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**SHORT COMMUNICATION**

# The evolution replacing para rubber sawdust by using bagasse and rice straw with giant mimosa for substrate cultivation P. sajor-caju

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## Abstract

**Purpose** Profiting from agricultural waste and lowering production costs for farmers have been made possible by the incorporation of bagasse and local resources as a substitute for sawdust.

**Method** The experiment was using a CRD. Follows: Bagasse 100 % Bagasse: Rice straw (25:75%) Bagasse: Rice straw (50:50%) Bagasse: Rice straw (75:25%) Bagasse: Giant mimosa (25:75%) Bagasse: Giant mimosa (50:50%) Bagasse: Giant mimosa (75:25%) Bagasse: Rice straw: Giant mimosa (25:35:40%) Bagasse: Rice straw: Giant mimosa (50:25:25%) Bagasse: Rice straw: Giant mimosa (75:15:10%) Rice straw 100% Giant mimosa 100% and Sawdust 100% (control)

**Results** The highest average fabric expansion rate of 9.76 cm was generated by the bagasse to gigantic mimosa ratio of 75:15:10. Also, Para rubber sawdust had the lowest fiber rate of growth of 7.26 cm on average (100%). When evaluating mushroom proliferation, the 8th procedure to solve the bagasse: straw: giant mimosa (25:30:40%) gave the greatest average number of mushrooms per bag equal to 8.25. The technique that produced the lowest mushroom per bag of 100% of giant mimosa was 5.50, with diameter pileus ranging from 5.93 to 6.77 cm, and flower stripe length ranging from 3.12 to 3.75 cm. There was no statistical difference at the 95% confidence level according to the findings. Whenever biological efficiency (B.E.) was considered.

**Conclusion** The results showed that bagasse: chopped straw: chopped giant mimosa (25:35:40%) would have a maximum value of 58.96%. Which was the best approach being the best for utilizing as material for growing mushrooms or introducing farmers.

**Keywords** Bagasse, Giant mimosa, Mushroom cultivation, Para rubber sawdust, Rice straw

## Introduction

The oyster mushroom was economically valuable to the mushroom family, as well as tasty (Mosimanegape et al. 2018) and includes numerous nutrients such as proteins, carbohydrates (approximately 50-65 % by dry weight), vitamins, and minerals that have health advantages (Nithyatharani and Kavitha 2018). It also helps to prevent excessive blood lipids, heart disease, and high blood pressure, as well as having anti-cancer effects (Lini et al. 2021; Tripathi et al. 2018). Furthermore, it is very inexpensive and simple to cultivate and it may grow effectively in a variety of agricultural waste materials. The fibers walk well in cellulose-based materials (Rathore et al. 2019). Farmers in Thailand that grow mushrooms as a side-line typically utilize rubber saws as raw materials for

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fresh mushrooms which retail for 60-120 Baht per kilogram. A monthly income of 5,000-10,000 Baht for the family demonstrates that mushroom farming is a supplemental activity that may also help farmers establish a career. However, the current challenge is that farmers are having difficulty with production expenses, particularly raw resources utilized in the manufacture of mushroom cubes. Farmers will squander, and if there is no rubber sawdust, mushroom lump manufacturing will be halted. As a result, even if there are adequate sources for creating local mushroom lumps such as rice straw, bagasse, giant mimosa, and so on, the cultivation of mushrooms for sale is hampered. These raw resources can be used to help farmers cut production expenses.

Bagasse is a byproduct of sugar manufacturing. It has more nutrients than wood sawdust rubber and contains nitrogen, phosphorus, and potassium which are the major nutrients and secondary elements needed for plants and microorganisms to develop (Belay et al. 2020). Although bagasse is inexpensive and widely available in the sugar industry. There has been little research and development into how to use it as a mushroom-producing resource, even though it reduces farmers' production costs. In general, it is sold for 600-700 Baht a ton, which is nearly ten times less than rubber Para sawdust, including transportation costs along the distance of roughly 1,000-2,000 Baht for every vehicle. Furthermore, there is agricultural waste in the neighborhood that may be utilized to make mushroom cultivation ingredients. Rice straw is an agricultural waste that is created after huge amounts of rice are harvested and are mainly burned by farmers, polluting the environment. Giant mimosas are weedy legumes that grow in rivers and wet places. Due to various their high protein content, proteins are regarded as rich in resources and can also be used in the manufacturing of animal feed. Maomoonha (2018) discovered that giant mimosa leaves may be used to enhance soil organic matter for planting or maximize organic matter content in all stages, as well as improve soil chemistry and the physical soil texture by increasing the percentage of air pockets in the soil, causing it to crumble. It has the potential to lower soil density while increasing soil water retention capacity (Podong and Phinthong 2019). The use of waste products such as bagasse, rice straw, and giant mimosa in the production of mushrooms will assist in lowering manufacturing costs (Sutha et al. 2019). As a result, it is an opportunity that should be encouraged to give farmers a body of knowledge and skill to serve as a guide (Dagnew and Abel 2018) when making decisions about future mushroom production investments. Including assisting farmers in generating money and maintaining a long-term stability in their lives. Resulting in a stronger economy for the people in the neighborhood. The community's strength is compatible with the government's objective of strengthening local communities and increasing the country's economic potential. The objectives of this study were to investigate agricultural waste materials that have been appropriate for cultivating Bhutanese fairy mushrooms (*P. sajor-caju)* and to examine the biological efficiency (B.E.) of mushroom cultivation materials derived from agricultural waste.

