



Production Performance and Proximate Nutrient and Myco-chemical Composition of Paddy Straw Mushroom, *Volvariella volvacea*, Isolates Cultivated on Supplemented Banana Leaf Substrates

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Abstract

Volvariella volvacea (Bull.: Fr.) Singer (Plutaceae), commonly known as the paddy straw mushroom, is widely cultivated in the Philippines, where banana leaves are traditionally used as a substrate. However, standardized protocols for their efficient utilization remain limited. In this study, six isolates of *V. volvacea* were evaluated, comprising three commercial isolates from San Jose, Nueva Ecija (SJ), Tarlac City (TC), and La Union (LU), and three wild isolates collected from Brgy. Rang-ayan, Muñoz, Nueva Ecija (VVA), Central Luzon State University (VVB), and San Mateo, Rizal (SP). Supplementation of rice bran to banana leaf substrates significantly enhanced fruiting performance in isolates SJ, TC, LU, and SP, yielding biological efficiencies of 9.17%, 17.04%, 7.65%, and 10.98%, respectively. In contrast, coconut water supplementation was more effective for isolates VVA and VVB, with biological efficiencies of 9.22% and 9.61%, respectively, under uniform cultivation conditions. Proximate analysis of the harvested fruiting bodies revealed appreciable amount of carbohydrate (43.8-49.1%), crude protein (23.8-29.7%), crude fiber (10.4-19.7%), ash (12.2-14.2%) and very low crude fat (0.4-0.7%). Phytochemical screening further showed the presence of flavonoids and alkaloids exclusively in isolates SJ and TC. These confirm that both production performance and biochemical composition in *V. volvacea* are strongly isolate-dependent, highlighting the importance of strain selection and substrate optimization in improving cultivation efficiency and functional properties.

Keywords: Cultivation, Yield, Biological Efficiency, Proximate Composition, Flavonoid and Alkaloid

1. Introduction

The Philippines is a tropical country favored with enormous biodiversity including a very rich macrofungal species. Macrofungal species locally known as mushrooms are generally found existing abundantly in natural forest. Indigenous groups in the Philippines were reported in utilizing edible mushrooms such as *Pleurotus* and *Lentinus* spp., while several mushrooms are also utilized as medicine for treatment of various diseases. Among these species includes *Schizophyllum commune*, *Auricularia auricula*, and *Volvariella volvacea* [1].

Volvariella volvacea (Bull.: Fr.) Singer 1951, also known as paddy straw mushroom, an edible basidiomycetous mushroom species belonging in the family Plutaceae. It is locally known as *kabuteng saging* once found growing on decaying banana leaves or *kabuteng dayami* when growing on rice straw [2]. The fruiting body of *V. volvacea* has grayish-to-black egg-shaped volva at young and rupture to expand the pileus up to nearly flat. The expanded pileus is attached centrally to a white to brown stipe. The fruiting bodies of this mushroom are

usually collected during the onset of the rainy season by the people in the community and consumed this species as an ingredient of their viand.

V. volvacea is regarded as a culinary ingredient due to its texture, umami taste, and strong aroma. Nutritionally, its fruiting bodies contain carbohydrate, sugar, protein, crude fiber and fats. It also contains vitamins, minerals, and is rich in amino acids [3]. Nutrients and secondary metabolites such as flavonoids, alkaloids, tannins, terpenoids, lectins, sterols, and phenolic substances have emerged as natural sources of compounds that have antioxidant, antibacterial, and radical scavenging activities [4].

V. volvacea is the first introduced commercially cultivated mushroom in the Philippines. It was initially cultured in indoor cultivation using either dried banana leaves or rice straw in a bed-type pile with very minimal aeration and illumination at 30–35 °C for 14 days [5]. It was recorded from previous bodies of research that yield and biological efficiencies vary on the fruiting body cultivated on different substrates.

Other wastes that were found to have potential in *V. volvacea* cultivation were sawdust, cotton waste, wheat straw, rice straw, and peanut shells among others [6,7,8,]. Different methods for *V. volvacea* cultivation were also assessed. The cage method of cultivation showed superiority to the bed method, heap method, and spiral method after it gave bio-efficiency of 12.10 % [9].

