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Proximate and Phytochemical Composition of Tropical Wood Substrates and Their Effects on *Pleurotus ostreatus* (Jacq. Ex Fr. Kummer) Yield

Nnyam, L. B., David-Sarogoro, N., Chukunda, F. A. and Ogunbode, A. S.
Department of Forestry and Environment, Faculty of Agriculture, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Nigeria.
***Corresponding Author:** *nnyam.lebatam@rsu.edu.ng*

ABSTRACT

The study investigated the proximate and phytochemical composition of sawdust substrates from four tropical wood species; *Pterocarpus santalinoides, Mitragyna ciliata, Musanga cecropioides* and *Hevea brasiliensis* and their effects on the yield of *Pleurotus ostreatus* (Jacq. ex Fr.) Kummer. Proximate parameters included ash, moisture, crude fibre, lipid, protein and carbohydrate, while phytochemical analyses assessed alkaloids, flavonoids and saponins. Fruit-body morphology and yield were evaluated across three flushes, with treatment means compared using Duncan's Multiple Range Test at 5% probability. Substrate composition varied considerably. Ash ranged from 0.21% in *H. brasiliensis* to 2.87% in *P. santalinoides*, moisture from 7.51% in M. ciliate to 17.52% in *H. brasiliensis*, and crude fibre from 38.74% to 56.31%. Crude lipid ranged from 0.46% to 11.74%, protein from 1.05% to 1.25%, and carbohydrate from 13.17% to 48.60%. *M. ciliata* recorded the highest alkaloids (7.14%), flavonoids (13.10%) and saponins (5.72%), whereas *H. brasiliensis* had the lowest values. Morphologically, fresh and dry weights ranged from 48.91-110.87 g and 3.38-9.61 g, respectively. *H. brasiliensis* produced the highest overall yield, while *P. santalinoides* recorded the largest cap diameter (11.0 cm). The findings indicate that mushroom productivity depends on combined substrate characteristics rather than carbohydrate concentration alone. *H. brasiliensis* sawdust is therefore recommended for high mushroom yield, while *P. santalinoides* may be preferred for larger caps and sustained production.

Keywords: Proximate, Phytochemical, Constituents, Hardwood, Softwood, Substrates, *Pleurotus Ostreatus*.

Introduction

Mushroom cultivation has increasingly attracted scientific and commercial interest because it provides an efficient means of converting lignocellulosic materials into nutritious food and other value-added biological products. Among cultivated mushrooms, *Pleurotus ostreatus* (Jacq. ex Fr.) Kummer, commonly known as oyster mushroom, is particularly important because of its ability to colonise a wide range of agricultural and forestry residues (Aluko, et al., 2024). Its ability to utilise cellulose, hemicellulose and lignin is associated with an extensive extracellular enzyme system, including cellulases, hemicellulases, laccases and ligninolytic enzymes.

Consequently, wood sawdust and other lignocellulosic wastes can serve as relatively inexpensive substrates for its production. Vera et al. (2022) similarly noted that *Pleurotus* species can colonise and degrade a broad range of cellulose-, hemicellulose- and lignin-containing materials.

The productivity of *P. ostreatus*, however, is strongly influenced by the chemical and physical characteristics of the cultivation substrate. Substrates differ in carbon content, fibre, lignin, cellulose, nitrogen, ash, moisture and secondary metabolites. These differences determine the availability of nutrients to the fungus, the rate of mycelial colonisation and ultimately the development of fruiting bodies.

Obodai et al. (2003), demonstrated considerable differences in *P. ostreatus* yield among lignocellulosic substrates and found positive relationships between mushroom yield and cellulose, lignin and fibre contents.

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The chemical composition of wood is particularly important because hardwoods and softwoods differ substantially in their lignocellulosic structure and extractive compounds. Some wood constituents may support fungal growth, whereas others may inhibit colonisation or alter nutrient availability.

Hardwood sawdust, softwood sawdust and other lignocellulosic substrates can produce different growth and nutritional outcomes in *P. ostreatus*, indicating that substrate selection is an important component of mushroom production. Kortei et al. (2022) emphasised that proximate constituents such as moisture, ash, crude fibre, lipid, protein and carbohydrate are therefore useful indicators of substrate quality.

