ASSESSMENT OF THE SUITABILITY OF CASSAVA PEELS AND SAWDUST BASED SUBSTRATE IN THE CULTIVATION OF AN EDIBLE MUSHROOM (*Plurotus tuber-regium*).

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ABSTRACT

This study assessed the suitability of the cultivating *Pleurotus tuber-regium* on a mixture of cassava peels and sawdust based substrates. Two percent lime was added to stabilize the pH of the substrate while 5% wheat bran was added (addictive) to enrich the substrate with nitrogen. The experiment was laid out in a completely randomized design (CRD) and replicated three times. The treatments for this investigation comprised of the following ; T1 (100% cassava peels) as the control, T2 (75% cassava peels and 25% sawdust), T3 (50% cassava peels and 50% sawdust), T4 (75% cassava peels and 25% sawdust) and T5 (100% sawdust). The chemical properties of the treatments were evaluated at the Federal University of Technology, Owerri, School of Agriculture and Agricultral Technology, general laboratory. The following chemical properties were evaluated; Moisture content (%), Nitrogen (%), Carbon (%), pH and C/N ratio, while the yield parameters includes: Mean mushroom weight (MMW) in grams, Mean number of mushroom (MNM), Stipe lenght (cm), Pilus diameter (cm), Biological effeciency (%) and Age at first fruiting (days). The data generated were subjected to analysis of variance (ANOVA) at (p=0.05). The result obtained from the evaluation of the chemical properties showed significant differences in all the parameters evaluated namely; Moisture content (64.7-70%), Nitrogen (0.09-1.22%), Carbon (17.8-18.9%), pH (7.2-8.5) and C/N ratio (15.4-26.2). Significant differences were also recorded in the following yield parameters viz MMW (0-30g), MNM (0-8), lenght of stipe (0-5.1cm), Pilus diameter (0-3.0cm), Biological efficiency (0-3.0%), and Age at first fruiting (0-37.7 days). The result further revealed that T3, T4 and T5 were outstanding in supporting the growth and colonization of *P.tuber-regium* and fruitbody producton. The major findings from this study showed that cultivating *P.tuber-regium* on cassava peels require supplimentation with different levels of sawdust to ensure adequate growth/ colonization and fruitbody production, however further studies is recommended especially to determine the optimum levels of sawdust and wheat bran for *P. tuber-regium* production.

Key words: Assessment, Suitability, Cassava peels, Sawdust, Substrate, Cultivation, Mushroom

1.0 INTRODUCTION

Cassava (*Manihot esculenta* Crantz, Euphorbiaceae) is the sixth most important food crop globally, in terms of annual production (FAOSTAT, 2010), and it is a staple food for approximately 800 million people (Lebot, (2009).This perennial root crop is grown in the tropics, including sub-Saharan Africa, Asia, Pacific Islands, and Central and South America (Lebot, 2009; Burns, *et al.*, 2010). In the tropics, cassava is the most important root crop and the fourth most important calorie source, after rice, maize and sugar cane.

The cassavs peel is a byproduct of processing the roots for starch, flour, and "gari" (a fermented cassava meal product) which constitute 11% of the root, with approximately 400,000 MT (dry matter basis) of it produced annually (FAOSTAT, 2012). Cassava peels and corncobs are lignocellulosic materials which consist of three main components, namely, cellulose, hemicellulose, and lignin (Baah, *et al*., 2011; Youri, 2003). In many developing Countries cassava is also the cheapest available calorie source. It produces the highest calorie yields per hectare of all staple crops and has a high efficiency of energy unit per labour input ratio, as its cultivation requires much lower labour input than most tropical crops. (De Vries, *et al.* 1967; Coursey and Haynes, 1970; Onwueme and Charles, 1994).

Cassava processing yields by-products that can be valuable livestock feeds when properly processed such as peels which represent about 5-15% of the root (Aro, *et al*. 2010; Nwokoro, *et al*. 2005). They are obtained after the tubers have been water-cleansed and peeled mechanically (Aro, *et al.* 2010). They may contain a high amounts of cyanogenic glycosides and have a higher protein content than the other parts of the tuber (Tewe, 2004).

