anticancer agents (Rehana *et al*., 2007). The study aimed at evaluating the effect of supplements on the growth performance and nutritional composition of P. *sajor-caju* cultivated on sawdust.

Materials and Methods

Culture preparation: The pure culture of *Pleurotus sajor-caju* was obtained from the Pathology section of Forestry Research Institute of Nigeria, Jericho. Ibadan, Nigeria. The cultures were maintained on Potato dextrose agar slants at 4^0C, and sub culturing done after 15days.

Spawn preparation: Spawn was prepared in jam bottles. Whole wheat grains were soaked in cold water overnight, washed and drained of excess water. The grains were boiled in water bath for 15min, packed

(250g) in jam bottles and sterilized in an autoclave at 121^0C for 30min. After sterilization, the bottles were inoculated with actively growing mycelia of *Pleurotus sajor-caju* from the slants and incubated at (28 ± 20C) for mycelia growth in the dark room 10-15days until the bottles are fully ramified.

Substrates preparation and Cultivation: The sawdust of *Triplochiton scleroxylon* (Obeche) was collected from sawmills in Ibadan South, Western Nigeria and made into heap, thoroughly watered till it attained about 65% moisture content. The sawdust was mixed with 5% wheat bran, 1% lime (CaCo3) and 1% sugar. The sawdust was composted for 30days being turned at five days interval until rancid odour disappeared. Thereafter, 1% CaCo3, 1% sugar and 5% wheat bran were varied into five treatments and added to the substrates to enhance the mushroom growth. The first treatment (T^1) consist of wheat bran, lime and sugar, second treatment (T^2) of wheat bran and lime, third treatment (T^3) wheat bran only, fourth treatment (T^4) lime only and fifth treatment (T^5) wheat bran and sugar. Each treatment was mixed with water to moisten the substrates. The polythene bags of size 15cm x 35cm were filled with substrate of 1kg and sterilized in an autoclave at 121^0C for 2hours. After sterilization, the substrate bags were allowed to cool. Thereafter, the substrate bags were inoculated with spawn (mushroom seed). The spawn was added at the rate of 2% of the wet weight basis of substrate. After inoculation, the bags were kept in house where the temperature and humidity were maintained around 25^0C and 80-90% with sufficient ventilation for 3-4weeks. The spawn run was completed within 25days. The polythene bags were torn-off at the tips following the spawn run. Formation of fruit bodies was evident within 4-5days after opening the polythene. The bags were maintained up to the harvest of the fifth flush, which was completed in 43days after spawning. A small layer of substrate was scrapped off from all the side of the bags after each harvest. Each of the five treatments was replicated five times.

***Yield and Biological efficiency*:** Parameters such as length of stipe, height, diameter of Pileus and total weight of the fruiting bodies harvested from all the five picking were measured as total yield of the mushroom. The biological efficiency was calculated thus;

$$\text{B.E. \%} = \frac{\text{Fresh weight of mushroom}}{\text{Dry weight substance}} \text{x100}$$

***Moisture content*:** The moisture content of mushroom was also expressed in percent and calculated thus;

$$\text{Moisture content (\%)} = \frac{\text{Weight of fresh samples – weight of dry sample}}{\text{Weight of fresh sample}} \text{x100}$$

Nutritional Analysis: Protein, fat, ash, crude fibre and total carbohydrate were determined with the procedure recommended by AOAC (1995).

Data analysis: The data obtained in this study were analyzed using analysis of variance and descriptive statistics with the aid of statistical packages for social sciences (SPSS) version 16.

Keys:
T1= wheat bran, lime and sugar
T2= wheat bran, lime
T3= wheat bran only
T4= lime only
T5= wheat bran and sugar