Carbohydrate constitutes an important carbon source for fungal metabolism, while fibre reflects the structural carbohydrate fraction available for enzymatic degradation. Ash provides an indication of the inorganic mineral fraction, whereas moisture influences microbial metabolism and mycelial development (Orngu et al., 2021).

Recent research has similarly demonstrated substantial chemical variation among sawdust substrates and established cellulose as a major component of wood substrates used for *P. ostreatus* cultivation. In addition to proximate constituents, wood contains secondary metabolites, including alkaloids, flavonoids, saponins, phenolics, tannins and other extractives. These compounds may influence fungal growth through either stimulatory or inhibitory effects.

Phytochemical composition can therefore partly explain differences in substrate suitability. Research on *P. ostreatus* has demonstrated that the cultivation substrate can influence the bioactive compounds associated with the resulting mushroom and its growing medium (Yilmaz et al., 2017; Yildiz, et al., 2017).

The present study therefore evaluates the proximate and phytochemical characteristics of selected tropical hardwood and softwood sawdust substrates and examines their relationship with morphological development and yield performance of *P. ostreatus*.

Materials and Methods

Experimental materials

The experimental substrates sawdusts were obtained from four tropical wood species of hardwood and soft wood. The supplied dataset was replicated. The hardwood were *Pterocarpus santalinoides* (African rosewood), and *Mitragyna ciliate* (Abura). While the softwood were *Musanga cecropioides* (African Corkwood Tree) and *Hevea brasiliensis* (Rubber tree).

Substrate preparation

The sawdust substrates were prepared for mushroom cultivation by cleaning and processing the wood residues to obtain relatively uniform particle sizes. Blocks of each substrate sample (1kg) were made by putting the substrate in a long 25cm heat resistance thick polythene bag. The transparent bag identified the substrates that were contaminated and fully colonized. After bagging, sterilization by heating was carried out on the various substrates for 3-4 hours to eliminate germs and microbes which affected the growth of the mycelia (Muhammad *et al.,* 2007). The substrates were loaded in a sterilization drum using 50kg gas cylinder as a source of heat. The heated samples were allow to cold and inoculated with *P. ostreatus* mycelia (Shyam et al., 2010). The same method was used to prepared all the different wood substrates. Before inoculation, the substrates should be appropriately conditioned and sterilised/pasteurised to reduce competing microorganisms.

Proximate analysis of sawdust substrates

The proximate composition of the sawdust substrates was assessed in terms of ash, moisture content, crude fibre, crude lipid, crude protein and carbohydrate using procedures of AOAC (2019). The uploaded results identify these six components and report their values for the four wood species.

Phytochemical analysis of sawdust samples

This is to determine selected secondary metabolites such as total alkaloids, total flavonoids and total saponins. The supplied results report the concentrations of these three phytochemical groups.

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Phytochemical assays should be performed using validated quantitative procedures appropriate to each compound class. The choice of extraction solvent, extraction duration, standard compound and spectrophotometric conditions should be explicitly reported in the final manuscript because these factors can influence measured phytochemical concentrations.

Cultivation of *Pleurotus ostreatus*

The prepared wood substrates were inoculated with *P. ostreatus* spawn and maintained under suitable incubation and fruiting conditions take place within an interval of 3-4 weeks from the day of inoculation. 28^0C – 30^0C temperature. Following complete colonisation and initiation of fruiting, fruit bodies were harvested at the appropriate maturity stage.

Determination of morphological characteristics of *P. ostreatus* fruiting bodies

The morphological parameter was calculated using the formula of (Chukunda *et al*, 2017). The Cap diameter was determined by placing a transparent ruler across the center of the pileus of each harvested mushroom fruit body and reading off the diameter.

The Stripe length was determined by placing a transparent ruler along the length of each fruit body stripe. The Weight of fresh fruit bodies was determined by weighing each fresh fruit body immediately after harvest using a portable digital balance.

Determination of yield

This was assessed by calculating the total fresh weight (g/kg) and number of flushes of all the fruit bodies harvested from all 10 replications was measured as the total yield of mushroom. Yield was assessed from the fresh and dry weights of harvested fruit bodies and from successive flushes. Three flushes were recorded for each substrate.