Wood and agro-industries generate huge amounts of wastes annually which are often not properly disposed of in an environmental friendly manner were they constitute hazard to humans and the

environment (Elenwo, and Okere 2007). The efficent re-integration of wastes through recycling especially through edible mushroom cultivation will not only minimize health hazards in the environment but can serve to generate wealth (Elenwo and Okere, 2007). Chang and Miles (1989) believed that using only 25% of the yearly volume of burnt cereal straws in the world for mushroom production could result in a mushroom yield of 317 million metric tons (317 billion kg) of fresh mushrooms per year. It is also the belief of Poppe (2004) that about 360 billion kg of fresh mushrooms would have been produced from the estimated 600 billion kg of dry wastes generated from agriculture (500 billion kg) and forestry (100 billion kg) within a year. Such level of mushroom production will directly translate to 60kg of mushroom per head per year which will automatically provide the 4% protein content of mushroom to them.

In the cultivation of mushrooms, various lignocellulosic wastes are used as substrates and these act as sources of nutrients for their growth (Upadhyay, 2002). These wastes include, among others cereal grains, rice straw, wheat straw, cottonseed hulls, soybeanmeal, and sawdust (Przybylowicz, and Donoghue, 1990; Levanon, *et al*., 1993; Bisko, *et al*., 1996; Philippoussis, *et al*., 2001). Due to varying nutrients in the substrates, different mushroom yields have been recorded by various workers (Adebayo, *et al*., 2009; Baig, *et al*., 2009). *Pleurotus* spp. are macrofungi which utilize polysaccharides (cellulose and hemicelluloses) from various lignocelluloses to produce expensive protein for human consumption (Gbedemah, *et al.*, 1998; Frimpong-Manso, *et al*., 2011). Their global economic value is now incredible, and the reason for the rise in consumption is a combination of their value as food (Kala, 2009;Kortei, 2008) and their medicinal or nutraceutical properties (Kortei, 2011; Ferreira, 2010; Ferreira, 2009; Singh, 2012).

Therefore the aim of this study is to evaluate the suitability of cassava peels and sawdust based substrate in the cultivation of edible mushroom with the aim of utilizing the spent mushroom substrate as a feed stock for formulating livestock feed.

2.0 MATERIALS AND METHODS

2.1 Study site and source of sample.

This research was conducted at the Federal University of Technology Teaching and Research Farm Owerri, Imo State Nigeria. Cassava peels and sawdust were collected around Eziobodo community, while mushroom spawns established on guinea corn seed were obtained from Dilomat mushroom farm and services Port Harcourt Rivers State Nigeria.

2.2 Sample preparation.

Samples were prepared according to the modified method of Stamets, (2000). Shredded and moistened cassava peels and sawdust were mixed with 5% wheat bran. Two per cent lime ($CaCO_3$) was added to correct the pH of the substrate. The five combination of cassava peels and sawdust represented the treatments which were replicated three times and composted for one week**.** One kg of the composted substrate were measured into high density polypropylene bags. The bags were packed inside a drum steamer and pasteurized for three hours and allowed to cool overnight before been inoculated with spawn of *Pleurotus tuber-regium* grown on guinea corn seed. The inoculated substrates were incubated at ambient temperature in a specially constructed growth chamber. After incubation, the bags were opened after 43 days of spawning for fruit body production.

2.3 Laboratory analysis

The chemical properties of the substrate were determined using standard proceedures at the School of Agriculture and Agricultural Technology, Federal University of Technology Owerri general laboratary.

2.4 Productivity evaluation

The following parameters were measured: Mean Mushroom Weight (w/w) (MMW) in grams using a scale balance, Mean Number of Mushroom (MNM) by counting, Stipe lenght (cm) and Pilus diameter (cm) were measured using a ruler, Biological efficiency (B.E) in percent was measured as the mushroom fresh weight produced per 100 g of substrate used. Age of the substrate at first fruiting (days) . The substrates were lightly watered to induce fruiting. The production cycle for this study was 65 days.

2.5 Experimental design and data analysis

The experiment was laid out in a completely randomized design. The data generated were subjected to analysis of variance (ANOVA). Means were separated using Fishers Least Significant Difference at p=0.05 according to the procedure outlined by Steel and Torrie, (1982).

