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Research Article

Assessment of yield and nutritional composition of *Pleurotus ostreatus* (Jacq.Ex.Fr) p. Kumm. fruit bodies cultivated on *dactylis glomerata* L. and *chloris gayana* kunth

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ABSTRACT

This study was conducted to determine the influence of agro-waste of *Dactylis glomerata* (DG) and *Chloris gayana* (CG) on the fructification, nutritional composition, and mineral compositions of *Pleurotus ostreatus* fruit bodies. The experiment was conducted in a completely randomized design. Data were analyzed using Statistical Package for Social Scientists (SPSS) version 22.0. Means were separated using Turkey's honestly significant difference at 5% level of significance. Results of the investigation showed that all substrates (CG, DG, and 50% CG + 50% DG) started producing fruit bodies after 15 days. About 50% CG + 50% DG gave the highest number of fruit bodies 297and CG gave the lowest number (184) of fruit bodies. Results on the morphological characteristics of *P. ostreatus* fruit bodies showed that CG and DG substrates performed better than 50% mixture of CG and DG. The result on the proximate (%) composition of *P. ostreatus* fruit-bodies showed that *P. ostreatus* cultivated on all the substrates gave appreciable amount of dry matter (DM), crude protein, and carbohydrate. The ash and crude protein recorded a significant difference ($P \geq 0.05$) between the fruit bodies harvested from CG substrate and fruit bodies harvested from DG substrate and 50% mixture of CG and DG substrate. Fruit bodies harvested from DG substrate contained highest quantities of DM with value (91.17±0.09%) and carbohydrates with value (62.74±0.25%). The DM and carbohydrate contents for DG substrate were significantly different ($P \geq 0.05$) from values obtained in CG substrate. Result of minerals content of *P. ostreatus* fruit bodies in all substrates showed that the fruit bodies contained good quantity of minerals such as calcium, potassium, sodium, and phosphorus but copper was in a low quantity. Therefore, farmers who specialize in mushroom cultivation can substitute compliment these common substrates such as rice straw and wheat straw with CG and DG substrates because they are good sources of *P. ostreatus* fruit-bodies, as well as supporting large number of qualities, nutrient, and fruit-bodies of the mushroom.

Keyword: *Chloris gayana*, *dactylis glomeraata*, fruit-bodies, nutritional composition, yield

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INTRODUCTION

Mushrooms are large reproductive structures of fungi belonging to either *Ascomycota* or *Basidiomycota*. They are fungi fruit bodies which occur seasonally all over the world in various habitat. Mushrooms comprise a large heterogeneous group having various shapes, sizes, and colors, which are quite different in character, appearance, and edibility. More than 2000 mushroom species exist, about 300 species of which are edible, belonging to 70 genera[1] Mushrooms can also be described as, the fleshy spore-bearing fruiting bodies of fungi, typically produced above ground on soil or on its food source (substrate). Based on standard morphology, the word "mushroom" was mostly used to describe those fungi sporophores that have a stem (stipe), a cap (pileus), and gills (lamellae) or pores on the underside of the cap, for example, in the groups Basidiomycota and Ascomycota. However, it is generally referred to a variety of gilled fungi, with or without stems. Mushrooms are also described as macro-fungi with a distinctive fruiting body which can be either epigeous or hypogenous and large enough to be seen with the naked eyes and to be picked by hand.[1] Only fruiting body of the mushroom can be seen whereas the rest of the mushroom remains underground as mycelium. They are heterotrophic, because of

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the absence of chlorophyll, they take up nutrients from outer sources.[2] Mushrooms reproduce by spores, under favorable conditions. The mushroom mycelia accumulate nutrients from the substrate and colonize it and when stimulated by variable environmental conditions, the mycelia colony forms pin-heads (young fruit-bodies). The pin-heads ultimately grow to mature fruit-bodies and finally differentiate into cap and stipe called mushroom.[3] Some mushrooms are capable of `producing underground tuber-like structure called sclerotia. The sclerotia are usually harvested from decaying logs, from the soil or other substrates where the mushroom is growing. The dark brown exterior is peeled off and the white compact mycelia tissue is used for food[4] and as seasoning in soups or in the preparation of the local spicy delicacy in combination with melon seeds.[5]