Proximate analysis of *P. ostreatus* fruiting bodies

P. ostreatus fruiting bodies which developed following cultivation on the different sawdust substrates were evaluated for proximate and phytochemical constituents using analytical procedures such as those provided by AOAC (2019).

Statistical analysis

The supplied proximate and phytochemical Tables indicate that treatment means were compared using Duncan Multiple Range Test (DMRT) at the 5% probability level. Means carrying the same superscript letter were interpreted as not significantly different, whereas different superscripts indicate significant differences.

Results

The proximate composition of hardwood and softwood sawdust substrates is presented in Table 1.

Table 1: Proximate Composition of both Hard and Softwoods

Proximate component	Hardwood		Softwood	
	Pterocarpus santalinoides	*Mitragyna ciliate*	*Musanga cecropioides*	*Hevea brasiliensis*
Ash	2.87^{a}	2.14^{a}	0.48^{b}	0.21^{b}
Moisture Content	8.13^{c}	7.51^{c}	14.9^{d}	17.52^{d}
Crude Fiber	38.74^{bc}	40.83^{bc}	51.68^{cb}	56.31^{cb}
Crude Lipid	0.52^{ac}	0.46^{ac}	1.83^{ab}	11.74^{ab}
Crude Protein	1.14^{de}	1.25^{de}	1.14^{ee}	1.05^{ee}
Carbohydrate	48.6^{aa}	47.81^{aa}	29.97^{bb}	13.17^{bb}

Note: Means ± STD within the same row bearing the same superscript letter are not significantly different (P< .05) according to Duncan Multiple Range Test (DMRT).

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The results show that ash ranged from 0.21% in *Hevea brasiliensis* to 2.87% in *Pterocarpus santalinoides*. Moisture content ranged from 7.51% in *Mitragyna ciliata* to 17.52% in *Hevea brasiliensis*. Crude fibre ranged from 38.74% in *P. santalinoides* to 56.31% in *H. brasiliensis*, while crude lipid increased from 0.46–0.52% in the two hardwoods to 1.83% in *M. cecropioides* and 11.74% in *H. brasiliensis*.

Crude protein was relatively low and ranged from 1.05 to 1.25%, whereas carbohydrate declined from 48.60% in *P. santalinoides* to 13.17% in *H. brasiliensis*. The relatively high ash content of *P. santalinoides* (2.87%) and *M. ciliata* (2.14%) compared with *M. cecropioides* (0.48%) and *H. brasiliensis* (0.21%) indicates differences in their inorganic mineral fractions. Ash represents the residue remaining after combustion and is generally associated with mineral constituents.

The low ash content of *H. brasiliensis* is particularly noteworthy because the same substrate recorded the highest mushroom yield. This suggests that high ash concentration was not a prerequisite for superior *P. ostreatus* productivity in the present experiment. Rather, the overall balance of carbon, fibre, moisture and other substrate constituents appears more important.

Moisture content was highest in *H. brasiliensis* (17.52%), followed by *M. cecropioides* (14.90%), while *P. santalinoides* and *M. ciliata* recorded considerably lower values of 8.13% and 7.51%, respectively. The high moisture content of *H. brasiliensis* may have contributed to its superior fruit-body production by providing a favourable water environment for fungal metabolism. Water is essential for nutrient diffusion, enzymatic activity and maintenance of cellular processes during mycelial growth and fruit-body formation.

This result is consistent with the broader understanding that moisture is a major determinant of successful *Pleurotus* cultivation. However, moisture must remain within an appropriate range because excessive water can reduce aeration and create anaerobic conditions. The strong performance of *H. brasiliensis* in the present study suggests that its moisture condition may have been more favourable than those of the other untreated substrates.

Crude fibre was particularly high in the softwood substrates, with 51.68% in *M. cecropioides* and 56.31% in *H. brasiliensis*, compared with 38.74% and 40.83% in *P. santalinoides* and *M. ciliata*, respectively. This is an important finding because *P. ostreatus* is a white-rot fungus capable of degrading complex lignocellulosic materials. The high fibre concentration of *H. brasiliensis* may therefore have supplied substantial structural carbohydrate material for fungal colonisation. Crude lipid showed the most striking difference among substrates. The hardwoods contained only 0.52% and 0.46%, whereas *M. cecropioides* contained 1.83% and *H. brasiliensis* recorded 11.74%.