3.0 RESULTS AND DISCUSSION

3.1 Evaluation of the chemical properties of the mushroom substrate

The results obtained from the evaluation of the chemical properties of the mushroom substrate is presented in Table 1.

Moisture content (%)

The result showed that the control T1 (100% cassava peels) had less moisture content than all the other treatments by 3.6, 4.0, 5.3 and 4.4% for T2 (75% cassava peels + 25% sawdust), T3 (50% cassava peels + 50% sawdust), T4 (75% cassava peels + 25% sawdust) and T5 (100% sawdust) respectively, while T2 had 0.4, 1.7, and 0.8% less moisture than T3, T4 and T5 but 3.6% higher moisture content than the control (T1). T3 also had 1.3 and 0.4% less moisture content than T4 and T5 but 4.0 and 0.4% higher moisture content than T1 and T2, respectively.T4 had higher moisture content than all the treatments by 5.3, 1.7, 1.3 and 0.9 % for T1, T2, T3 and T5, respectively. T5 also had 0.9% less moisture content than T4 but higher moisture content

than T1 (the control), T2 and T3 by 4.4, 0.8 and 0.4% , respectively which were highly significantly different. This study revealed that the optimum moisture content of the substrate for mushroom cultivation on cassava peels and sawdust based substrate was 64.7-70.0 % which were significantly different. This result is in agreement with the findings of Elenwo and Okere, (2007) who stated that relatively high moisture content of the growth medium above 70 % during the composting period hinders mycelia growth. This also agreed with Kleb's first principle which states that cessation of vigorous vegetative mycelia growth depends on either the exhaustion of nutrients or the accumulation of staling factors like excess moisture in the medium.

Nitrogen (%)

T1 (the control) had 0.54, 0.07, 0.49 and 0.53% higher nitrogen than T2, T3, T4 and T5, while T2 had 0.54, 0.47, 0.05 and 0.01% less nitrogen than T1 (control) , T3, T4 and T5, respectively. However, T3 had 0.07% less nitrogen than the control but 0.47, 0.42, 0.42 and 0.46 % higher nitrogen than T2, T4 and T5, respectively. T4 had 0.49 and 0.42 % less nitrogen than T1 and T3 but 0.05 and 0.04% higher than T2 and T5, respectively. T5 had 0.53, 0.46 and 0.04 % less nitrogen than T1, T3 and T4 but 0.01% less than T2. The result further showed that T1 (100% cassava peels ie the control) contained significantly the highest level of nitrogen which is in aggreement with the findings of Tewe, (2004) who observed that cassava peels contained higher nitrogen content than the other parts of the tuber.

Carbon (%)

T1 had 0.6, 0.7, 1.10 and 0.8 % higher percent carbon than all the other treatments namely T2, T3, T4 and T5, respectively, while T2 had 0.6 % less carbon than T1, but 0.1, 0.5 and 0.2% higher than T3, T4 and T5, respectively. T3 had 0.7 and 0.1 % less carbon than T1 and T2 but 0.4 and 0.1% higher carbon than T4 and T5, respectively. However T4 had less carbon than all the other treatments by 1.10, 0.50, 0.40 and 0.30 for T1, T2, T3 and T5, respectively. T5 had 0.3% higher carbon than T4 but less than all the other treatments viz T1, T2 and T3 by 0.8, 0.2 and 0.1 % , respectively which were also significantly different.

pH

T1 (control) had 0.2 less pH than T2 and T4 but 0.9 and 1.0 higher pH than T3 and T5, respectively. T2 had equal pH value with T4 but higher value than T1, T3 and T5 by 0.2, 1.10 and 1.20, respectively. T3 had 0.10 higher pH value than T5 but less than all the other treatments by 0.9, 1.10 and 1.10 for T1, T2 and T4, respectively. T4 had higher pH than T1, T3 and T5 by 0.2, 1.10 and 1.20, respectively but equal pH with T2. However , T5 had less pH value than all the other treatments by 1.0, 1.2, 0.1 and 1.2 for T1, T2, T3 and T4, respectively which were significantly different. The result also showed that the treatments with pH values above 8 had poor mycelial growth while the treatments with pH of 7 had better mycelial growth.This observation is in aggreement with the findings of Kortei, *et al.*, (2014) and Wajid-Khan, *et al.*, (2013).