Mushroom is cultivated worldwide, especially in Southeast Asia, India, Europe, and Africa. Mushroom cultivation represents one of the current economically viable biotechnology processes for the conversion of waste plant residues from forests and agriculture.[6]

Pleurotus ostreatus (Jacq.) P. Kumm, of the Pleurotaceae family, was indigenous to China, but now distributed all over the world, except for the Northwest Pacific because of the arctic climate. Cultivation methods were developed in Germany during World War I and then successfully applied on a large scale. This was the result of the search for new food sources, due to the problem of hunger in Germany.[7] Like many other mushrooms, it is found on dead wood and the branches of living trees, especially hornbeam (*Carpinus* sp.), beech (*Fagus* sp.), willow (*Salix* sp.), poplar (*Populus* sp.), birch-tree (*Betula* sp.), and common walnut (*Juglans regia*). *P. ostreatus*ar florida is tolerant of low temperatures; however, it has high requirements for light under low light conditions it does not produce fruiting bodies, or produces very small ones.[7]

Mushroom possess the enzymatic mechanisms for the transformation of complex organic macromolecules into simple molecules, capable of biodegradation of a wide variety of plant wastes due to their ability for delignification.[8]

Mushroom is used extensively in many cuisines (notably Chinese, Korean, European, and Japanese). They are the "meat" of vegetable world. Oyster mushroom is popular for cooking, torn up instead of sliced, especially in stir fry or sauce, because they are consistently thin and so will cook more even than uncut mushroom of other types.[9] Mushrooms cultivation provides an environmental-friendly agriculture practices especially for farmers in villages. Many drugs and dietary supplements contain at least some component produced from fungi because of their immune system enhancing qualities. Conjugated linoleic acid is found in mushrooms, and the study indicated it can stop cancer cell growth through blocking cancer cell production.

Agro-wastes are of little importance to humans. They are unsightly and constitute nuisance to the society. Agro-wastes also cause forest fires leading to the destruction of lives and properties. Mushrooms are known to grow on a wide variety of substrates and habitats.[10] Most of the edible fungi have strong enzyme system and are capable of utilizing complex organic compounds, which occur as agricultural wastes and industrial by-product. Hence, various agricultural by-products are used as substrates for the cultivation of oyster mushrooms. The agricultural wastes are converted into edible biomass in the form of fruit-bodies. Different substrates are, therefore, examined to get the best substrate that will give a desired product in terms of qualities and quantity for the world's health and economic benefits.

Cultivation of mushrooms therefore is a biotechnological process for the recycling of lignocellulosic wastes. Various agricultural by-products us have been tested for use as substrates for the cultivation of oyster mushroom which include wheat and rice straw, banana leaves, peanut hull and corn leaves, sugarcane leaves;[11,12] Many authors are still investigating the use of agro-wastes in the cultivation of mushrooms. Already,[5] used local Nigerian substrates such as straws of *Andropogon gayanus, Pennisetum,* and *Oryza sativa* in a study of production of *P. ostreatus*. They reported that among these substrates, *Andropogon* straw supported significantly higher fruit body yield and fresh weight than all other straws. In another study, Okwulehie *et al*.[13] produced mature and young fruiting-bodies of *Pleurotus pulmonarius* on *A. gayanus* straw and *Khaya ivorensis* sawdust. They reported that the two substrates *A. gayanus* straw and *K. ivorensis* sawdust were ideal for the production of mushroom. According to Okwulehie *et al*.,[5] on the yield of *P. ostreatus* var florida on different substrates, the results obtained from the study recorded that andropogon straw yielded the highest fruit-bodies and fresh weight of *P. ostreatus* var florida compared to the other substrates used. Shah *et al*.[14] investigated the use different substrates such as wheat straw, leaves, and sawdust for *P. ostreatus* production in Pakistan, and concluded that sawdust was the best one among the others with respect to yield, quality, and efficiency but *Chloris gayana* (CG) and *Dactylis glomerate* (DG) had the lowest values for yield respectively.