The exceptionally high lipid value of *H. brasiliensis* distinguishes it chemically from the other substrates. However, the relationship between substrate lipid and mushroom yield cannot be considered direct because fungi primarily require readily available carbon and nitrogen sources for biomass formation. The high yield observed on *H. brasiliensis* may therefore result from the combined substrate characteristics rather than lipid alone.

Crude protein ranged narrowly from 1.05% to 1.25%, with *M. ciliata* showing the highest value. The relatively small variation suggests that nitrogen availability from the native sawdust alone may not explain the large differences in mushroom yield. This observation is particularly important when comparing *M. ciliata* and *H. brasiliensis*. Although *M. ciliata* contained the highest protein concentration (1.25%), it produced only 48.91 g fresh weight, whereas *H. brasiliensis* produced 110.87 g.

Carbohydrate was highest in *P. santalinoides* (48.60%) and *M. ciliata* (47.81%), but considerably lower in *M. cecropioides* (29.97%) and *H. brasiliensis* (13.17%). Interestingly, the substrate with the lowest measured carbohydrate, *H. brasiliensis*, produced the highest fresh mushroom weight. This apparently counterintuitive result indicates that the measured proximate carbohydrate fraction does not necessarily correspond directly to the fraction of structural carbohydrates accessible to *P. ostreatus*. Cellulose, hemicellulose and lignin fractions would provide a more mechanistic explanation of substrate utilisation than total proximate carbohydrate alone.

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Generally, the most important finding from Table 1 is that no single proximate constituent explains the observed yield ranking. *H. brasiliensis* had the highest moisture, crude fibre and lipid but the lowest carbohydrate and protein, yet it produced the highest mushroom yield. Conversely, *P. santalinoides* had the highest carbohydrate concentration but did not produce the highest yield.

The results of the phytochemical constituents of the sawdust substrates is presented in Table 2.

It demonstrates that all four wood substrates contained detectable levels of alkaloids, flavonoids and saponins, but their concentrations differed considerably. Total alkaloid ranged from 2.97% in *H. brasiliensis* to 7.14% in *M. ciliata*. Total flavonoid ranged from 5.18% in *H. brasiliensis* to 13.10% in *M. ciliata*, while total saponin ranged from 2.49% to 5.72%. *M. ciliata* recorded the highest total alkaloid concentration (7.14%), followed by *M. cecropioides* (4.17%), *P. santalinoides* (3.46%) and *H. brasiliensis* (2.97%).

Table 2: Phytochemical constituent of the various hard wood and soft wood sawdust species

Content (%)	*Pterocarpus santalinoides*	*Mitragyna ciliata*	*Musanga cecropioides*	*Hevea brasiliensis*
Total Alkaloid	3.46^{a}	7.14^{a}	4.17^{a}	2.97^{a}
Total Flavonoid	9.83^{b}	13.1^{c}	7.48^{b}	5.18^{c}
Total Saponins	4.02^{a}	5.72^{a}	3.24^{a}	2.49^{a}

Note: Values across rows (PC) are significantly different (P<0.05) between Hard and Softwood using Duncan Multiple Range Test (DMRT).

Alkaloids are biologically active secondary metabolites and may influence microorganisms differently depending on their chemical identity and concentration. Their relatively high concentration in *M. ciliata* could potentially contribute to biological interactions during fungal colonisation. However, the present data do not establish whether the alkaloid concentration inhibited or stimulated *P. ostreatus*. This distinction is important because *M. ciliata*, despite having the highest alkaloid level, produced the lowest fresh mushroom yield. Thus, the result raises the possibility that some extractive constituents may have constrained fungal productivity, although a causal relationship cannot be established from the present experiment.

Flavonoid concentration followed a similar pattern, with *M. ciliata* recording the highest value (13.10%), followed by *P. santalinoides* (9.83%), *M. cecropioides* (7.48%) and *H. brasiliensis* (5.18%). The relatively low flavonoid concentration in *H. brasiliensis* coincided with its highest mushroom yield. Conversely, *M. ciliata* had the highest flavonoid concentration but the lowest yield. This inverse pattern suggests that the abundance of some secondary metabolites may be associated with differences in substrate suitability.