To date in the Philippines, *V. volvacea* farming has been growing with mushroom growers sharing their expertise and practices in social media and other platforms [10]. However, this growing production of *V. volvacea* in the Philippines is mainly for business purposes without further mass of inquiries or research considered by the farmers due to simple cultivation techniques of this mushroom. To the best of researchers' knowledge, articles related to cultivation of *V. volvacea* Philippine isolate and assessment of its nutritional properties [3], have been stated to exist in literature. On the other hand, no record has been found focusing on enhancing substrate using nutritional enrichments such as rice bran and coconut water with an intensive observation to different isolates. Exploring the optimum substrate formulation to certain isolates is essential in acceleration of fruiting and yield performance.

Therefore, these gaps are opening a research opportunity in establishing the growth requirements and banana leaves utilization as substrate for local *V. volvacea* isolates. This research intended to establish necessary information for the generation of practical production technology in order to properly harness its promising potential and to fully realize its position in the Philippine mushroom industry. It will also give insights for future research in biotechnology and medical mycology.

2. Materials and methods

2.1. Source of Isolates

Pure cultures of the three wild isolates of *V. volvacea* were acquired from the culture collections of the Center for Tropical Mushroom Research and Development, Central Luzon State University, Muñoz, Nueva Ecija, Philippines. Pure cultures of three commercially cultivated isolates were obtained from the mushroom growers. The culture code, and place of origin of the different *V. volvacea* isolates are summarized in Table 1.

Table 1 The culture code and origin of the different isolates of *V. volvacea*.

Isolate Type	Culture Code	Place of origin
Commercially Cultivated	SJ	San Jose City, Nueva Ecija
	TC	Tarlac City, Tarlac
	LU	Agoo, La Union
Wild	VVA	Brgy. Rang-ayan Muñoz, Nueva Ecija
	VVB	CLSU, Nueva Ecija
	SP	San Mateo, Rizal

2.2. Preparation of Substrate

Dried banana leaves continuing to hang on the banana plants were collected. They were soaked in running water for 24 hours and were rinsed using distilled water. After the leaves were drained and air-dried, they were manually chopped in lengths of 11-13 inches. The following substrates for *V. volvariella* were then prepared: 100 % banana leaves as the control treatment, 90 % banana leaves + 10 % Coconut water, and 90 % Banana Leaves + 10 % Rice bran. The proportion of mixtures were measured by mass.

2.3. Evaluation of Fruiting Body Performance

Substrates were laid side by side occupying approximately 0.5 X 0.3 X 0.3 m of the ground space inside the mushroom greenhouse. After which, planting spawn was inoculated at the periphery of the layer, leaving a margin of 12-15 cm from the edges. Another layer of the same substrate was laid on top of the first layer and once again

inoculated with planting spawn. The process was done until the third layer. A total of 3 kgs of substrate was used for all three layers and approximately 70% (70g) of the spawn bag was consumed. The substrates were prepared in triplicates for each treatment formulation for all isolates. Cultivation of these isolates started during the onset of summer season in the Philippines until harvesting was done (March to April). The number of days for primordium initiation was recorded. Yield performances of grown mushrooms from three different treatments were recorded as fresh weights in grams and biological efficiencies were computed by using the total fresh weight of the fruiting bodies from 1st flushing following the methods of Ajika et al., Biswas and Layak, and Biswas [8, 9, 11].

$$\text{Biological efficiency (\%)} = \frac{\text{total fresh wt. of fruiting body} \times 100}{\text{Dry weight of Substrate}}$$

Dry weight of substrate refers to the weight of the substrate after completely draining from washing and air-drying [8, 9, 11]. The harvested fruiting bodies from the best substrates (based on biological efficiency) of each of the 6 isolates were selected. They were later oven-dried for 3 days at 40 °C, pulverized and submitted to laboratories for further biological tests, namely: proximate analysis, and presence of flavonoid and alkaloid screening.