Hypsizygus marmoreus (Peck) Bigelow has been cultured on sawdust rice bran medium using bottle cultivation method. This mushroom requires a long spawn run (60–70 days) to allow mycelial maturation for a high yield. The effect of temperature, substrate, and moisture content of *H. marmoreus* has been studied to show optimal temperature for the mycelia growth at 25–28°C and for fruit body development at 15–18°C at an optimal substrate moisture content of 65–70%. Rice straw was a good substitute for wheat bran as it was rich in protein.

The proximate, macro-element, and mineral contents of *P. ostreatus* var *florida* fruit bodies grown on different substrates and substrate

supplementations were carried out by Okwulehie *et al*.[5] The findings showed significant high levels of protein, carbohydrate, vitamins, fats, and oil in the substrates studied. They also evaluated the influence of two levels of organic manure on macro-element and vitamin contents of *P. ostreatus* to understand the best ways to use these manures for sustainable cultivation of the macro-fungus. The proximate, macro element and vitamin composition of the fruit bodies of *P. ostreatus* as affected by substrate and additive types were in appreciable quantities. In another study to determine the influence of different substrates on the nutritional composition of *P. pulmonarius*, by Okwulehie *et al*.[15] It was reported that substrate type influenced the bioactive nutrients and vitamin constituents of oyster mushrooms.

The present study is carried out to investigate the performance of *P. ostreatus* on DG and CG as substrate, to assess the yield and biological efficiency (BE) of *P. ostreatus* fruit-bodies cultivated on DG and CG, to investigate the nutritional composition of *P. ostreatus* fruit-bodies cultivated on DG and CG, *t*o determine the fruiting duration of *P. ostreatus* fruit-bodies cultivated on DG and CG and *t*o compare the quality and quantity of the fruit-bodies produce in the two agro-waste substrates.

MATERIALS AND METHODS

Source of Materials

Pure mycelia culture of *P. ostreatus* was obtained from the Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture, Umudike, Abia state while dry DG and CG were obtained from Ubani Main Market, Umuahia, Abia State.

Location of Study

The study was conducted at the mushroom house of the Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture Umudike, Abia State.

Umudike is located between longitude 7^0 and 70^005^0E and latitude 5^0 and 5^025^0N; with humid tropical climate. Rainfall is bi-modally distributed with peaks between July and September of each year. Annual rainfall is approximately 170 mm, spread between April and November each year.[16]

Experimental Design

The experiment was conducted in completely randomized design. Three straw substrates were used which includes DG substrate, CG substrate and a mixture of DG and CG substrate at 50% for each. The experiment was replicated 4 times resulting into a total of 15 observations.

Substrate Preparation

The substrates were further dried and chopped into pieces of about 2–4 cm lengths and steeped in tap water overnight following the method of Okwulehie *et al*.[5]

One kilogram of each substrate was steeped separately in tap water overnight and drained of excess water before being transferred into a metallic drum for pasteurization at 80°C for 1. 30 min. The pasteurized substrates were allowed to cool overnight as recommended by Muhammad *et al*.[17] Two sets of 2.5 L transparent plastic buckets; made into four replications each was used as the mushroom growing container. After cooling, 200 g of DG and 200 g of CG substrate was dispensed (2/3 full) into each of the perforated containers for spawn inoculation. Then, the third substrate was a mixture of DG and CG 100 g each. Each substrate was made into five replications of 200 g each.

Preparation of Cropping Room

Before the inoculation of substrate, the cropping room floor was scrubbed with water and detergent. The walls were got rid of cobwebs and disinfected with detol disinfectant. The room was well illuminated and ventilated by opening the window panes. This equally maintained the daytime temperature at 27 ± 2^0C and improves ventilation in the room.[18]

Inoculation of Substrates

After cooling, each bucket containing the substrates was inoculated with about 30 g grains spawn of *P. ostreatus* by placing them between four layers of the substrate. The buckets were hence covered and placed on wooden racks in the dark cropping room. After 8 days (i.e. when the substrates were fully colonized by mycelium), light intensity and humidity of the air were increased to about 400 lux and 75%, respectively, before primordial initiation. Mushroom fruit bodies were harvested at maturity.