Nevertheless, it would be scientifically inappropriate to conclude that flavonoids directly inhibited *P. ostreatus* because the study did not isolate individual compounds or conduct inhibition assays. Saponins ranged from 2.49% in *H. brasiliensis* to 5.72% in *M. ciliata*. Again, *M. ciliata* showed the highest concentration while *H. brasiliensis* showed the lowest. The simultaneous occurrence of relatively high alkaloid, flavonoid and saponin levels in *M. ciliata* and its comparatively poor yield is noteworthy. One possible explanation is that some secondary metabolites or combinations of extractives may interfere with fungal colonisation. However, this remains a hypothesis because no direct antifungal bioassay was included.

The morphological performance of *P. ostreatus* results demonstrate clear differences among mushrooms cultivated on the four sawdust substrates. Fresh weight was highest in mushrooms cultivated on *H. brasiliensis* (110.87g), followed by *P. santalinoides* (96.12g), *M. cecropioides* (73.60g) and *M. ciliata* (48.91g). Dry weight followed the same general ranking: 9.61, 7.63, 5.28 and 3.38g, respectively. This indicates that *H. brasiliensis* provided the most favourable conditions for fruit-body biomass production.

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Its superiority may be associated with its relatively high moisture content and crude fibre content. The high fibre concentration may have provided a substantial lignocellulosic resource for *P. ostreatus*, while adequate moisture may have supported mycelial metabolism.

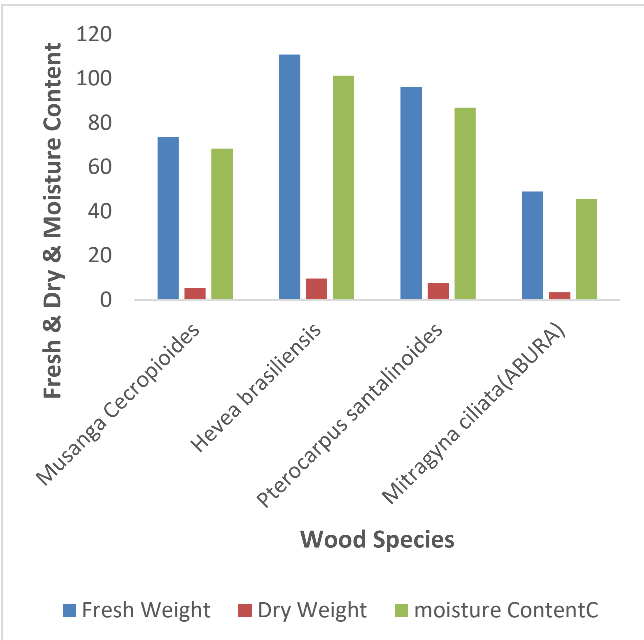

Figure 1: Fresh, dry and moisture content of harvested *P. ostreatus* on hard and softwood species

The results of the cap diameter and strip height of harvested P. ostreatus on hard and softwood species are as presented in Figure 2. The largest cap diameter was recorded for *P. ostreatus* grown on *P. santalinoides* (11.0 cm), followed by *H. brasiliensis* (10.5 cm), *M. ciliata* (9.2 cm) and *M. cecropioides* (8.8 cm).

An important observation is that the substrate producing the greatest fresh weight did not produce the largest cap diameter. *H. brasiliensis* produced the highest fresh biomass whereas *P. santalinoides* produced the largest cap. This indicates that yield and individual morphological dimensions are related but not identical traits. A substrate may favour larger caps without necessarily producing the greatest overall biomass. Consequently, substrate evaluation should incorporate several morphological and yield parameters rather than relying on cap diameter alone.

Stipe height was highest in *H. brasiliensis* (6.0cm), followed by *P. santalinoides* (5.25cm), *M. cecropioides* (4.0cm) and *M. ciliata* (3.1cm). The higher stipe height observed on *H. brasiliensis* corresponds with its highest fresh and dry weights.