2.4. Proximate Composition Analysis

Ten (10) g of dried (oven-dried for 3 days at 40 °C) and powdered fruiting bodies of each six isolates were sealed. The sealed samples were labeled and sent out to the Rice Chemistry and Food Science Division of Philippine Rice Research Institute, Science City of Muñoz, Nueva Ecija, for Proximate Analysis following the guidelines of Official Methods of Analysis of A.O.A.C. [12]. Moisture content, ash, crude protein, crude fat and crude fiber were analyzed. Moisture Content of samples were determined using the oven drying method while ash content of sample was determined by ashing method using muffle furnace at 300 °C for 2 hours. Crude Protein content of samples was determined by Kjeldahl method using N 3.99 protein conversion. Crude fat content was measured using the Soxtec method. Samples containing the fat were analyzed using Soxtec Fat Analyzer (ST 243 Soxtec Solvent Extraction System, FOSS). Crude Fiber Content was determined using the defatted samples. The carbohydrate content was determined by subtracting from 100 the summed-up percentage composition of moisture, protein, lipid, fiber and ash content.

2.5. Flavonoid and Alkaloid Screening

For the extraction of crude compounds, 10 g of oven-dried and pulverized samples were sent out to the Center for Natural Sciences, St. Mary's University, Nueva Vizcaya for mycochemical screening following the protocol of Dulay et al. [13]. The 10 g of dried and pulverized samples of *V. volvacea* were soaked to 500 mL methanol and the extraction was done twice with a mixer for 20 min. Extracts were filtered using Whatman filter No. 2 and concentrated to dryness using a rotary evaporator (Rotavap R-215 Buchi Labortechnik AG, Flawil, Switzerland). The flavonoid and alkaloidal screening was conducted qualitatively using the test tube method for determining the specific mushroom constituents. The specific methodologies used for testing the selected plant constituents were based on the methods published by Guevara et al. [14]. For testing the presence of flavonoids, a small portion of mushroom extract was dissolved in 95 % ethanol. Then, 3-5 drops of concentrated hydrochloric acid were added and finally, a small piece of magnesium metal was dropped onto the mixture. Results were determined after effervescence stops and were checked for the presence of either pink, red, orange, or yellow solution – indicating the presence of flavonoids. For testing the presence of alkaloids, a small portion of mushroom extract was dissolved in 95 % ethanol. Then, 3-5 drops of Dragendorff's reagent were added to the solution. The presence of an orange to red-orange precipitate indicated the presence of alkaloids in the extract.

2.6. Statistical Analysis

Analysis of variance was used to analyze the data of three replicates using Minitab 22 Statistical Software (Minitab 22.2.2). Tukey's HSD at 0.05 significance level was used for the comparison among treatment means.

3. Results

3.1. Evaluation of Fruiting Body Performance of *V. volvacea* Isolates

3.1.1. Initiation of Primordia

Primordial initiation is the indication of the development of the fruiting bodies. The spawn was inoculated on banana leaves, banana leaves + 10 % coconut water, and banana leaves + 10 % rice bran, and the spawn primordium initiation were then evaluated. Table 2 shows that in all isolates, pure banana leaves-control substrate registered the longest period to develop the primordia across all isolates, except to VVA on rice bran supplemented substrate that shows no fruiting. Shortest period of primordium initiation was noted on banana leaves + rice bran for SJ, TC, and SP while banana leaves + coconut water for LU, VVA, and VVB.

Table 2 Number of days to primordia initiation of *V. volvacea* isolates cultivated on the different substrate formulations.