Fruiting and Harvesting

After full ramification of the substrates by the mycelium of the mushroom. The mushroom fruit bodies started to appear 16 days after inoculation. Fully formed fruit bodies were harvested by carefully detaching them from the holes on the perforated plastic containers.

Determination of Yield and BE

Total fresh weight (g) of all the fruit bodies harvested from each of the four replicate sets of perforated buckets were measured as the total yield of the mushrooms. The BE, that is, the percentage yield of fresh mushroom fruit bodies per dry weight (g/kg) substrate was calculated using the formula recommended by Chang and Miles,[1] namely:

$$\text{B.E} = \frac{\text{Fresh weight of mushroom}}{\text{Dry weight of substrate}} \times \frac{100}{1}$$

Sample Preparation for Analysis

Mushroom samples were arranged according to their source of collection and sundried. Dried fruit body samples were made into fine powdery samples using manual grinding machine and

stored in dry air-tight bottles for further analysis, following the method of Okwulehie and Odunze.[18]

Proximate Analysis

Proximate analysis was conducted on each of the powdery samples. The protein, ash, fat, and crude fibers were determined by the method of. AOAC.[19]

Determination of Crude Protein

Crude protein of different samples was determined by Kjedahl method. By this method, total nitrogen content was determined first and the value was multiplied by 0.25 coefficients. Two grams of dry powdered sample were digested in 5 ml of concentrated H_2S0_4 and a tablet of selenium catalyst was added in a fume cupboard. The digest was made up to 250 ml with the acid.190 ml of the digest was distilled and titrated with 0.2N H_2SO_4. The crude protein was finally obtained by multiplying the total nitrogen by 0.25.

Determination of Moisture Content

Moisture content was determined by placing 2 g of the powdered dry samples on clean, dry glass Petri dishes of known weight and placed in an electric oven at 75°C for 7–8 h.[19] The oven dried samples were maintained at constant weight and weighed. The percentage moisture content was calculated thus:

$$\frac{\text{Weight of fresh sample} - \text{wt of dry sample}}{\text{Fresh weight of sample}} \times \frac{100}{1}$$

Determination of the Ash Content of Fruit-bodies

To obtain the ash content value of the fruit bodies, 5 g of the ground dry sample was used. This was weighed before and after burning it at 500°C overnight in a crucible. The sample was allowed to cool in desiccator and later weighed again.[20] The percentage ash content was then expressed as:

$$\frac{\text{Weight of crucible} + \text{lid} + \text{ash} - \text{wt of crucible} + \text{lid}}{\text{Weight of sample}} \times \frac{100}{1}$$

Determination of Crude (Dietary Fibre)

The total crude fiber of the fruit bodies was determined by the Weende method.[19] Two grams of the sample was put into a 250 ml beaker and hydrolyzed by adding 20 ml of dilute sulfuric acid and boil for about 30 min on a hot plate. The mixture was filtered through hot distilled water. The residue was boiled again with 50 ml of 2.5% sodium hydroxide (NaOH) for 30 min; filtered and rinsed with distilled water. The residue was finally collected and transferred into a crucible, dried in the oven to a constant weight. The sample was finally ached in a muffle furnace. The weight of the fiber was calculated and expressed as percentage crude fibers as follows:

crude fibre=wt. of dry sample + crucible – wt of crucible + ash

$$\% \text{ crude fibre} = \frac{\text{weight of fibre}}{\text{weight of sample}} \times \frac{100}{1}$$

Determination of the Carbohydrate Content of the Sample

The carbohydrate contents of the dry samples *P. ostreatus* var *florida* was calculated as follows:

$$\text{CHO (\% dry wt)} = 100 - \text{CP} + \text{FO} + \text{ash} + \text{MC} + \text{DF}$$

(In g/100g DW), where:
CHO = Carbohydrate, FO = Fats and Oil, MC = Moisture content, DF = Dietary fibre.

