Bioconversion and yield evaluation of an edible mushroom (*Pleurotus ostreatus*) cultivated on cassava and sugarcane peels with wheat bran

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Abstract

This study describes the bioconversion efficiency and yield of *Pleurotus ostreatus* (Jacq. ex Fr.) Kummar, cultivated on cassava and sugarcane peels substrates. Two percent lime and wheat bran were added to stabilize the pH and enrich the substrate with nitrogen. The treatments for this investigation comprised T1 (100% cassava peels - control), T2 (75% cassava peels + 25% sugar cane peel), T3 (50% cassava peels + 50% sugar cane peel), T4 (25% cassava peels + 75 sugar cane peel), and T5 (0% cassava peel + 100% sugar cane peel). The experiment was laid out in a completely randomized design (CRD) and replicated three times in a specially constructed growth chamber. Yield parameters evaluated include mean mushroom weight in grams, mean number of mushrooms, stipe length (cm), pileus diameter (cm), dry weight of fruit bodies (g), dry matter loss (%), biological efficiency (%), bioconversion efficiency (%), and number of mushroom flushes. The nutritional composition of the fruit bodies was determined. The result obtained from the evaluation of the yield attributes revealed significant differences in the following yield parameters namely mean mushroom weight (2.63–32.8 g), mean number of mushroom (1–11.5), pileus diameter (2.56–15.95 cm), length of stipe (1.53–5.85 cm), dry matter loss (23.30–157.5%), dry weight of fruit bodies (0.76–6.67 g), stipe girth (1.3-8.0 cm), biological efficiency (0.26–3.28%), bioconversion efficiency (0.11–0.68%), mean number of mushroom flushes (0.67–2.0) and yield duration (25.67–41.0 days).The result further revealed significant differences in the nutritional compositions of the mushroom fruit bodies: moisture content (20.30–25.07%), crude fiber (1.05–1.27%), ash (0.89–1.01%), protein (30.7–44.38%),crude fat (1.62–1.83%), total soluble carbohydrate (TSC) (28.87–44.18%). The 15.8%, 31.5%, 47.4% and 5.3% of the total mushroom fruit bodies harvested belonged to the 'very small', 'small', 'medium' and 'very big' categories, respectively. T5 was the outstanding in supporting the colonization, yield and bioconversion efficiency of *P. ostreatus*. This study concludes that *P. ostreatus* should not be cultivated on cassava peels alone. Supplementing the sugarcane peels with cassava peels increases the protein content of the fruit bodies.

Keywords: Bioconversion, Cassava, Mushroom, *Pleurotus ostreatus,* Sugarcane.

Introduction

Non-timber forest products (NTFPs), which are referred as minor forest products or non-wood forest products, include goods and services of biological origin excluding wood derived from forest and allied land uses (FAO, 2001). It has been reported that these Non-timber forest products which includes edible mushrooms are integral part of the survival and development strategy for the continued well-being of man, livestock, flora and fauna (Jimoh *et al.*, 2012). In economic terms, Non-timber forest products contribute significantly to international trade, nutrition and economic growth globally. The wild plant resources contribute an average of US$ 194–1114 per household per year in South Africa (Shackleton, 2000). However, these Non-timber forest products especially edible mushroom are continuously under threat and presently almost been classified as extinct or endangered species due to rapid urbanization and population explosion in Nigeria and other developing countries of the world. Hence, there is a need to develop appropriate biotechnologies to domesticate and make them available all the year round in order for them to continue meeting the needs of mankind (Okere *et al.,* 2017).

The wood and agro industries produce high levels of waste annually which are either dumped or burnt in places where they constitute hazard to the environment and humans. The recycling and wise utilization of these huge waste materials will not only serve to generate income, but also help to minimize health hazards in the environment (Markson *et al.*, 2012). Mushroom is an economic crop to grow in the developing countries for obvious reasons such as their ability to grow on various agricultural and industrial wastes which results in the production of high quality fruit bodies rich in nutrients with low cholesterol and also helps in the

conservation of the environment through wastes recycling (Khan *et al.,* 2012). *Pleurotus* species can grow on different kinds of substrate material than any other mushroom (Cohen *et al.,* 2002). *Pleurotus* is an efficient lignin-degrading mushroom and can grow and yield well on different types of lingo-cellulosic materials. Cultivation of *Pleurotus* species require very simple and low-cost production technology which is being developed continuously with the potential of high biological efficiency (Wajidkhan *et al.,* 2013).