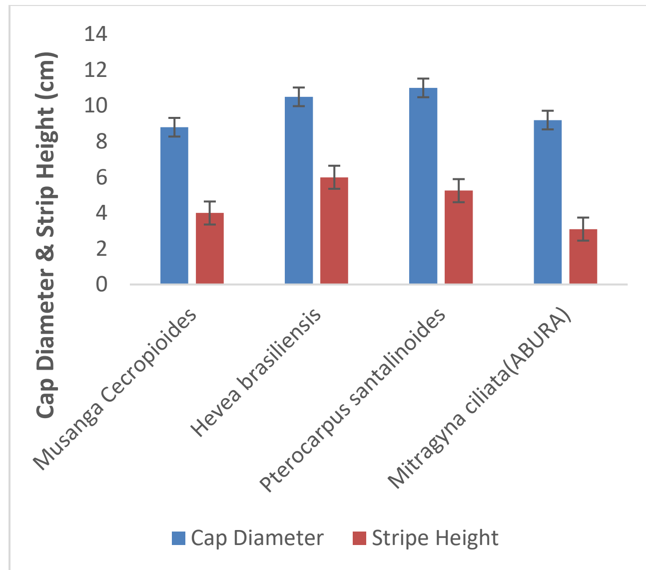

Figure 2: Cap diameter and strip height of harvested *P. ostreatus* on hard and softwood species

This suggests that the substrate may have supported more extensive fruit-body development overall. By contrast, *M. ciliata* consistently performed poorly in fresh weight, dry weight and stipe height. This consistency strengthens the interpretation that *M. ciliata* was the least suitable of the four substrates under the experimental conditions.

The yield performance of *P. ostreatus* is as presented in Figure 3. The yield data show substantial differences in productivity among the four wood substrates. Across the first three flushes, *H. brasiliensis* produced 110.868, 78.792 and 54.836g, respectively. *P. santalinoides* produced 78.168, 93.067 and 42.728g, whereas *M. cecropioides* produced 66.368, 46.792 and 25.339g. *M. ciliata* recorded 43.809, 34.953 and 20.840g, respectively.

The first flush was highest for *H. brasiliensis*, while *P. santalinoides* recorded its highest production during the second flush. This demonstrates that substrate effects were not constant across the cropping cycle.

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The first flush clearly favoured *H. brasiliensis*, with approximately 110.87g, followed by *P. santalinoides* at 78.17g, *M. cecropioides* at 66.37g and *M. ciliata* at 43.81g.

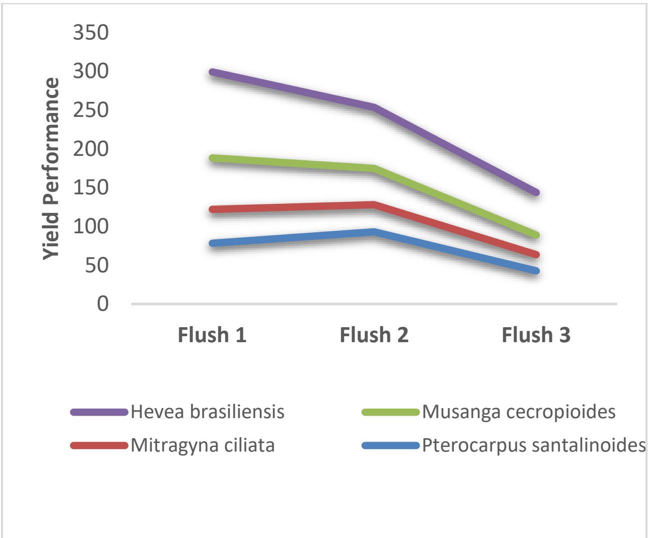

Figure 3: Yield performance of harvested Mushroom on hard and soft woods

The strong first-flush performance of *H. brasiliensis* indicates rapid conversion of substrate resources into fruiting biomass. This may be related to its higher moisture and fibre concentrations. An interesting reversal occurred during the second flush. *P. santalinoides* produced approximately 93.07g, exceeding *H. brasiliensis* at 78.79g. This suggests that the carbohydrate-rich *P. santalinoides* substrate may have retained sufficient accessible nutrients to support substantial subsequent fruiting. The result illustrates why evaluating only the first harvest can give an incomplete assessment of substrate suitability.