Determination of dry matter (DM)

Moisture was evaporated from sample by oven drying. Total DM was determined gravimetrically as residue remaining after drying. Weighing was made after cooling in a desiccators.[19]

Determination of Fats and Oils

The fats and oil contents of the samples was determined following Twisselman method using diethyl either as solvent.[19] Two grams of each sample were inserted into an either extracting thimble and placed on the solvent reflux flask connected to a round-bottom flask of known weight. The apparatus was placed on a heating mantle filled with about 250 ml of petroleum ether. The oil was extracted by a reflux system. After a series of refluxing, a clear solution was obtained in the flask, and then the sample was removed. Further heating separated the ether from the extraction oil. The round bottom flask containing the oil was finally dried in an oven at 70°C. Fats and oil were determined by the gravimetric method as follows:

Wt of oil = Wt. of flask + oil – Wt. of flask (after drying).

The sample was finally ashed in a muffle furnace. The weight of the fiber was calculated and expressed as percentage crude fiber as follows:

$$\% \text{ fats and oil} = \frac{\text{Weightof fibre}}{\text{Weight of sample}} \times \frac{100}{1}$$

Determination of Mineral Content of the Dry Samples of the Mushroom

Minerals composition of dried mushroom samples was determined by wet-washing method. The solutions of ash obtained from the samples was dissolved in a drop of Nitric acid ($HN0_3$) and made up to 50 ml with deionized water and analyzed for Calcium (Ca) and Magnesium (Mg), using vanadate ethyldiaminetetra acetic acid complexometric

titration method. According to Mattila *et al*.,[20] Sodium (Na) and Potassium (K) were estimated using flame photometer; while Phosphorus (P) was determined using UV-visible spectrometer after making Ammonium vanado-molybdate at 436 nM according to the established procedures of Mattila *et al*.[20] To this mixture, about two drops of sulfuric acid (H_2SO_4) were added and observed for yellow coloration which would disappear on storage.

Statistical Analysis

All the data collected from various samples were subjected to Analysis of Variance (ANOVA). Level significance was evaluated by mean separation while comparison between different means was done using Duncan multiple range test.

RESULTS AND DISCUSSION

Results

The results of the fruiting duration and fruit-body number of *Pleurotus* are presented in Table 1 above. The result shows that all substrates (CG, DG, and 50% CG + 50% DG) started producing fruit bodies after 15 days. About 50% CG + 50% DG gave the highest number of fruit bodies 297 and this was followed by DG with a total of 249 fruit bodies and CG gave the lowest number with a total of 184 fruit bodies.

The result of the effect of straw substrates on the yield (g) and BE (%) of *P. ostreatus* fruit-bodies is presented in Table 2. The result indicated that the highest quantity of fruit-bodies was obtained from the 1000g of CG (325.5) with BE of 32.35%, followed by 50% mixture of CG and DG substrate at 247.7 and 15%, respectively, while the least fruit body production (150) and BE (24.77%) were recorded in DG substrate.

Tables 1: Fruiting duration and fruit body number of *Pleurotus ostreatus*

Substrates	Fruiting duration	FBN (g)
CG	15	184
DG	15	249
50%CG+50%DG	15	297

Whrere CG: *Chloris gayana* and DG: *Dactylis glomerate,* FBN: Fruit body numbee

Tables 2: Effect of straw substrates on the yield (g) and biological efficiency (%) of *Pleurotus ostreatus* fruit-bodies

Substrates	Dry weight of substrate	Yield (g)	B.E (%)
CG	1000	325.5	32.35
DG	1000	150.2	15.00
50%CG+50%DG	1000	247.7	24.77

Whrere CG: *Chloris gayana* and DG: *Dactylis glomerata*

Result in Figure 1 represents the effect of straw substrates on the morphological characteristics of *P. ostreatus* fruit bodies. The result indicates that cap diameter was highest in the CG substrate (4.65 ± 2.47) while the 50% mixture of CG and DG substrate recorded the lowest value (3.11 ± 1.51). DG substrate recorded the highest stipe length (2.30 ± 0.91) while the 50% mixture of CG and DG substrate recorded the lowest stipe length (1.38 ± 0.71). The means of DG and the interaction treatment were significantly different ($P \leq 0.05$).