Cassava peels are lingno cellulosic materials which basically consists of three major components namely cellulose, hemi cellulose and lignin (Youri, 2003; Tewe, 2004). However, Tewe (2004) reported that cassava peels contain higher levels of cyanogenic glycosides and higher protein content than other parts of the tuber. The peel from cassava is a byproduct of processing the cassava tuber. The tuber can be processed into starch, flour and garri, which constitutes about 11% of the roots with about 400,000 MT (dry matter basis) of it produced annually (Oei, 2003). Cassava peels are used to feed livestock in Nigeria and other parts of Africa, hence there is the need to investigate the ability of edible fungi to enrich it for the formulation of livestock feeds. One of the major problems associated with the cultivation of edible mushroom is the lack of technical know-how (Belewu, 2006). Different materials such as rice husk, wheat and other cereals straw, sorghum stover, sawdust, cotton waste, cocoa bean shell including rice straw, water lilly and banana leaves have been as substrates in the cultivation of mushrooms (Bajwa *et al.,* 1999a,b; Belewu and Ademilola, 2002). However, there is the need to investigate the use of other agro-wastes such as cassava peels and sugar cane peel mixture in the cultivation of edible mushroom and to assess its effects on the chemical composition of the spent substrate as a potential livestock feed. Therefore, the aim of this research was to investigate the possibility of cultivating *P. ostreatus* on cassava and sugar cane peels wastes and to evaluate their effects on the nutritional composition of the edible mushroom fruit bodies.

Material and Method

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 was sourced around Eziobodo community, while the sugar peels were obtained from Hausa quarters along Port Harcourt road Owerri. The mushroom spawn established on guinea corn seed were obtained from Dilomat mushroom Farm and Services, Port Harcourt Rivers State Nigeria.

Sample preparation

Samples were prepared according to the modified method of Stamets (1993). Shredded and moistened cassava and sugar cane peels mixed with 2% lime was added to correct the pH of the substrate while wheat bran (2%) was added as an additive to enrich the substrate nutritionally. The treatments for this investigation are as follows: T1 (100% cassava peels control), T2 (75% cassava peels + 25% sugar cane peel), T3 (50% cassava peels + 50% sugar cane peel), T4 (25% cassava peels + 75 sugar cane peel) and T5 (100% sugar cane peel). The experiment was composted for two weeks while 1 kg of the composted substrate was 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 *P. ostreactus* grown on guinea corn seed. The inoculated substrates were incubated at ambient temperature in a specially constructed growth chamber, the temperature and relative humidity were monitored. The bags were opened and lightly watered to induce fruiting after 43 days of spawning for fruit body production.

Productivity evaluation

The following parameters were measured: Mean mushroom weight in grams that was obtained by taking the wet weight of each flush. Mean number of mushroom was obtained by counting the number of fruit bodies from the mushroom flushes. Stipe length (cm) and pileus diameter (cm) were measured using a measuring tape. Dry matter loss (%) represents the ratio of the weight of the substrate at spawning and weight of the substrate at the end of the production circle. Dry weight of the fruit bodies in grams was also measured. Biological efficiency (%) was calculated thus: grams of fresh mushroom produced per 100 g of dry substrate used. Bioconversion or bio-transformation efficiency (%) was calculated as grams of dry mushroom produced per 100 g of dry substrate used. The number of mushroom flushes produced was also evaluated. The mushroom quality were evaluated based on different size groups according to the methods described by Elenwo and Okere (2007) classified as follows: pileus diameter above 13 cm (very big), 10–13 cm (big), 5–10 cm (medium) 2.5 cm (small) and 0–2 m very small. The production cycle for this study was 65 days.