Substrate	Initiation of Primordia (day)					
	SJ	TC	LU	VVA	VVB	SP
BL	19.00 ^a	17.00 ^a	17.00 ^a	18.00 ^a	18.00 ^a	18.00 ^a
BL + CW	14.00 ^b	12.00 ^b	10.00 ^b	11.00 ^b	10.00 ^b	13.00 ^b
BL + RB	13.00 ^b	10.00 ^b	10.00 ^b	-	12.00 ^b	10.00 ^c

Data are presented as a mean of triplicate (n=3). Letters of the same superscript are not significantly different according to Tukey's HSD ($P < 0.05$). BL, Banana Leaves; CW, Coconut water; RB, Rice bran; SJ, San Jose; TC, Tarlac City; LU, La Union; VVA, Brgy. Rang-ayan; VVB, CLSU; SP, San Mateo Rizal.

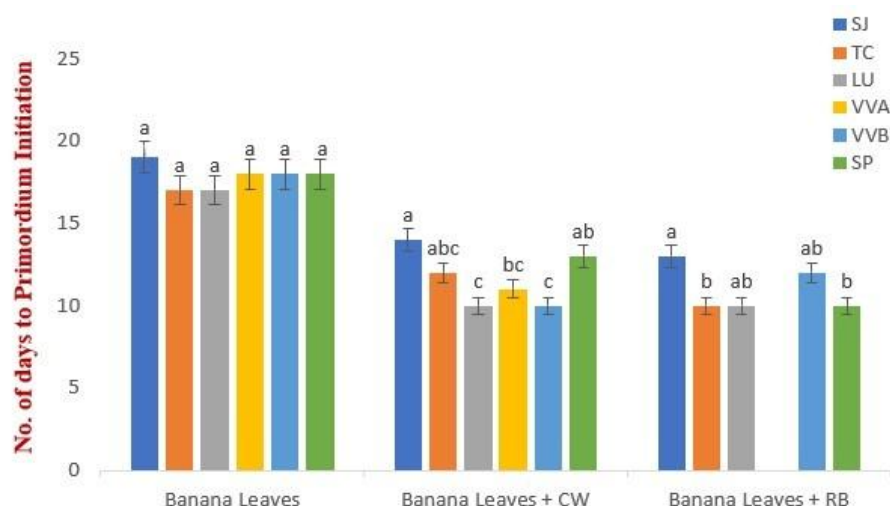


Figure 1 Comparison of different substrate formulations on the number of days to primordium initiation [Banana leaves, Banana leaves + Coconut Water & Banana leaves + Rice Bran] of *V. volvacea* isolates. Shorter bars indicating shorter days to primordium initiation. Letters of the same superscript are not significantly different according to Tukey's HSD ($P < 0.05$). [Isolates SJ (San Jose), TC (Tarlac City), LU (La Union), VVA (Brgy. Rang-ayan) VVB (CLSU), & SP (San Mateo Rizal). Treatment with no bar means no fruiting]

3.1.2. Fruiting Body Yield and Biological Efficiency

The harvesting of the fruiting body is usually done on the button stage or just after it ruptures. However, fruiting bodies fully developed into the maturity stage were also harvested for the computation of bio-efficiency. Table 2 shows the fresh weight of the fruiting bodies of six isolates of *V. volvacea* grown on banana leaves substrate formulations. The entire harvest period lasted for nine days. It can be noted that four isolates (SJ, TC, LU and SP) grown on banana leaves supplemented with 10 % rice bran produced the highest yield. On the other hand, the two isolates (VVA and VVB) cultured on banana leaves + 10 % coconut water recorded the highest amount of fruiting bodies.

Table 3 Average fresh weights of *V. volvacea* fruiting bodies cultivated on different substrate formulations.

Substrate	Yield of Fruiting Body (gram)					
	SJ	TC	LU	VVA	VVB	SP
BL	15.23±12.01 ^b	13.8±18.66 ^b	16.63±14.62 ^b	7.47±4.87 ^b	18.4±19.07 ^b	9.33±5.78 ^b
BL + CW	6.60±6.09 ^b	6.70±5.05 ^b	73.37±115.61 ^a	92.23±99.04 ^a	96.13±29.67 ^a	3.83±1.88 ^b
BL + RB	91.67±69.75 ^a	170.43±140.89 ^a	76.5±113.43 ^a	-	39.1±47.91 ^b	109.60±7.28 ^a