Results in Figure 4 represent dry weight of *P. ostreatus*. Dry weight was highest in CG substrate (2.49 g), followed by 50% mixture of CG and DG substrate (2.40 g) while *D. glomerate* substrate was observed to have the lowest value (2.30 g). The mean CG, DG, and the interaction treatment were significantly different ($P \leq 0.05$)

The result in Table 3 shows that the proximate (%) composition of *P. ostreatus* fruit bodies shows that among all the proximate compositions obtained from various straw substrates, fruit bodies harvested from CG substrate contained highest quantities of moisture content, ash, crude protein, ether extract, and joint values with DG substrate for crude fiber. The moisture content ranged from 8.83 ± 0.09 to 9.46 ± 0.05%, the ash contents ranged from 3.32 ± 0.11 to 3.75 ± 0.04%, the crude protein content ranged from 17.51 ± 0.12 to 18.87 ± 0.04%, ether extract ranged from 3.80 ± 0.05 4.19 ± 0.00%, and the crude fiber ranged from 3.76 ± 0.11 to 3.80 ± 0.03%. The ash and crude protein recorded a significant difference ($P \geq 0.05$) between the fruit bodies harvested from CG substrate and fruit bodies harvested from DG substrate and 50% mixture of CG and DG substrate. Fruit bodies harvested from DG substrate contained highest quantities of DM with value (91.17 ± 0.09%) and carbohydrates with value (62.74 ± 0.25%). The DM and carbohydrate contents for DG substrate were significantly different ($P \leq 0.05$) from values obtained in CG substrate.

Figure 1: Substrates fully ramified with mycelia

Table 4 shows the results on the effect of different straw substrates on the minerals (mg/100g) composition of *P. ostreatus* fruit-bodies. From the result shown, it was observed that the calcium, phosphorous, and sodium contents were highest in fruit bodies harvested from CG substrates with values (138.66 ± 0.19 mg/100 g), (519.50 ± 1.78 mg/100 g), and (59.56 ± 0.12 mg/100 g), respectively. The potassium contents and copper contents were highest in fruit bodies harvested from DG substrates with values (840.69 ± 0.12 mg/100 g) and (2.74 ± 0.02 mg/100 g), respectively. The calcium and potassium contents of the fruit-bodies obtained from CG substrates and 50% mixture of CG and DG substrate were not significantly different ($p \leq 0.05$), but were significantly different ($P \geq 0.05$) from fruit-bodies obtained from DG substrate. The phosphorous, sodium, and copper contents in fruit bodies harvested from all substrates were significantly different ($P \geq 0.05$) from each other.

Figure 2: Fully matured fruit-bodies od *Pleurotus ostreatus*

DISCUSSION

The result of the study showed that fructification of *P. ostreatus* [Figure 2] occurred in all the substrates. This indicates that these substrates contained nutrients that supported the growth of the mushroom as reported by Okwulehie *et al*.[5] Results showed that all substrates (CG, DG, and 50%CG+50%DG) started producing fruit bodies after 15 days. About 50% CG + 50% DG gave the highest number of fruit bodies (297), followed by DG (249) fruit bodies and CG gave the lowest number with a total of 184 fruit bodies. Some researchers have recorded similar results on the number of fruit bodies and fruiting duration[21] reported high fruit body number of *P. ostreatus* with shorter days on wheat and paddy straws. Shah[14] recorded longer fruiting time of *P. ostreatus* with saw dust, wheat straws, and other agro-wastes combinations.