Experimental design and data analysis

The experiment was laid out in a completely randomized design and replicated three times. 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 (1980).

Laboratory analysis

The proximate analysis was conducted to determine the nutritional composition of the mushroom fruit bodies using standard procedures at the Biochemistry Laboratory, School of Biological Sciences, Federal University of Technology Owerri, Nigeria.

Results and Discussion

Mean mushroom weight (g)

The result obtained from the evaluation of the effects of the treatments on the bioconversion and yield parameters of *P. ostreatus* grown on cassava and sugarcane peels is presented in Table 1. The result revealed that T1 (control) which had 100% cassava peels were not colonized and fruit bodies were not produced from this treatment. However, T2 produced higher mean mushroom fruit body weight than T3 and T4 by 10.2 and 4.9 g respectively but 19.9 g less than those produced from T5. T3 produced 10.2, 5.3 and 3.2 g less mushroom fruit body weight than those produced from T2, T4 and T5 respectively. T4 had 4.9 and 24.9 g less mushroom fruit body weight than T2 and T5 but 5.3 g more than those produced from T3, while T5 produced 19.5, 30.2 and 24.9 g more mushroom fruit body weight than those produced from T2, T3 and T4 respectively. There was significant difference when mean mushroom weight from T1 was compared with T5. Furthermore, there was significant difference when mean mushroom weight from T5 was compared with those from T2, T3 and T4.

Mean number of mushrooms

The result further revealed that T2 had 0.3, 3.0 and 10.5 less number of mushroom fruit bodies than those produced from T3, T4 and T5 respectively, while T3 produced 0.3 more fruit bodies than T2 but 2.7 and 10.2 less than those produced from T4 and T5. T4 produced 3.0 and 2.7 more fruit bodies than T2 and T3 but 7.5 less than those produced from T5. However, T5 produced 10.5, 10.2 and 7.5 higher number of mushroom fruit bodies than those produced from T2, T3 and T4 respectively which were also significantly different.

Pileus diameter (cm)

The result obtained from the evaluation of the pileus diameter of the mushroom fruit body showed that T2 produced mushroom fruit bodies with 3.9cm pileus diameter larger than those produced from T3 but 0.6 and 9.5 cm less than those produced from T4 and T5 while T3 produced smaller mushroom fruit bodies with less pileus diameter than those produced from T2, T4 and T5 by 3.9, 4.5 and 13.4 cm respectively. However T4 produced fruit bodies with 0.6 and 4.5 cm pileus diameters larger than those produced from T2 and T3 but 8.5cm less than those produced from T5. Furthermore, T5 produced mushroom with 9.5, 13.4 and 8.9 cm larger pileus diameter than those obtained from T2, T3 and T4, respectively, which are also significantly different.

Stipe length (cm)

The result further revealed that T2 produced mushroom fruit bodies with 2.5 and 0.07 cm longer stipe than the fruit bodies obtained from T3 and T4 but 1.9 cm shorter stipe than those produced from T5. T3 produced mushroom fruit bodies with shorter stipe than all the other treatments by 2.5, 2.4 and 4.3 cm for T2, T4 and T5 respectively, while the fruit bodies obtained from T4 had 0.07 and 1.9 cm shorter stipe than those obtained from T2 and T5 but 2.4 cm longer than those obtained from T3. However, T5 produced fruit bodies with longer stipe than those obtained from T2, T3 and T4 by 1.9, 4.3 and 1.9 cm, respectively, which were significantly different.

Dry matter loss (%)

The result of the evaluation of dry matter loss of the substrate showed that T2 had 12.7% higher dry matter loss than T3 but 15.7 and 121.5% less than T4 and T5. T3 had 12.7, 28.3 and 134.2% less dry matter loss than T2, T4 and T5, respectively. However, T4 had 15.7 and 28.3% higher dry matter loss than T2 and T3 but 105.8% less than T5, while T5 had higher dry matter loss than all the other treatments by 121.5, 134.2 and 105.8% for T2, T3 and T4 respectively which were significantly different.

