SUGARCANE POTENTIAL IN *Pleurotus sajor-caju* CULTIVATION

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ABSTRACT

Sugar production in Vietnam plays an important role in the agriculture and creating a plenty sugarcane bagasse source (SCB). SCB is reused in various industries. In this study, we deployed SCB potential in *Pleurotus sajor-caju* (*P. sajor-caju*) mushroom cultivation and evaluated the combination between SCB and sawdust served as raw substrates to increase the yield of mushroom cultivation. Results showed that the ratio of SCB to sawdust 3:1 generated higher body fruits and bio-efficiency. Furthermore, this ratio showed shorter time for crops, with cheaper materials and higher profit as compared to other combinations. These results premise SCB utilization in mushroom cultivation, reuse available materials and protect the environment.

Keywords: Pleurotus sajor-caju, sugarcane bagasse, rubber sawdust, bio-efficiency, profits.

1. INTRODUCTION

The agricultural sector employs seventy percentage of Vietnam population and therefore it generates huge amount of agricultural wastes [1]. Many types of wastes potentially serve as materials for other industries [2, 3]. Therefore, new findings for agricultural wastes utilization are urgently necessary. Cane for sugar production is widely cropped in Vietnam and creates abundant source for biofuel, animal feeding, paper or board making [2-5]. Recently, sugarcane bagasse (SCB) is used for further purposes such as dietary fiber rich products, fish culture, poultry industry [6-9]. Furthermore, nutrients in SCB are also believed to fit mushroom cultivation [3, 10]. SCB shows itself profit in mushroom production as compared to paddy or mustard straw or corncob and sawdust [11, 12]. Therefore, reusing SCB in mushroom production might be a great potential and partly limit agricultural wastes as well.

Pleurotus sajor-caju (*P. sajor-caju*) is one of the popular edible mushrooms, which has high value of nutrients and therapeutic metabolites [13]. Phenolic compounds in *P. sajor-caju* are believed to inhibit bacteria growth, antioxidant or anti-inflammatory activities [13-15]. Many researches have been employed wastes for edible mushroom productions [11, 12, 16, 17]. In this study, we exploited the bagasse - a waste from sugarcane for *P. sajor-caju* production and analyzed the economic efficiency of this model as compared to sawdust substrate. These results propose a potentiality of existing wastes – bagasse as the new cost-effective material in *P. sajor-caju* cultivation and suggest the new approach to environment protection.

2. MATERIALS AND METHODS

2.1. Materials

P. sajor-caju and rubber sawdust were collected from Center of Scientific Research and Practice, Thu Dau Mot University. Bagasse from sugarcane was derived from Thanh Thanh Cong Sugar limited company located at Bien Hoa city.

2.2. Methods

2.2.1. Material preparation

SCB was exposed to 1% lime in order to sterilize and neutralize pH, then mixed evenly and covered by nylon canvas to get humidity. Air humidity was maintained at 70-95%. Sawdust was also treated 1 day with lime. Bagasse and sawdust were mixed each other as indicated ratios and dispensed into glass bottles for autoclave at 121°C, 1 atm. *P. sajor-caju* was sown after 24 hours and ventilated-grown at 30-32 °C, 8 air changes/hour and 100-150 lux. The combination of bagasse and sawdust was shown in below table (Table 1).

Table 1. Design of experiments

Experiments	C0	100% rubber sawdust
	C1	75% rubber sawdust + 25% bagasse
	C2	50% rubber sawdust + 50% bagasse
	C3	25% rubber sawdust + 75% bagasse
	C4	100% bagasse

2.2.2. Harvest

The expansion of mycelium was measured daily and time at body fruiting was noted. Body fruits in different experiments were collected and weighted. Bio-efficiencies of each experiment was calculated via the formulation: weight of harvest/weight of dry substrate (w/w). Economic effectiveness was analyzed in different experiments via the gross and expenses.

2.2.3. Statistical analysis

Experimental differences were examined using ANOVA and Student's *t*-tests, as appropriate by Graphpad prism 6.01. Each of experiments was duplicated. All values are expressed as mean ± SD (n = 3); *p value* < 0.05 were considered to indicate statistical significance.

3. RESULTS

3.1. The expansion of mycelium

Mycelium expansion was recorded every 3 days (day 3, day 6 and day 9). At day 3, there was no significant difference between experiments. At day 6, C3 and C4 expanded mycelium length slower as compared to C0/ C1/ C2 (data not shown). At day 9, however, C0 showed the highest expansion rate versus the rest of experiments and there was no statistical difference between C1/ C2/ C3 and C4 (Figure 1). Therefore, these data suggested that increasing the proportion of bagasse might lower mycelium expansion rate in *P. sajor-caju*.