The result of the effect of straw substrates on the yield (g) and BE (%) of *P. ostreatus* fruit-bodies showed that the highest quantity of fruit-bodies was obtained from the 1000g of CG (325.5) with BE of 32.35%, followed by 50% mixture of CG and DG substrate at 247.7 and 15%, respectively, while the least fruit body production (150) and BE (24.77 %) were recorded in DG substrate. The high yield and BE obtained in CG substrate could be due to the high nutrients making it a good lingo-cellulosic material for mushroom cultivation. This was in line with the works of Wood and Smith[6] Mattila *et al*.[20] Muller[22] Ali *et al*.[23] and Mattila *et al*.[20] who reported that oyster mushrooms are capable of growing on various categories of lingo-cellulosic materials, such as straws, logs, saw dust, and *A. gayanus*. A similar observation was also made by Okwulehie *et al*.[5] who maintained that *Pleurotus* species have a high saprophytic ability and can grow well in a variety of cellulosic substrates.

The results on the morphological characteristics of *P. ostreatus* fruit bodies [Figure 3], showed that CG and DG substrates

Table 3: Effect of straw substrates on the Proximate (%) Composition of *Pleurotus ostreatus* Fruit-bodies

Substrate	Moisture content	Dry matter	Ash	Crude protein	Ether extract	Crude fiber	Carbohydrates
CG	9.46±0.05^{a}	90.54±0.05^{a}	3.75±0.04^{a}	18.87±0.04^{a}	4.19±0.00^{c}	3.80±0.03^{a}	59.92±0.05^{a}
DG	8.83±0.09^{b}	91.17±0.09^{b}	3.32±0.11^{b}	17.51±0.12^{b}	3.80±0.05^{a}	3.80±0.02^{a}	62.74±0.25^{c}
CG+DG	9.12±0.02^{a}	90.88±0.02^{a}	3.41±0.09^{b}	18.18±0.08^{c}	4.05±0.07^{b}	3.76±0.11^{b}	61.48±0.16^{b}

Means followed by the same superscript within columns are not significantly different by Turkey's HSD test ($P \leq 0.05$), Values are mean ± SD (n=2). Whrere CC: *Chloris gayana* and DG: *Dactylis glomerata*

Table 4: Effect of straw substrates on the Minerals (mg/100g) composition of *Pleurotus ostreatus* fruit-bodies

Substrate	Ca	K	P	Na	Cu
CC	138.66±0.19^{a}	767.17±2.02^{b}	519.50±1.78^{b}	59.56±0.12^{a}	1.87±0.04^{a}
DG	124.43±0.24^{b}	840.69±0.12^{c}	434.72±0.16^{c}	54.77±0.09^{c}	2.74±0.02^{c}
CC+DG	130.69±0.12^{a}	794.47±0.00^{b}	484.59±0.15^{a}	57.60±0.16^{b}	2.09±0.07^{b}

Means followed by the same superscript within columns are not significantly different by Turkey's HSD test ($P \leq 0.05$), Values are mean ± SD (n=2). Where CG: *Chloris gayana* and DG: *Dactylis glomerata*

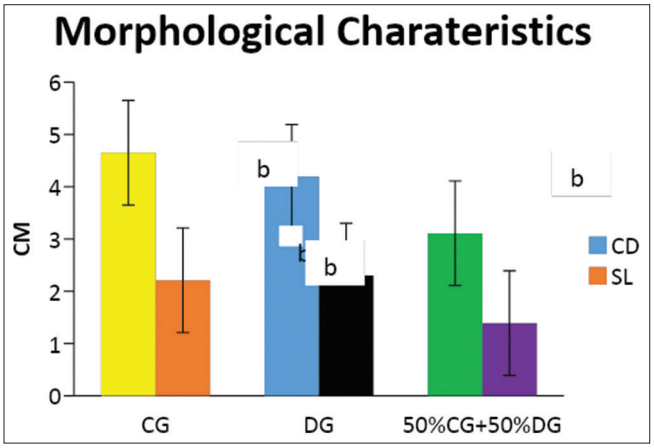

Figure 3: Effect of straw substrates on the morphological characteristics of *Pleurotus ostreatus* fruit-bodies. Means followed by the same superscript within columns are not significantly different by Turkey's HSD test ($P \leq 0.05$), values are mean ± Standard Deviation ($n = 2$). Where CG: *Chloris gayana* and DG: *Dactylis glomerate* CD: C ap diameter, SL: Stipe length and WT: Dry weight