Number of days for fruit body production after induction

The result presented showed that T2 produced mushroom fruit bodies after 11.9 and 0.8 days more than T3 and T4 but it produced fruit bodies 3.5 less number of days than T5. T3 produced mushroom fruit bodies 11.8, 11.0 and 15.3 less number of days than T2, T4 and T5. However, T4 produced fruit bodies 0.8 and 4.3 days less than T2 and T5 but 11.0 more than T3. T5 produced mushroom fruit bodies 3.5, 15.7 and 4.3 more days after induction than T2, T3 and T4 respectively which were significantly different.

Mushroom fruit body dry weight (g)

The result of the mushroom fruit body dry weight showed that T2 produced 1.9 and 1.6 g higher dry weight than those produced from T3 and T4 but 3.9 g less than those produced from T5. Mushroom fruit bodies obtained from T3 had 1,9, 0.3 and 5.9 g less fruit body dry weight than those obtained from T2, T4 and T5, respectively. However, the fruit bodies obtained from T4 had 1.6 and 5.6 g less fruit body dry weight than those obtained from T2 and T5 but 0.3 g higher dry weight than those obtained from T3. T5 on the hand produced mushroom fruit bodies

with higher dry weight than those obtained from T2, T3 and T4 by 3.9, 5.9 and 5.6 g, respectively.

Stipe girth (cm)

The mushroom stipe girth obtained from this investigation showed that T2 produced fruit bodies with 0.2, 2.2 and 6.7 cm smaller girth than T3, T4 and T5, respectively. T3 produced fruit bodies with bigger stipe girth than those obtained from T2 by 0.2 cm but 1.9 and 6.5 cm less than fruit bodies obtained from T4 and T5. However, T4 produced fruit bodies with 2.2 and 1.9 cm larger stipe girth than those obtained from T2 and T3 but they produced fruit bodies with 4.5 cm less stipe girth than fruit bodies obtained from T5. T5 produced fruit bodies with 6.7, 6.5 and 4.5 cm larger stipe girth than those obtained from T2, T3 and T4, respectively, which are equally significantly different.

Biological efficiency and bioconversion efficiency (%)

The result presented further showed that T2 had 1.03 and 0.51% higher biological efficiency than T3 and T4 but 1.98% less than T5.T3 again had less biological efficiency than all the other treatments by 1.04, 0.53 and 3.02% for T2, T4 and T5, respectively. However, T4 had 0.51 and 2.49% less biological efficiency than T2 and T5 but 0.53% higher than T3, while T5 had the highest biological efficiency than all the other treatments namely T2, T3 and T4 by 1.98, 3.02 and 2.49% respectively. Furthermore, T2 had higher bioconversion efficiency than T3 and T4 by 0.19 and 0.16% but 0.41% less than T5. T3 had the lowest value of bioconversion efficiency than all the other treatments by 0.19, 0.03 and 0.60% for T2, T4 and T5 respectively, while T4 had 0.16 and 0.57% less bioconversion efficiency than T2 and T5 but 0.03% higher than T3. However, T5 had the highest bioconversion efficiency than T3 and T4 by 0.41, 0.60 and 0.57%, respectively.

Mean number of mushroom flushes

The result revealed that T2 had 0.33 higher mushroom flushes than T3 but 0.3 and 1.0 less than T4 and T5. T3, however, had 0.3, 0.67 and 1.3 less mushroom flushes than T2, T4 and T5, respectively, while T4 had 0.3 and 0.67 more flushes than T2 and T3 but 0.67 less than T5. However, T5 had 1.0, 1.3 and 0.67 more flushes than other treatments namely T2, T3 and T4, respectively, which were significantly different.