C/N Ratio `

T1 had less C/N ratio than all the other treatments by 11.5, 0.43, 9.0, 10.2 for T2, T3, T4 and T5, respectively, while T2 had higher C/N ratio than all the other treatments by 11.5, 11.1, 2.5, 1.3 for T1, T3, T4 and T5, respectively. However, T3 had 0.43 higher C/N ratio than T1 but 11.1, 8.6 and 9.8 than T2, T4 and T5, respectively. T4 had 2.5 and 1.2 less C/N ratio than T2 and T5 but higher C/N ratio than T1 and T3 by 9.0 and 8.7, respectively. T5 had 1.3 less C/N ratio than T2 but higher C/N ratio than T1, T3 and T4 by 10.2, 9.8 and 1.2, respectively which were significantly different. Additionally, the result further revealed that T1 and T2 with low C/N ratio of 15.4 and 15.5 had poor mycelial growth hence zero fruitbody production unlike the treatments with C/N ratio above 26.2. This findings are also in aggreement with the findings of Mantovani, *et al.*, (2007) who reported that higher C/N ratio promoted good fungal growth as they investigated the effect of addition of nitrogen sources to cassava fiber and C/N ratios on fungal growth.

Table 1. Evaluation of the chemical properties of the mushroom substrate

Treatment	Moisture content(%)	Nitrogen(%)	Carbon(%)	pH	C/N
T1	64.7^{b}	1.22^{a}	18.9^{a}	8.3^{b}	$15.4:^{d}$
T2	68.3^{b}	1.18^{b}	18.3^{b}	8.5^{a}	15.5^{a}
T3	68.7^{b}	0.95^{c}	$18.2^{b,c}$	7.4^{c}	19.2^{d}
T4	70.0^{a}	0.73^{d}	17.8^{d}	7.2^{c}	24.3^{c}
T5	69.0^{b}	0.69^{e}	18.1^{c}	7.3^{c}	26.2^{b}
LSD ($_{p=0.05}$)	**0.372**	**0.0082**	**0.082**	**0.0816**	**0.489**

Key: T1=100% cassava peels
T2= 75% cassava peels +25% sawdust
T3 =50% cassava peels + 50% sawdust
T4 =25% cassava peels + 75% sawdust
T5= 100% sawdust
Mean values within the same colume with no common superscript letter differs

3.2 Evaluation of the yield and yield components of the mushroom

The result obtained from the evaluation of the yield and yield components of the mushroom is presented in Table 2.

Mean mushroom weight (MMW) : The results obtained from the evaluation of the MMW showed that T1 (the control) did not support the growth/ colonization of mycelium while T2 supported mycelial growth/colonization but did not produce any mushroom fruitbodies. This could be attributed to the high level of hydrogen cynaide which could hinders mycelial growth and low C/N ratio of about 15.5 (Table 1). This agrees with the findings of Mantovani, *et al*. (2007) who reported that greater C/N ratios promoted good fungal growth. T3 produced 5g higher MMW than T4 but had 10g less than those produced from T5. T4 produced 5 and 15 g less MMW than T3 and T5, respectively. However, T5 produced 10 and 15g higher MMW than T3 and T4, respectively which were significantly different. This result suggests that supplimenting cassava peels with sawdust influenced the MMW of *P. tuber-regium.* However the low yield obtained from this investigation could be attributed to poor environmental conditions in the growth chamber. This result is in agreement with the findings of Das, *et al.* (1991) which stated that variations in seasons seriously affect the number of mushroom fruit bodies produced. They reported that favorable temperature and moisture conditions enhanced the production of fruiting bodies of mushroom.

Mean number of mushroom (MNM): The result further showed that T3 had 2.6 more MNM than T4 and T5 while T4 produced more fruitbodies by 4 than T5 but less than T3 by 2. However T5 produced less number of mushroom fruitbodies than those produced from T3 and T4 by 6 and 4 which were significantly different which further suggest that supplementing cassava peels with sawdust enhanced the mean number of mushroom fruitbodies produced. This result is also in aggreement with the findings of Uddin, *et al.,* (2011) and Markson, *et al.,* (2012).