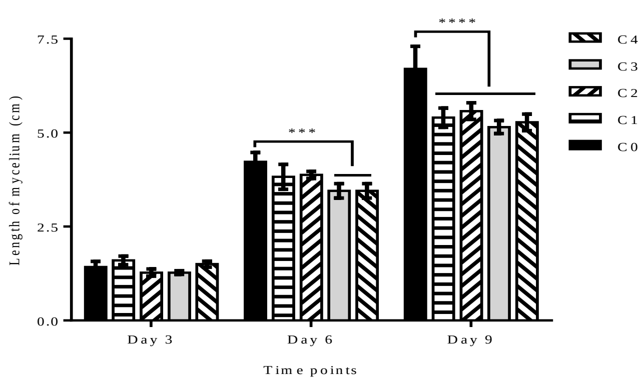

Figure 1. The mycelium length of different combinations.

3.2. Body fruiting

Body fruits were collected, weighted and compared to each other in order to figure out the combination resulting in the highest efficiency. Results showed that C3 combination significantly generated the highest body fruits versus other combinations (Figure 2). There was no statistical difference between C0/ C1/ C2 and these groups were slightly lower than C4 (*p value* < 0.05, data not shown). Taken together, these data indicated that bagasse supplement (75%) into *P. sajor-caju* cultivation materials reflects the highest rate of body fruiting.

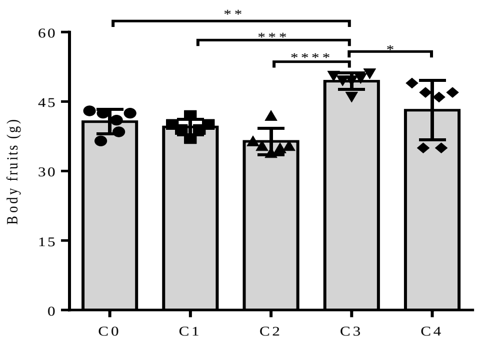

Figure 2. Body fruiting of different combinations.

3.3. Harvest time

Short crops time facilitates to increase the crop number and maximize the crop efficiency. In this study, results showed that the time for mycelium formation in C0 and C4 were shortest, followed by C1, C2 and C4, respectively (Figure 3). Regarding to the time for harvest, C3 combination minimized harvest time as compared to other combinations (Figure 3). Taken together, these data suggested C3 combination fits to increase the crop number.

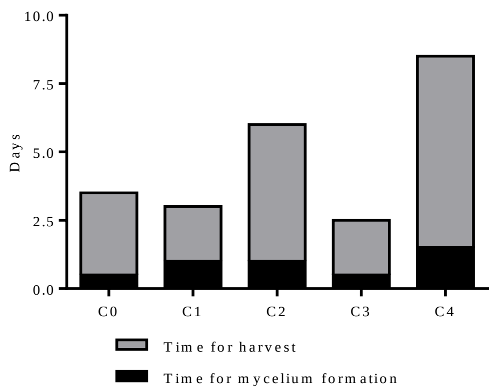

Figure 3. Harvest time of different combinations

3.4. Bioefficiency

Bioefficiency (BE) is an important parameter which represents the effectiveness of mushroom cultivation [18]. This index helps grade different combinations of substrates or evaluate the yields of mushroom strains. In this study, the results indicated BE of C3 combination significantly higher from C0/ C1/ C2 while not different to C4 (Figure 4). These data confirmed that mixing bagasse and sawdust at ratio 3:1, is able to promote *P. sajor-caju* yield and increase BE.

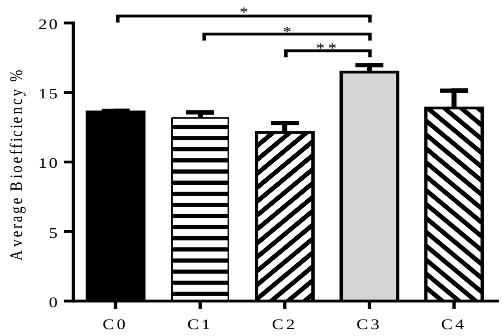

Figure 4. Average bioefficiency of different combinations

3.5. Profit

Profit reflects the effectiveness and helps sustain the business. To figure out which combination might benefit the mushroom business, we examined the costs and compared the profits among different experiments. Results showed that C3 gained the highest profit, followed by C4. However, the sugarcane bagasse mixed with sawdust at ratio 1:1 did not benefit efficiently (Figure 5). This result further confirmed the supremacy of bagasse supplement (75%) in mushroom cultivation.

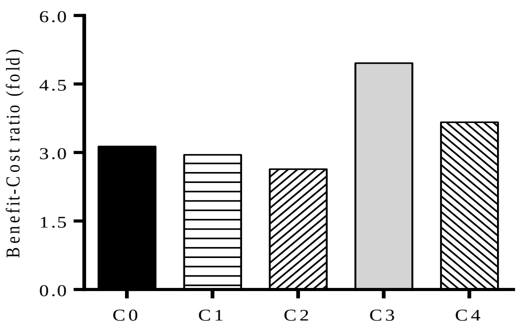

Figure 5. Profits of different combinations.