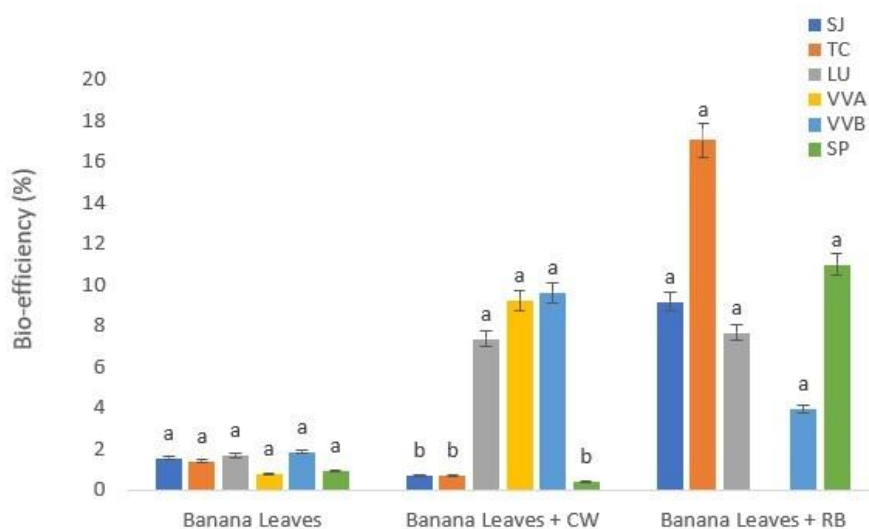
Data are presented as a mean ± standard deviations of triplicate (n=3). Letters of the same superscript are not significantly different according to Tukey's HSD ($P < 0.05$). BL, Banana Leaves; CW, Coconut water; RB, Rice bran; SJ, San Jose; TC, Tarlac City; LU, La Union; VVA, Brgy. Rang-ayan; VVB, CLSU; SP, San Mateo Rizal.

Bio-efficiency refers to the ability of the mushroom to transform the substrates into fruiting bodies. This parameter is directly proportional to the amount of yield produced by the mushroom. The bio-efficiency of six *V. volvacea* isolates is shown in Table 4. Considering the yield of different isolates, four isolates (SJ, TC, LU and SP) grown on banana leaves supplemented with 10 % rice bran recorded the highest bio-efficiency. Hence, the two isolates (VVA and VVB) cultured on banana leaves + 10 % coconut water recorded the highest bio-efficiency. Similar to primordium initiation, Figure 3 shows that the pure banana leaves-control substrates may yield higher bio-efficiency across all isolates when treated with nutrient enrichment.

Table 4 Average biological efficiencies of *V. volvacea* isolates cultivated on different substrate formulations. [Isolates SJ (San Jose), TC (Tarlac City), LU (La Union), VVA (Brgy. Rang-ayan) VVB (CLSU), & SP (San Mateo Rizal)].

Substrate	Biological Efficiency (%)					
	SJ	TC	LU	VVA	VVB	SP
BL	1.52 ^b	1.38 ^b	1.67 ^b	0.75 ^b	1.84 ^b	0.93 ^b
BL + CW	0.66 ^b	0.69 ^b	7.34 ^a	9.22 ^a	9.61 ^a	0.38 ^b
BL + RB	9.17 ^a	17.04 ^a	7.65 ^a	-	3.91 ^b	10.98 ^a

Letters of the same superscript are not significantly different according to Tukey's HSD ($P < 0.05$). Treatment with no value means no fruiting

**Figure 2** Comparison of different substrate formulations contributing to the biological efficiency of *V. volvacea* isolates [Banana leaves, Banana leaves + Coconut Water & Banana leaves + Rice Bran] (n = 3). [Isolates SJ (San Jose), TC (Tarlac City), LU (La Union), VVA (Brgy. Rang-ayan) VVB (CLSU), & SP (San Mateo Rizal)]. Letters of the same superscript are not significantly different according to Tukey's HSD ($P < 0.05$). Treatment with no bar means no fruiting