Yield duration (days)

The result on yield duration further revealed that T2 produced mushroom fruit bodies 14.3 and 0.3 days more than T3 and T4 but 1.0 day less than T5. T3 produced fruit bodies for 14.3, 14.0 and 15.3 days less than T2, T4 and T5, respectively, while T4 equally produced fruit bodies for 0.3 and 1.3 days less than the duration of yield for T2 and T5 but 14.0 days longer than T3. However, T5 produced fruit bodies for 1.0, 15.3 and 1.3 days longer than T2, T3 and T4 respectively which were significantly different. These results showed that T1 (control) with 100% cassava peel did not record any significant mycelia growth hence could not produce fruit bodies. This result could be attributed to the high level of Hydrogen cyanide and a higher nitrogen content as reported by Tewe (2004) resulting in low C/N ration which could hinder mycellia growth. This finding is in agreement with the findings of Mantovani *et al.* (2007) who reported that higher C/N ratio will hinder good fungal growth. However, supplementing the cassava peels with various levels of sugarcane peels encouraged fungal colonization with fruit body production. This result further agreed with the findings of Okere *et al.* (2019) who reported that cultivation of *Pleurotus* species on cassava peels required supplementation with other ligno cellulose materials. The result showed that T5 (100% sugarcane peels) were outstanding in both mycelia growth and fruit body production. This could be attributed to the high levels of cellulose, hemicelluloses and lignin which are highly suitable for mushroom cultivation (Arushdeep *et al.*, 2014).

Proximate analysis of the mushroom fruit bodies

The result obtained from the evaluation of the effects of the treatments on the nutritional composition of the mushroom fruit bodies of *P. ostreatus* grown on cassava and sugarcane peels is presented in Table 2.

Moisture content (%)

The result presented revealed that T2 contain 1.97 and 0.97% higher moisture content than the fruit bodies obtained from T3 and T5 but 2.7% less than those harvested from T4. Mushroom fruitbodies obtained from T3 had 1.97, 4.76 and 1.0% less moisture content than fruit bodies harvested from T2, T4 and T5 . However, T4 contained more moisture than T2, T3 and T5 by 2.78, 4.76 and 3.77, respectively. T5 contain 0.57 and 3.75% less moisture when it was compared with fruit bodies harvested from T2, T3 and T4 respectively.There were significant differences when the treatments were compared with each other.

Crude fiber (%)

The result of the analysis of crude fiber revealed that T2 contained 0.11 higher crude fiber than T3 but 0.23 and 0.20 less than T4 and T5, T3 on the other hand, had 0.11, 0.033 and 0.21 less crude fiber than T2, T4 and T5, respectively. However, T4 had 0.22 and 0.033% more crude fiber than T2 and T3 but 0.178% less than T5. However T5 contained 0.201, 0.212 and 0.178% higher crude fiber than T2, T3 and T4, respectively. These results were not significantly different when the treatments were compared among each other.

Ash (%)

The result presented equally revealed that T2 contained 0.056 and 0.050% higher ash than fruit bodies obtained from T3 and T4 but they had 0.063% higher than those obtained from T5. T3 contained less ash than the other treatments namely T2, T4 and T5 by 0.057, 0.007 and 0.120% respectively, while T4 contained 0.12 and 0.113% less than the mushroom fruit bodies obtained from T2 and T5 but 0.0066% higher than fruit bodies from T3. However, T5 contained more ash than fruit bodies obtained from T2, T3 and T4 by 0.063, 0.12 and 0.113%, respectively. The results revealed that T5 was significantly different when it was compared with T1, T2, T3 and T4 while there were no significant differences between T3 and T4.

Protein (%)

The result presented again showed that mushroom fruit bodies obtained from T2 contained 1.65 and 12.43% higher protein than the fruitbodies from T3 and T5 but it had 1.25% less protein than those fruit bodies obtained from T4, T3 had less protein than T2 and T4 by 1.64 and 2.89% but 10.78% higher than T5. Again T4 contained the highest value of protein when it was compared with the other treatments investigated namely T2, T3 and T5 by 1.25, 2.89 and 13.68%, respectively. However T5 contained the lowest value of protein than the fruit bodies obtained from T2, T3 and T4 by 12.43, 10.78 and 13.68%, respectively, which were significantly different.