Results and Discussion

The proximate composition of the fruiting body of *P.sajor-caju* grown on sawdust is presented in Table I. The moisture content (%) ranged from 73.42-79.35%. T5 had the highest moisture content followed by T^1, T^4, T^3 and T^2 with values of 79.35, 77.54, 76.79, 74.11 and 73.42% respectively. Consequently, the protein contents encountered across the five treatments were found to be relatively higher, and ranged from 25.12-30.72%. Similar result were obtained by Nurudeen *et al*., (2013) who reported protein content of 30.12 for *P. sajor-caju* grown on sawdust. Syred *et al*. (2003) also confirmed that protein content of mushroom is the highest. The result of the protein content obtained is an indication that nutritional status of *P.sajor-caju* can be influenced by substrates composition. The percentage fat content exhibited by *P.sajor-caju* across the five treatments is an indication that mushrooms is low in fat and cholesterol (Syred *et al*., 2003). The observation made in their fibre and ash content is equally noteworthy as fibre content help to facilitate digestion in man (Onuoha, 2007). The carbohydrate content of these mushroom ranged from 61.04 to 70.15% as shown in Table 1. The result is similar to those obtained by Nurudeen *et al*. (2013) who reported carbohydrate content of *P.sajor-caju* grown on different agricultural wastes ranged from 65.68-67.22%. Despite variation in supplement added, the overall nutritional values of the mushrooms across the five treatments were good. The effect of supplements was not significant on the nutritional composition of *P.sajor-caju*, however, T1 indicated higher nutritional content compared to others. Table 2 shows the mycelia growth from the bags on weekly basis. This was observed for four weeks and the percentage performance recorded. There is no clear variation in mycelia ramification across the five treatments. Hence, all the treatments attained 100% ramification by the fourth week, therefore, there was significant difference in the ramification of all five treatments. Table 3 present mean length of stipe (cm) attained by *P.sajor-caju* across the treatments. For the first flush, T1 had the highest length (cm) followed by T2, T4, T5 and T3 with their values as 7.2, 6.5, 6.1, 4.5, and 3.6cm respectively. There was harvest for T5 up till fourth flush and stooped at flush 5. While T1, T^2, T3 and T5 produced till fourth flush, T4 stopped fruiting at third flush. T1 and T2 successfully produced up to fifth flush. Supplement inadequacy may be responsible for the inability of T3, T4 and T5 to produce fruit at the other flushes as observed by the findings of Ekpo *et al*. (2008) who reported that supplement such as lime and wheat bran contributed to the high yield of the mushroom (*Pleurotus florida*). From the result obtained (Table 4 and 5), the mushroom height and the diameter of pileus obtained from the fruiting mushroom is an indication that supplements have significant achievement in the yield and fruit body production of *P.sajor-caju*.

The biological efficiency (%) is presented in Table 6. The obtained result showed that T1 (wheat bran, lime and sugar) had the highest biological efficiency followed by T4 (lime only), T2 (wheat bran and lime), T3 (wheat bran only) and T5 (wheat bran and sugar) with B.E (%) of 84.61, 59.85, 57.28, 43.52 and 31.61 respectively. The result showed that T1 utilized the substrate effectively, thus resulted in high B.E (%). This can be attributed to the fact that all the supplements were found present in T1 and the fungus (*P.sajor-caju*) was able to utilize all the nutrients which in turn led to better fruiting body. The low B.E encountered in T3 and T5 could be attributed to supplement deficiency, an indication that B.E depends on availability of supplement. There was a significant difference from the analysis of variance, therefore, the need for follow up procedure using Duncan multiple range test (DMRT) to separate the mean difference (Table 6). The result obtained indicated that the highest yield were found in T1 followed by T2, T4, T3 and T5 with mean yield values of 141.65 ± 7.86, 92.56 ± 4.71, 86.96 ± 3.45, 64.08 ± 2.22 and 52.11 ± 2.04 (g/kg) respectively. This result shows that the supplements added helps in the yield of *P.sajor-caju*. Consequently, it could be deduced from the result that the higher the yield of the fruiting body, the higher the biological efficiency (Table 6). Furthermore, the implication of this is that the more the fruiting body produced by *P.sajor-caju*, the better the fungus (*P.sajor-caju*) utilizes the substrate and this in turn led to higher B.E (%). The yields produced by *P.sajor-caju* across the five treatments were found to be good except in T5 (wheat bran and sugar) whose yields were a bit lower compared to the others (52.11 ± 2.04). The result obtained is in agreement with Nurudeen *et al*. (2012), that lime plays a vital role in mushroom cultivation by sustaining the yield of the fruiting body and making the substrate conductive for growth. Lime (CaCo3) present in mushroom cultivation as reported by Nurudeen *et al*. (2012), neutralizes the soil pH, hence, sawdust is close in texture when compared with soil, thereby making it possible for it to stabilize the pH of sawdust, and consequently aids microbial activities of the substrate and in turn contributed to the yield performance of the fruiting body.