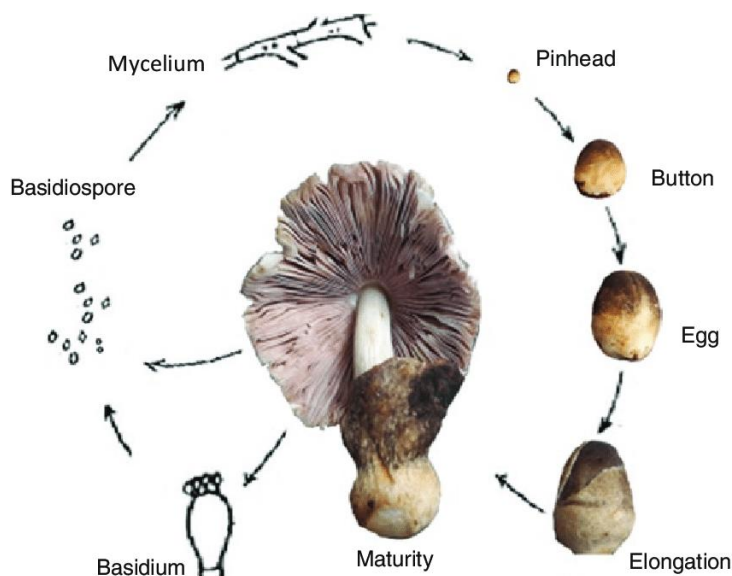


Figure 3 Developmental stages of *V. volvacea* [15]

3.2. Myco-chemical Composition of *V. volvacea* isolates

3.2.1. Proximate Composition

Proximate analysis is a test used to determine the nutritional composition of mushrooms fruiting bodies. In this study, SJ, TC, LU, and SP fruiting bodies were harvested from rice bran-supplemented substrate while the fruiting bodies of VVA and VVB were harvested from coconut water-supplemented substrate due to their highest bio-efficiencies from respective substrates. Varying amounts of nutrients shown in proximate analysis are summarized in Table 3 that shows the nutrient composition of *V. volvacea* isolates in terms of moisture, ash, crude protein, crude fat, crude fiber, and carbohydrate. It shows on the table that there are significant differences to some isolates on the same parameters.

Table 5 Proximate composition of six isolates of *V. volvacea*. [Isolates SJ (San Jose), TC (Tarlac City), LU (La Union), VVA (Brgy. Rang-ayan) VVB (CLSU), & SP (San Mateo Rizal)].

Nutrient (%)	SJ	TC	LU	VVA	VVB	SP
Moisture	10.7±0.00 ^f	16.9±0.05 ^a	14.3±0.10 ^b	13.5±0.00 ^d	14.0±0.00 ^c	11.1±0.05 ^e
Ash	14.2±0.10 ^a	13.4±0.23 ^c	12.2±0.05 ^e	13.0±0.00 ^d	13.4±0.10 ^{bc}	13.7±0.00 ^b
Crude Protein	29.7±0.20 ^a	25.2±0.36 ^c	24.0±0.11 ^{de}	24.7±0.46 ^{cd}	23.8±0.23 ^e	28.4±0.20 ^b
Fat	0.4±0.05 ^b	0.7±0.05 ^a	0.4±0.00 ^b	0.7±0.05 ^a	0.4±0.05 ^b	0.5±0.05 ^b
Fiber	14.5±0.26 ^d	19.1±0.15 ^{ab}	10.4±0.25 ^e	19.7±0.36 ^a	18.5±0.15 ^b	15.7±0.15 ^c
Carbohydrate	44.9±0.20 ^d	43.8±0.45 ^e	49.1±0.05 ^a	48.1±0.40 ^b	48.3±0.32 ^{ab}	46.4±0.17 ^c

Data are presented mean percentages ± standard deviations (n = 3). Letters of the same superscript are not significantly different.