Crude fat (%)

The presented result revealed that T2 contained 0.043% higher crude fat than T3 but 0.077 and 0.163% less when it was compared with T4 and T5. T3 however had 0.04, 0.12 and 0.207% less crude fat than T2, T4 and T5, respectively. Furthermore, T4 contained more crude fat than T2 and T3 by 0.076 and 0.12% but 0.087 less than T5. T5 had the highest values of crude fat than all the other treatments namely T2, T3 and T4 by 0.16, 0.207 and 0.087%. The result show significant differences among T1, T4 and T5 while there were no significant difference between T2 and T3.

Total soluble carbohydrate (%)

Result obtained from the evaluation of the total soluble carbohydrate equally showed that T2 contained 1.94 higher total soluble carbohydrate than T3 but 0.85 and 13.37 less than T4 and T5. T3 contained the lowest value of total soluble carbohydrate by 1.94, 2.80 and 15.31% for T2, T4 and T5, respectively. While T4 contained 0.85 and 2.80% more total soluble carbohydrate than those obtained from T2 and T3 but 14.49 % less than those obtained from T5. However, T5 had the highest values of total soluble carbohydrate than T2, T3 and T4 by 11.38, 13.33 and 10.53%, respectively. There were significant differences when the treatments were compared between each other.

The treatment with 100% sugarcane peels contained the highest values of crude fiber, ash, crude fat and total soluble carbohydrate but it contained the lowest values of protein than the other treatments that were supplemented with cassava peels. The higher protein content in the treatments that were supplemented with cassava peels could be attributed to the high levels of nitrogen in the cassava peels as reported by Tewe (2004). Therefore, addition of cassava peels to sugarcane peels in the cultivation of *P. ostreatus* increases the level of protein in the fruit bodies, perhaps this could be the first account of this observation.

Evaluation of mushroom quality by different pilus size groups (%)

The results obtained from the evaluation of the quality of mushroom fruit bodies evaluated by different pileus sizes are presented in Table 3. The result showed that a total of 19 fruit bodies were harvested from the four treatments that produced fruit bodies namely T2, T3, T4 and T5. The result revealed that 5.5% of the fruit bodies obtained from T2 belong to the 'medium' category , 5.3% each of the fruit bodies obtained from T3 belong to the 'small' and medium category, while 5.3%, 5.3% and 10.5% obtained from T4 belong to the 'very small', 'small' and 'medium' categories respectively. However, 10.5%, 21.0%, 26.3% and 5.3% mushroom fruit bodies produced from T5 belong to the 'very small', 'small', 'medium' and 'big' categories respectively. The mushroom quality showed that T5 produced more fruit bodies belonging to both the 'medium' and 'big' categories. This could be attributed to the high sugar level present in the sugarcane which is porous and allows for easy colonization by the fungi mycelium, unlike the other treatments that were more compact and less porous. The porosity of the substrate after opening of the bags allows for aerobic conditions which favored fruit body formation as reported by Scharel (1990).

Conclusion

The major findings from this investigation are as follows: *P. ostreatus* cannot be cultivated on cassava peels alone but require supplementation with different levels of sugarcane peels. 100% sugarcane peels were outstanding in both the growth and yield performance but low in protein content. Therefore, supplementing cassava peels with sugarcane peels improves the protein content of the fruit bodies however for the purpose of enriching cassava peels as a possible feedstuff for livestock feeds, T2 (75% cassava peels + 25% sugar cane peels) is highly recommended.

Table 1: Effect of the treatment on yield and yield components of *P. ostreatus.*