Production declined across all treatments during the third flush. Nevertheless, *H. brasiliensis* remained the highest producer at approximately 54.84g, followed by *P. santalinoides* at 42.73 g, *M. cecropioides* at 25.34g and *M. ciliata* at 20.84g. The decline in yield with successive flushes is expected because nutrients and readily accessible carbon sources become progressively depleted. The persistence of relatively high production from *H. brasiliensis* indicates that this substrate retained sufficient resources to sustain later fruiting.

Carbohydrate concentration alone *P. santalinoides* contained approximately 48.6% carbohydrate, substantially greater than *H. brasiliensis* at 13.17%, yet *H. brasiliensis* produced approximately 15% more fresh mushroom biomass. The superior performance of *H. brasiliensis* is therefore likely to reflect a favourable combination of fibre, moisture and accessible lignocellulosic components, rather than its crude carbohydrate concentration alone. A particularly interesting relationship was observed between phytochemical concentration and mushroom productivity. *M. ciliata*, which produced the lowest fresh weight (48.91 g), had the highest concentrations of total alkaloids (7.14%), flavonoids (13.10%) and saponins (5.72%). In contrast, *H. brasiliensis*, which produced the highest fresh weight (110.87 g), had the lowest alkaloid (2.97%), flavonoid (5.18%) and saponin (2.49%) concentrations. This inverse association suggests that the phytochemical profile of the wood may contribute to substrate selectivity. Certain secondary metabolites can possess antimicrobial properties and could potentially interfere with mycelial development. However, the current experiment cannot demonstrate that alkaloids, flavonoids or saponins caused the lower yield. A stronger experimental design for establishing this relationship would involve measuring mycelial growth rate, colonisation percentage and enzyme activity in addition to yield, and conducting inhibition assays using extracts from the four wood species.

Discussion

Similar cultivation studies use sterilised sawdust-based substrates, inoculation with *P. ostreatus* spawn, incubation until complete mycelial colonisation, followed by controlled fruiting and sequential harvesting (Vera et al., 2022). This finding agrees with the general conclusion of Obodai et al. (2003) that substrate suitability cannot be evaluated on the basis of a single chemical constituent because yield reflects the integrated effects of several substrate characteristics.

The finding is strongly supported by Obodai et al. (2003), who reported a positive correlation between mushroom yield and substrate cellulose, lignin and fibre contents.

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Their work demonstrated that lignocellulosic composition can be an important determinant of *P. ostreatus* productivity. The present result is also consistent with the review by Kortei et al. (2022), which identified sawdust and other lignocellulosic materials as important substrates for oyster mushroom cultivation.

Thus, substrate nitrogen concentration alone did not determine productivity. This agrees with the broader literature showing that substrate composition and supplementation interact to determine *P. ostreatus* performance. For example, supplementation of sawdust with rice bran has been shown to improve oyster mushroom yield in Nigeria, demonstrating the importance of balancing carbon-rich substrate with nitrogen-rich supplements.

Boadu et al. (2023) similarly showed that sawdust used for oyster mushroom cultivation contained substantial cellulose and lignin, demonstrating that chemical composition at the structural-carbohydrate level is important when evaluating sawdust suitability. This demonstrates that *P. ostreatus* productivity is governed by the combined chemical architecture of the substrate, particularly the accessibility of lignocellulosic carbon, moisture, mineral composition and possible inhibitory extractives. This interpretation is consistent with Obodai et al. (2003), whose experimental data showed that multiple lignocellulosic characteristics were associated with yield.

Yılmaz et al. (2017) demonstrated that substrate type can influence phenolic, flavonoid and tannin characteristics associated with *Pleurotus* cultivation, supporting the broader principle that substrate chemistry influences fungal bioactive profiles.

Vera et al. (2022) reported that *P. ostreatus* cultivated on different substrates showed differences in phytochemical components, demonstrating that cultivation substrate can influence the bioactive profile of the mushroom system. Their study detected compounds including flavonoids, saponins and alkaloids under some treatments.

Yılmaz et al. (2017) also demonstrated that *P. ostreatus* cultivated on different sawdust substrates could exhibit differences in phenolic, flavonoid and tannin contents.

The present study extends these observations by showing that the wood substrates themselves differ substantially in phytochemical composition, potentially providing a chemical explanation for some of the differences in mushroom development.