Moisture content refers to the amount of water present in the fruiting bodies. ANOVA analysis revealed significant differences in the moisture content of the 6 isolates. TC isolate recorded the highest moisture content with a mean of 16.9 % while SJ isolate exhibited the lowest moisture content with a mean of 10.7 %. ANOVA analysis revealed significant differences in the ash content of the isolates. The highest ash content was observed in SJ isolate with a mean of 14.2 % while the lowest was recorded in LU isolate with a mean of 12.2 %. It can also be gleaned from the table that SJ isolate recorded the highest protein content with a mean value of 29.7 %. On the other hand, the lowest value was noted in VVB isolate with a mean of 23.8 %. The amount of crude fat in the six *V. volvacea* isolates ranged from 0.4 to 0.7 %. The highest fat content was observed in TC and VVA isolates with a mean value of 0.7 % while the lowest was recorded in SJ, LU and VVB isolates with the value of 0.4 %. The amount varies depending on the isolates and the difference is significant. The crude fiber of the different isolates ranged from 10.4 to 19.7 %. The highest value was obtained in VVA isolate with a mean value of 19.7 % while the lowest value was noted in LU isolate with a mean value of 10.4 %. Significant variation was noted among different isolates. Lastly, the concentration of carbohydrates contained in the fruiting bodies of the six *V. volvacea* isolates evaluated ranged from 49.1 to 43.8 %. The highest concentration was observed in LU isolate with a mean value of 49.1 while the lowest was recorded in TC isolate with a mean value of 43.8 %.

3.2.2. Presence of Flavonoid and Alkaloid

Mycochemicals are a class of mycological compounds generated primarily by mushrooms. Similarly, fruiting bodies screened for the presence of flavonoid and alkaloid were harvested from highest the yield-producing substrate. Table 4 shows the presence or absence of the flavonoids and alkaloids in the fruiting bodies of *V. volvacea* isolates. Three isolates were detected to contain flavonoids (SJ, TC, & VVB). On the other hand, three isolates (SJ, TC, & SP) were detected to have alkaloids.

Table 6 Mycochemical Compounds of *V. volvacea* isolates. [+ indicates presence and – indicates absence of the secondary metabolites].

V. volvacea isolates		Mycochemical Compounds	
		Flavonoids	Alkaloids
Commercial	SJ	+	+
	TC	+	+
	LU	-	-
	VVA	-	-
Wild	VVB	+	-
	SP	-	+

4. Discussion

In this study, primordium initiation of six *V. volvacea* isolates on banana leaves accelerated after the addition of nutrient enrichments. Supplementation of coconut water to substrate was once found to induce mycelial growth and fruit development for *Pleurotus* sp. while addition of 10 % wheat bran helps to achieve C:N values which are important for the growth of fungus [8,16]. These findings agree with Dulay et al. [17] who noted that supplementation of nutrients can affect the mycelial ramification which can result in acceleration or delay in the formation of primordia. In contrast, Ajikah et al. [8] reported a certain isolate of *V. volvacea* that has not shown fruiting on a substrate. In their study, the acidity of a substrate was found unsuitable for the growth of the mushroom, which could explain the absence of fruiting bodies of the VVA isolate on rice bran-supplemented banana leaves. Although the pH of the substrate in this present study was not determined, addition of rice bran increases the acidity of the substrate [18]. Moreover, the addition of rice bran to substrate can interfere with the productivity of fungus [19] due to the fact that a nutritious substrate may overwhelm the mycelia which can hinder the development of the fruiting body. This finding affirms the study of Khan and Chandra [20], that highlights the importance of maintaining the balance between carbon and nitrogen to substrate, because the composition of nutritious substrate may affect the induction of the fruiting body.

The highest yield obtained in the supplemented substrates could be attributed to the nutrients present in coconut water and rice bran. Rice bran is nutrient rich by product of milling process which is a rich source of a protein, fat, dietary fibers, vitamins, minerals, and phytochemicals such as oryzanols and tocopherols [21]. Moreover, mature coconut water is nutritious due to the presence of many nutrients such as glucose, fructose, and sorbitol and minerals namely: K, Ca, Na, Mg, P, Cu, and Fe [22, 23]. These findings suggest that banana leaves may yield higher fruiting bodies once supplemented with rice bran or coconut water hence, addition of nutrient enrichments to banana leaves increase the bio-efficiency. Based on the data, this parameter is also species and strain/isolate dependent. In addition, the biological efficiency of *V. volvacea* also depends on the substrates used and method of cultivation [7,9].