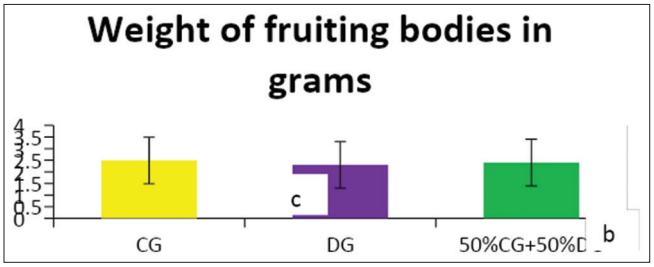

Figure 4: Illustration of fruit body weight of *Pleurotus ostreatus*. Means followed by the same superscript within columns are not significantly different by Turkey's HSD test ($P \leq 0.05$), Values are mean ± Standard Deviation ($n = 2$). Where CG: *Chloris gayana* and DG: *Dactylis glomerate,* CD: Cap diameter, SL: Stipe length and WT: Dry weight

performed better than 50% mixture of CG and DG substrate. Okwulehie and Okwujako[5] had similar results on fruit body yield, fresh weight morphological characteristics of *P. ostreatus* fruit bodies on straws of *A. gayanus*, *Pennisetum,* and *O. sativa.* These results further support the fact that *P.* species, as a class of edible mushroom, have a high saprophytic ability and are capable of growing on a variety of cellulosic wastes.[24] Different types of straws are commonly used in *Pleurotus* species cultivation. Straws can be composted or pasteurized and extra additives can be used to increase the B.E and morphological features.[25]

The result on the proximate (%) composition of *P. ostreatus* fruit-bodies showed that *P. ostreatus* cultivated on all the substrates gave appreciable amount of DM, crude protein, and carbohydrate. This is in line with the results observed by Onyeizu *et al*.[16] Okwulehie *et al*.,[26] who reported that *P. ostreatus* harvested from various categories of substrates contains high levels of carbohydrates, protein, and fats and oil. This could also be due to the fact that these substrates have the precursors to the mentioned nutrients and were absorbed by the fungus which further backs the claims by Mehmet and Sevda[27] Obodai[28] who maintained that substrates composition determines the nutritional contents of the mushrooms grown on it. This was also similar to earlier study conducted by Alam[29] on the nutritional values of dietary mushrooms. It was found that these mushrooms were rich in proteins and fibers in dry samples and contained a lower amount of lipid. The carbohydrate and total ash contents were in good quantity too. In another experiment,[30] also studied the myco-chemical, proximate mineral, and vitamin composition of two mushrooms; *P. squarrosulus* and *Termitomyces robustus.* The result of the investigation showed that both mushrooms have high nutritional potentials.

Result of minerals content of *P. ostreatus* fruit bodies with respect to various straw substrates (CG, DG and 50% of CG, and DG) showed that the fruit bodies contains good quantity of minerals such as calcium, potassium, sodium, and phosphorus but copper was in a low quantity. This result agrees with the reports of Okwulehie *et al*.[5] Okwulehie and Ogoke[31] investigated the mineral constituents of some edible mushrooms found in Nigeria and it was discovered that the studied mushrooms were good sources of nutrients and minerals needed for the maintenance of good health and can also be incorporated in the manufacturing of drugs. The minerals obtained from the *P. ostreatus* fruit bodies have been investigated and reported to be very important in human nutrition.[31]

CONCLUSION

The result from the investigation revealed that using CG substrate alone was best followed by DG substrate. CG substrate showed high values of nutritional contents and also appreciable quantities of minerals studied. The investigation also revealed that CG and DG substrates could be vital in production of *P. ostreatus* fruit-bodies. Farmers who specialize in mushroom cultivation can substitute these common substrates such as rice straw and wheat straw with CG and DG substrates because they are good sources of nutritional contents for *P. ostreatus* fruit-bodies.

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