Treat-ments	MW (g)	MN	PD (cm)	Stipe length (cm)	DML (%)	DFBO	MDW (g)	SG (cm)	BE (%)	BCE (%)	MMF	YD (days)
T1	0	0	0	0	0	0	0	0	0	0	0	0
T2	12.9^{b}	1.0^{b}	6.5^{b}	4.0^{b}	36.0^{b}	37.5^{a,b}	2.7^{b}	1.30^{c}	1.3^{b,c}	0.27^{b}	1.0^{b}	40.0^{a}
T3	2.6^{b}	1.3^{b}	2.6^{b}	1.53^{c}	23.3^{b}	25.7^{b}	0.76^{c}	1.53^{c}	0.26^{c}	0.08^{c}	0.6^{b}	25.7^{a}
T4	7.9^{b}	4.0^{b}	7.1^{b}	3.93^{b}	51.7^{b}	36.7^{a,b}	1.08^{c}	3.5^{b}	0.79^{b}	0.11^{c}	1.3^{b}	39.7^{a}
T5	32.8^{a}	11.5^{a}	15.9^{a}	5.85^{a}	157^{a}	41.0^{a}	6.67^{a}	8.00^{a}	3.28^{a}	0.68^{a}	2.0^{a}	41.0^{a}
$LSD_{0.05}$	**10.5**	**3.32**	**5.69**	**1.85**	**52.79**	**14.63**	**1.08**	**1.85**	**1.04**	**0.104**	**0.68**	**15.48**

In a column, values with different letters show significant difference.
MW: mushroom weight, **MN:** Mushroom number, **PD:** Pilus diameter, **DWS:** dry weight of substrate, **DML:** dry matter of loss, **DFBO:** days to fruit body formation after opening, **MD:** mushroom dry weight, **SG:** stipe girth, **BE:** biological efficiency, **BCE:** bioconversion efficiency, **MMF:** mean number of mushroom flushes, **YD:** yield duration. **T_1:** 100% cassava peels (control), **T_2:** 75% cassava peels + 25% sugar cane peels, **T_3:** 50% cassava peels + 50% sugar cane peels, **T_4:** 25% cassava peels +75 sugar cane peels, **T_5:** 0% cassava peel + 100% sugar cane peels.

Table 2: Proximate analysis of the mushroom fruit bodies.

Treatment	Moisture content(%)	Crude Fiber(%)	Ash(%)	Protein(%)	Crude Fat(%)	TSC (%)
T1	0^{e}	0^{b}	0^{d}	0^{e}	0^{e}	0^{e}
T2	22.28^{b}	1.06^{a}	0.95^{b}	43.13^{b}	1.67^{b,c}	30.81^{b}
T3	20.30^{d}	1.05^{a}	0.89^{c}	41.48^{c}	1.62^{c}	28.87^{c}
T4	25.07^{a}	1.09^{a}	0.90^{c}	44.38^{a}	1.74^{b}	31.67^{b}
T5	21.31^{c}	1.27^{a}	1.01^{a}	30.70^{d}	1.83^{a}	44.18^{a}
$LSD_{0.05}$	**0.921**	**0.047**	**0.047**	**0.978**	**0.085**	**0.860**

In a column, values with different letters show significant difference. **TSC:** Total soluble carbohydrates, **T_1:** 100% cassava peels (control), **T_2:** 75% cassava peels + 25% sugar cane peels, **T_3:** 50% cassava peels + 50% sugar cane peels, **T_4:** 25% cassava peels +75 sugar cane peels, **T_5:** 0% cassava peel + 100% sugar cane peels.

Table 3: Mushroom quality evaluated by different pileus size groups (%).

Treatments	0–1.9 cm (very small)	2–4.9 cm (small)	5–9.9 cm (medium)	10–12.9 cm (big)	Above 13 cm (very big)
T2	-	-	1(5.3%)	-	-
T3	-	1(5.3%)	1 (5.3%)	-	-
T4	1(5.3%)	1(5.3%)	2 (10.5%)	-	-
T5	2(10.5%)	4(21.0%)	5(26.3%)	1(5.3%)	-
Total	**3(15.8%)**	**6(31.6%)**	**9(47.4%)**	**1(5.3%)**	**-**

References

Arushdeep C, Umar F, 2014. Sugarcane baggasse: A potential medium for fungal culture. *Chin. J. Biol.,* **2014**: Article 840505.

Bajwa R, Kausar R, Javaid A, 1999a. Yield performance of *Pleurotus ostreatus* (oyster mushroom) cultivated on cereal crop residues amended with *Sesbania sesban* leaves. In: *Proc. 2nd Natl. Conf. Plant Pathol.,* September 27-29, 1999, University of Agriculture Faisalabad, Pakistan. pp. 160-164.