The result is consistent with Obodai et al. (2003), who found that substrate fibre, cellulose and lignin were positively associated with oyster mushroom yield. Vera et al. (2022) similarly observed significant differences in fruit-body height, pileus diameter and individual fruit-body weight among *P. ostreatus* substrates. A more plausible explanation is that *P. ostreatus* utilises structural carbohydrates such as cellulose and hemicellulose through extracellular enzymes, rather than simply relying on the proximate carbohydrate value. Obodai et al. (2003) found that cellulose, lignin and fibre were positively related to oyster mushroom productivity. This caution is necessary because *Pleurotus* is known to grow successfully on chemically diverse substrates. Vera et al. (2022), for example, obtained substantial differences in growth and yield among sawdust, corn-cob, palm-cone and elephant-stalk substrates, illustrating that substrate chemistry interacts with several biological and physical factors.

The present study generally agrees with Obodai et al. (2003), who demonstrated substantial substrate-dependent differences in *P. ostreatus* productivity. Their study found that composted sawdust produced particularly high yield and that yield was positively associated with cellulose, lignin and fibre content. The present findings also agree with Ogundele et al. (2017), who directly compared hardwood and softwood sawdust for *P. ostreatus*. Their study found that the hardwood substrate produced mushrooms with superior nutritional composition, whereas the softwood substrate produced better yield.

This distinction is particularly relevant to the present work because *H. brasiliensis*, softwood in the supplied classification, produced the highest fresh yield, whereas the hardwood *P. santalinoides* produced the largest cap diameter. Similarly, Vera et al. (2022) found that substrate type substantially affected mycelial growth, pinhead formation, fruit-body height, pileus diameter, individual fruit-body weight and biological yield.

Their results showed that sawdust-based treatments can perform differently depending on substrate composition and supplementation. The present findings further agree with the broader review of Kortei et al. (2022), which concluded that *P. ostreatus* can utilise numerous lignocellulosic substrates but that productivity varies according to substrate type.

However, the present study differs from a simplistic expectation that carbohydrate-rich substrates must always produce the greatest yield. *P. santalinoides* had the highest measured carbohydrate concentration but did not produce the highest fresh yield. This suggests that substrate quality for *P. ostreatus* is determined by nutrient accessibility and lignocellulosic structure rather than total proximate carbohydrate alone. Recent Nigerian work also supports the importance of substrate selection. Anaukwu et al. (2026) reported significant differences in *P. ostreatus* performance between sawdust substrates, with appropriately supplemented *Gmelina arborea* producing considerably greater biological efficiency than some alternative substrates.

First, the four tropical wood substrates differed substantially in proximate composition. *H. brasiliensis* was particularly characterised by high moisture and crude fibre, whereas *P. santalinoides* had the highest carbohydrate concentration.

Second, the substrates differed markedly in phytochemical composition. *M. ciliata* had the highest alkaloid, flavonoid and saponin concentrations, whereas *H. brasiliensis* had the lowest values for these measured phytochemical groups.

Third, morphological development differed among substrates. *P. santalinoides* produced the largest cap diameter, whereas *H. brasiliensis* produced the tallest stipe and greatest fresh and dry biomass. Fourth, *H. brasiliensis* was the most productive substrate based on fresh biomass and performance across the three flushes, whereas *M. ciliata* was consistently the least productive. Taken together, these findings indicate that wood species is an important determinant of *P. ostreatus* productivity, probably because different wood species provide different combinations of structural carbohydrates, moisture, nutrients and secondary metabolites.

Conclusion

The study demonstrated substantial differences in the proximate and phytochemical composition of the selected tropical wood substrates and corresponding differences in the morphological and yield performance of *P. ostreatus*. The results indicate that substrate chemical composition is closely associated with mushroom productivity, although no single proximate constituent adequately explains the observed differences. The findings of this study identified *H. brasiliensis* as the most promising of the four substrates for fresh biomass production of *P. ostreatus* under the conditions of this experiment.

Recommendations

Based on the findings of this study, the following recommendations are made:

The use of *Hevea brasiliensis* substrate is recommended due to its higher mushroom yield. The use of *Pterocarpus santalinoides* had higher mushroom caps and sustained production are desired beyond the first flush are important production objectives.

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