Stipe lenght (cm): The result further showed that T3 produced mushroom fruitbodies with longer stipe than those produced by T4 by 0.5cm but shorter than those produced from T5 by 0.1cm. Furthermore, T4 produced fruitbodies with shorter stipe when it was compared with those produced from T3 and T5 by 0.5 and 0.6cm, respectively, while T5 produced fruitbodies with longer stipe than those produced from T3 and T4 by 0.1 and 0.6cm, respectively which were significantly different.

Pilus Diameter (cm) : Mushroom fruitbodies produced from T3 had smaller pilus diameter than those produced from T4 and T5 by 0.5 and 0.4 cm , while those produced from T4 had larger pilus diameter than fruitbodies produced from T3 and T5 by 0.5 and 0.1cm. On the other hand T5 produced friutbodies with larger pilus diameter than those produced from T3 by 0.4cm but smaller pilus diameter than those produced from T4 by 0.1cm which were significantly different. The low yield obtained from this study could be attributed to poor environmental conditions. This result is in agreement with the findings of Stamets, (1993); Schmidt, (1983) in which they stated that the major ecological factors that affect mushroom yield especially stipe lenght, pilus diameter and pilus size in mushroom are temperature, humidity, fresh air.

Biological efficiency (%)

The result further revealed that T3 had less biological efficiency than T5 by 1.0% but higher than T4 by 0.5%. Furthermore T4 had less biological efficiency than T3 and T5 by 0.5% and 1.5%, respectively while T5 had higher biological efficiency than T3 and T4 by 1 and 1.5%, respectively which were significantly diiferent.The low biological efficiency obtained from this investigation could be attributed to the low mushroom yield obtained from this investigation which is in agreement with the findings of Okere, *et al*., (2014).

Age of the substrate at first fruiting (days)

T3 had longer age at first fruiting when it was compared with T4 and T5 by 2 and 1.3 days, while T4 on the other hand had 2 and 0.7 less number of days at first fruiting than T3 and T5, respectively. Furthermore, T5 had less age at first fruiting than T3 by 1.3 but 0.7 more days than T4 which were significantly different. The relatively long time for fruit body formation after the bags were opened could be attributed to the low temperature and high relative humidity in the growth chamber. This observation is supported by an earlier report by Bano and Srivastava, (1974) who stated that both temperature and humidty play an important role in the mycelial growth and fruit body formation.

Table 2.0 Evaluation of the mushroom yield and yield components

Treatment	MMW(g)	MNM	Lenght of stipe (cm)	Pilus diameter(cm)	BE(%)	Age at first fruiting(days)
T1 (control)	0	0	0	0	0	0
T2	0	0	0	0	0	0
T3	20.0^{b}	10.0^{a}	5.0^{a}	2.5^{b}	2.0^{b}	39.0^{a}
T4	15.0^{c}	8.0^{b}	4.5^{a}	3.0^{a}	1.5^{c}	37.0^{a}
T5	30.0^{a}	4.0^{c}	5.1^{a}	2.9^{a}	3.0^{a}	37.7^{a}
$LSD_{(p=0.05)}$	**0.632**	**0.632**	**0.369**	**0.0632**	**0.0632**	**0.989**

Key: T1=100% cassava peels
T2= 75% cassava peels +25% sawdust
T3 =50% cassava peels + 50% sawdust
T4 =25% cassava peels + 75% sawdust
T5= 100% sawdust
MMW= mean mushroom weight
MNM= mean number of mushroom
BE= Biological efficiency
Means values within the same colume with no common superscript letter differs.

CONCLUSION

The major findings from this investigation are as follows: cultivation of *P. tuber-regium* on 100% cassava peels alone failed to produce mushroom fruitbodies probably due to the presence of Hydrogen cynaide which hindered mycelial growth/colonization but supplimenting with 50 and 75 % sawdust gave a promissing prospect. Further studies is highly recommended.

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