Conclusion

Reactions of different supplements on the yield and nutritional constituents of oyster mushroom (*Pleurotus sajor-caju*) cultivated on sawdust were established in this study. Though there are variations in supplements added to the saw dust for the production of *P.sajor-caju*, the nutritional content obtained was good. Also, the result of the proximate analysis shows that, the effect of supplement was not significantly different. Furthermore, from the results obtained, lime (CaCo3) was found to be very important as it helps in neutralizing the substrate pH level, thus, aids microbial activities which resulted into sporophore emergence and high yield of the fruiting body. This shows the importance of lime in mushroom cultivation which cannot be ignored as an important supplement. Also supplement such as wheat bran enhanced the richness of the substrate, thus, resulted to high yield performance of *P.sajor-caju.* The use of saw dust and other lignocellulose materials in the cultivation of mushroom will help in decongesting the environment of waste that could pose as threat to the people and the surroundings. Mushroom cultivation is a good source of wealth generation and job creation too. Therefore, individuals and government should embrace the technology.

Table I: Proximate analysis of fruiting body of *P.sajor-caju* grown on *Triplochiton scleroxylon* (Obeche) sawdust

	T1	T2	T3	T4	T5
Ash	5.68	5.11	6.82	6.51	6.49
Carbohydrate	70.15	69.11	65.49	61.04	62.44
Fat	0.75	0.72	0.67	0.73	0.64
Fibre	8.39	7.25	5.78	8.11	7.11
Moisture	77.54	73.42	74.11	76.79	79.35
Protein	30.72	29.48	27.52	25.12	27.18

T^1= wheat bran, lime and sugar T^2= wheat bran, lime T^3= wheat bran only T^4= lime only T^5= wheat bran and sugar

Table 2: Mean mycelia growth (%) exhibited by substrates on weekly basis

Treatment	WK1	WK2	Wk3	WK4
T^1	36.13	67.17	92.14	100
T^2	27.70	60.15	81.40	100
T^3	26.48	53.11	70.02	100
T^4	23.72	48.11	75.61	100
T^5	22.17	46.81	60.37	100

T^1= wheat bran, lime and sugar T^2= wheat bran, lime T^3= wheat bran only T^4= lime only T^5= wheat bran and sugar

Table 3: Mean length of stipe (cm) per flush of mushroom grown on *Triplochiton scleroxylon* (Obeche) sawdust

Treatment	Flush1	Flush2	Flush3	Flush4	Flush5
T^1	7.2	8.2	6.3	7.5	6.5
T^2	6.5	7.2	7.1	8.6	6.1
T^3	3.6	4.6	3.7	5.8	-
T^4	6.1	6.9	7.5	–	-
T^5	4.5	4.7	5.2	5.4	-

T^1= wheat bran, lime and sugar T^2= wheat bran, lime T^3= wheat bran only T^4= lime only T^5= wheat bran and sugar

Table 4: The mean mushroom height (cm) grown on *Triplochiton scleroxylon* (Obeche) sawdust

Treatment	Flush1	Flush2	Flush3	Flush4	Flush5
T^1	9.2	9.6	7.3	8.4	8.5
T^2	7.5	9.2	8.3	9.2	9.1
T^3	7.2	8.5	6.9	7.5	-
T^4	8.9	8.1	8.6	–	-
T^5	6.4	7.2	7.1	6.9	-

T^1= wheat bran, lime and sugar T^2= wheat bran, lime T^3= wheat bran only T^4= lime only T^5= wheat bran and sugar

Table 5: The mean diameter of pileus (cm) of mushroom grown on *Triplochiton scleroxylon* (Obeche) sawdust

Treatment	Flush1	Flush2	Flush3	Flush4	Flush5
T^1	6.2	7.2	7.7	5.0	6.1
T^2	6.5	5.6	7.2	5.9	6.5
T^3	5.2	6.1	5.8	5.4	-
T^4	6.1	6.7	7.0	–	-
T^5	5.9	6.0	6.1	6.1	-

T^1= wheat bran, lime and sugar T^2= wheat bran, lime T^3= wheat bran only T^4= lime only T^5= wheat bran and sugar

Table 6: Duncan Multiple Range Test (DMRT) showing the significant difference in the yield of the fruiting body of *P.sajor-caju* cultivated on *Triplochiton scleroxylon* (Obeche) sawdust

Treatment	Mean(g/kg)	±S.E	Duncan rating	B.E (%)
T^1	141.65	7.86	A	84.61
T^2	92.56	4.71	B	57.28
T^3	64.08	2.22	C	43.52
T^4	86.96	3.45	B	59.85
T^5	52.11	2.04	D	31.61

Mean carrying the same alphabet are not significantly different from each other ($p \leq 0.05$)

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