In this present study, significant differences in most of the isolates across different proximate compositions agree in the findings of Anno et al. that proximate composition of different *V. volvacea* isolates from Côte d'Ivoire are isolate dependent [24]. Interestingly, in the review of Nur et al. about proximate composition of *V. volvacea*, ash and fiber contents of all isolates in this study are higher from the recorded review of 8.1 to 9.5 and 5.1 to 13.4 respectively. Meanwhile, protein and carbohydrate content of *V. volvacea* in this present study were registered within the range of 21.3 to 30.5 and 40.0 to 50.6 respectively. Lastly, fat content of *V. volvacea* from the review of 1.1 to 3.7 appears to be higher than the fat content of all *V. volvacea* Philippine isolates [25].

Proximate compositions of 6 isolates do not appear to vary greatly, and do not resemble commercial isolates to be more nutritious than wild isolates, or vice versa. This is in contrast to the findings of Barros et al. [26] that commercial mushrooms have higher carbohydrate and protein than wild mushrooms. Nevertheless, the lower fat and higher nutrients such as carbohydrates and protein of 6 isolates implies that *V. volvacea* is a good alternative for meat.

In this present study, the different isolates have differences when it comes to the presence of flavonoids and alkaloids. Flavonoids are a group of compounds present in fruits, vegetables and mushrooms. These compounds are now considered as an indispensable component in a variety of applications due to various biological properties coupled with their capacity to modulate key cellular enzyme function [27]. Flavonoids have been reported also in wild mushrooms of the Philippines such as *Paneolus* spp. [28]. Alkaloid is a group of naturally occurring organic nitrogen-containing compounds that are commonly found in plants which also reported in a number of mushroom

species such as *Auricularia auricula*, *Schizophyllum commune*, *Ganoderma lucidum*, and *Xylaria papulis* have also been reported to contain alkaloids [29]. Many alkaloids can be utilized to treat various diseases including malaria, diabetes, cancer, cardiac dysfunction etc. [30]. Differences in the presence of flavonoid and alkaloid compounds of the isolates might be due to the different practice of mushroom farmers on subsequent cultivation or to the grown substrate of wild mushrooms. This is because composition of different substrates, especially nutrients absorbed by mushrooms, also contributes to varying biological compounds [31,32].

5. Conclusion

It is evident in this study that supplementation of nutrient enrichments to banana leaves for *V. Volvacea* cultivation accelerates fruiting production and greatly increases yield and biological efficiency to all isolates. Although each isolate requires different nutrient enrichments of substrates, it is clearly evident that the nutrient requirement for the growth of local *V. volvacea* isolates is isolate-dependent, and thus, optimization for nutrient growth requirement is essential, especially in food production technology. Further investigation for optimum growth requirement of Philippine *V. volvacea* may include physical factors such as temperature, illumination, substrate-moisture, etc. Influence of substrate formulation for nutrient and other biological properties of *V. volvacea* can also be done through analysis of untreated control substrate and focusing on certain growth stages of the mushroom as well. Overall, Philippine *V. volvacea*, a mushroom that is a good source of nutrients and commonly known to grow on banana plantations, requires additional nutrients for banana leaves as substrate for mass production.

6. Conflict of Interest

The authors confirm that they have no conflict of interest to declare for this publication

7. Authors Contribution

L.S.Tapnio: Conceptualization, Data curation, Visualization, Investigation, Project administration, Writing – original draft. R.M.R.Dulay: Methodology, Resources, Visualization, Writing – review and editing. E.H.Mandia: Supervision, Writing – review and editing – formal analysis. L.M.Espiritu: Writing – review and editing, formal analysis. H.R.R.Landingin – Writing review and editing, formal analysis

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