4. DISCUSSION AND CONCLUSION

In this study, the combination of sawdust and SCB at ratio 1:3 (C3), indicated the optimal condition for *P. sajor-caju* cultivation. This ratio did not assist efficiently the growth of mushroom mycelium as compared to 100% sawdust. The reason is that *P. sajor-caju* might uptake the nutrients from sawdust more efficiently than the nutrients from SCB. Therefore, the length of mycelium grew faster in C0 at the same time point. Furthermore, capacity of humidity maintenance in sawdust is also a possibility. Humidity is required for mushroom growth and body fruiting process [19]. However, the ratio 1:3 improved body fruit performance significantly versus to other groups while curtailing the time for next crops. A possibility is that the nutrients with high availability in 25% sawdust premise for mushroom primary growth and high percentage of cellulose and hemicellulose in SCB aids body fruiting process. Moreover, mycelium growths were not event in all groups (data not shown). Although, the mycelium length in C3 was shorter versus to C0 at the same time point, however the SCB existence in raw materials with higher percentage of cellulose and hemicellulose led to the high density of mycelia, so that accumulating essential nutrients for body fruiting process [19-20]. This explains for body fruits harvested in C3 significantly higher than in combinations with the high sawdust proportion. In addition, time for mycelium formation in C0 and C2 groups did not differ notably from C3, nevertheless, harvest times were increased. Similarly, the time for harvest was extended and mycelium formations take longer in C4 (100% SCB) group. This increases the crop time and limits the number of crop per year. Therefore, C3 with 25% sawdust and 75% SCB might be an ideal option for mushroom crop adjustment.

BE is a key concern in the mushroom cultivation. It presents the mushroom capacity for substrate transform from raw materials. Combination at the ratio 1:3 (C3) yielded BE as compared to other groups (C0, C1 and C2). However, the BEs were not distinguished between C3 and C4. The possibility is that percentages of C/N in these groups were closed to each other, resulting in no difference of BEs. Nevertheless, C3 also created a profit comparable to other groups. This is resulted from low costs of materials while gaining higher body fruits and shorter harvest time. Similarly, another study of Vetayasuporn *et al.* showed that SCB mixed with sawdust (3:1) efficiently assist *P. ostreatus*- Kummer cultivation [21]. The study also indicated that this mixing ratio aids to promote body fruiting time and generate the highest yield and BE as compared to other combinations. In addition, Chukowry *et al.* reported the promising option in *P. sajor-caju* cultivation by mixing 75% SCB with 25% tea wastes [22]. These evidences consolidate the SCB potential in the mushroom cultivation and the ratio 3:1 might be the efficient combination for further testes.

The result of this study can be expanded in large scale and in factories of sugar production to reuse valuable materials. Furthermore, combinations between SCB and other prevalent raw materials such as coffee, coconut coir, rice or wheat straw… might be also tested to increase the mushroom performance. These results could be a reference for the cultivations of other mushroom strains via using SCB as raw substances. In conclusion, it is worthy to deploy SCB in the mushroom cultivation to minimize investigating fee and to yield up business with environmental friendly and green strategies.

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TÓM TẮT

TIỀM NĂNG ỨNG DỤNG BÃ MÍA TRONG TRỒNG NẤM BÀO NGƯ XÁM NHẬT (*Pleurotus sajor-caju*)

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Ngành nông nghiệp mía đường tại Việt Nam chiếm vị trí quan trọng trong nền nông nghiệp và đạng tạo ra nguồn bã mía dồi dào. Ứng dụng bã mía cho nhiều ngành khác nhau đã được triển khai. Trong nghiên cứu này, bã mía được sử dụng vào sản xuất nấm bào ngư xám Nhật (*Pleurotus sajor-caju)* và đánh giá khả năng kết hợp với mạt cưa cao su nhằm tăng năng suất nấm và hiệu quả kinh tế. Kết quả cho thấy, tỷ lệ phối trộn 3:1 bã mía và mạt cưa cho kết quả tối ưu ở khối lượng sản phẩm, hiệu suất sinh học. Bên cạnh đó, kết quả nghiên cứu cũng cho thấy tỷ lệ 3:1 có thời gian thu hoạch sớm, nguyên liệu giá thành rẻ hơn, mang lại lợi nhuận cao hơn so với các nghiệm thức khác. Kết quả này là tiền đề ứng dụng bã mía trong công nghiệp trồng nấm, giúp tận dụng nguồn nguyên liệu sẵn có và bảo vệ môi trường.

Từ khóa: Pleurotus sajor-caju, bã mía, bột cưa cao su, hiệu suất sinh học, lợi ích kinh tế.