Bajwa R, Majeed S, Javaid A, 1999b. Use of EM in mushroom cultivation. I: Yield performance of oyster mushroom (*Pleurotus ostreatus*) on EM treated cotton waste and wheat straw. In: *Proc. 2nd Natl. Conf. Plant Pathol.,* September 27-29, 1999, University of Agriculture Faisalabad, Pakistan. pp. 165-169.

Belewu MA, Ademilola L, 2002. Digestibility response of WAD goats to mushroom (*Volvariella volvacea*) treated cotton waste. *Moor J. Agric. Res.,* **3**: 83-86.

Belewu MA, 2006. Conversion of mansonia tree saw-dust and cotton plants by-product into feed by white rot fungi (*Pleurotus sajor caju*). *Afr. J. Biotechnol.,* **5**: 503-504.

Cohen R, Persky L, Hadar Y, 2002. Biotechnological applications and potential of wood degrading mushrooms of the genus Pleurotus. *Appl.*

Microbiol. Biotechnol., **58**: 582-594.

Elenwo EN, Okere SE, 2007. Waste re-cycling using edible mushroom cultivation. *J. Appl. Sci. Environ. Manage.,* **11**: 153-156.

FAO, 2001. Resource assessment of non-wood forest products: Experience and biometric principles (eds. Jennifer, L.G., Kirsti, T and Nell, B.). FAO, Rome. pp. 109.

Isikhuemhen OS, Okhuoya JA, 1999. Cultivation of *Pleurotus* tuber regium (Fr) Singer for production of edible sclerotia on agricultural wastes. Mushroom Biology and Mushroom Products. Royese (ed) Penn. State University

Jimoh SO, Amusa TO, Axeez IO, 2012. Prevalence, utilization and conservation strategies for non-timber forest production in south western zone of Nigeria. *Resour. Environ.*, **2**: 46-54.

Khan SM, Nawaz A, Ali MA, Ahmad T, Khan NA, Atiq-ur-Rehman, 2012. Response of oyster mushroom on different agricultural wastes of southern Punjab. *Pak. J. Agric. Sci*., **49**: 127-130.

Markson AAA, Madunagu BE, Akpan UD, Eshiet EL, 2012. Growth influences of some additives on the mycelia growth and fruit Body development of *Pleurotus ostreatus*. *J. Biol. Agric. Health.,* **2**: 59-68.

Naraian R, Sahu RK, Kumar S, Garg SK, Singh CS, Kanaujia RS, 2009. Influence of different nitrogen rich supplements during cultivation of *Pleurotus florida* on corn cob substrate. *Environmentalist,* **29**: 1-7.

Oei P, 2003. Mushroom cultivation, appropriate technology for mushroom growers. Backhugs Publishers, Leiden. The Netherlands.

Stamets P, 1993. Cultivation of morels mushroom. *J. Wild Mushroom.,* **11**: 9-15.

Steel GD, Torrie JH, 1980. Principles and procedures of statistics. A Biometrical approach 2nd edition. Mc Grain Hill Book Company Inc. New York. pp. 63.

Shackleton S, Shackleton C, Cousins B, 2000. Re-valuing the communal lands ofSouthern Africa: New understanding of rural livelihoods. ODI Natural Resource Perspectives no. 62. The Overseas Development Institute, London.

Tewe OO, 2004. The global cassava development strategy: Cassava for livestock feed in sub-Saharan Africa IFAD and FAO.

Wajidkhan M, Muhammad AA, Nasir AA, Muhammad AK, Nazir J, 2013. Effect of different levels of lime and pH on mycellial growth and production. efficiency of oyster mushroom (*Pleurotus* spp.). *Pak. J. Bot.,* **45**: 297-302.

Youri MR, 2003. Formulation of media for the production of *Pleurotus ostreatus* using agro-processing waste. MS thesis, Department of Nutrition and Food Science, University of Ghana.