## Materials and methods

### Preparation of the substrates

1) Local agricultural waste was used in this study, including rice straw, bagasse, and giant mimosa. Each waste was chopped into small pieces using a shredder, with a size that not exceeding 1-2 cm in diameter, and then air-dried before use (Fig. 1).

2) The bagasse was immersed in 200 L of water in a plastic bucket and allowed for 2 h to remove debris like dirt and rock. Then the bagasse was air dried before mixing in a mixer, according to the electrochemical process.

3) The preparation of inoculated mushrooms and this mushroom cultivation experiment were made using a Completely Randomized Design: CRD. Each procedure will be going through four repetitions of 10 components each as follows:

Treatment 1 Bagasse 100 %

Treatment 2 Bagasse: Rice straw (25:75%)

Treatment 3 Bagasse: Rice straw (50:50%)

Treatment 4 Bagasse: Rice straw (75:25%)

Treatment 5 Bagasse: Giant mimosa (25:75%)

Treatment 6 Bagasse: Giant mimosa (50:50%)

Treatment 7 Bagasse: Giant mimosa (75:25%)

Treatment 8 Bagasse: Rice straw: Giant mimosa (25:35:40%)

Treatment 9 Bagasse: Rice straw: Giant mimosa (50:25:25%)

Treatment 10 Bagasse: Rice straw: Giant mimosa (75:15:10%)

Treatment 11 Rice straw 100%

Treatment 12 Giant mimosa 100%

Treatment 13 Sawdust 100% (control)

4) Bring the mushroom cultivation material to the process to add supplemental food such as three kilograms of fine bran, 0.5 kilograms of lime, 0.1 kilograms of gypsum, and 0.1 kilograms of pumite-sulphate. Afterward, add water to the mixer and thoroughly mix hand-held test. It can be utilized if it sticks together as a lump with no water running between the hand prongs.

5) Pack the cultivation ingredients from each procedure into a 6.5 x 12 inches plastic bag weighing 600 grams each bag. According to the stated ratio manual work compacted, then attach the bottleneck and secure with a plastic cork (Fig. 2).

**Fig. 1** Supply chain network for cultivation

**Fig. 2** Mixing material and packing in plastic bags

6) The culture material lump is autoclaved for two hours in an autoclave at an autoclave temperature of at least 90-100 °C. It develops on sorghum seeds before being crushed into mushroom spores in a sterile environment. The researcher incorporated black *P. sajor-caju* mushrooms as test cultures in the beginning after inoculation of mushrooms and incubation of organic material in an incubator at 25-30 °C. When the fibers are full, the bag is moved to the flower house and the relative humidity in the house is not less than 70% and the temperature is about 25-30 °C. Then record the growth and biological performance data.

7) Data collection and data analysis During this point, the fungi's spore germination statistics were recorded as follows:

1) the length and duration of mushroom growth, 2) the fresh flower weight, 3) the diameter of the inflorescence of stem length, 4) the number of mushrooms, and 5) the dry weight of the seed medium. Duncan's Multiple Ranges Test (DMRT) was used to evaluate the mean values of each treatment based on the yield time and quantity of contaminated inoculums (Syed et al. 2009).

## Results and discussion

### Metamorphosis

The mycelial growth of *P. sajor-caju* cultivated using different substrates is presented in Table 1. It was found that the bagasse rice straw to giant mimosa ratio of 75:15:10 produced the maximum average fiber growth rate of 9.76 cm, while the lowest fiber growth rate was 8.23 cm. These materials, which included bagasse, accounted for 100% of the total.

**Table 1** A Comparison of the weekly mycelial growth of *P. sajor-caju* on various substrates

| Treatment | **Mycelium length** (cm) | | |
|---|---|---|---|
| | **First Week** | **Week 2** | **Week 3** |
| Bagasse 100 % | 3.40±0.15[bcd] | 6.50±0.10[cd] | 8.23±0.25[e] |
| Bagasse : Rice straw (25:75%) | 3.60±0.20[bc] | 6.76±0.25[c] | 9.20±0.20[d] |
| Bagasse : Rice straw (50:50%) | 3.63±0.15[bc] | 6.23±0.05[de] | 9.26±0.11[cd] |
| Bagasse : Rice straw (75:25%) | 3.70±0.17[b] | 5.70±0.17[fg] | 8.46±0.15[e] |
| Bagasse : Giant mimosa (25:75%) | 3.46±0.05[bcd] | 7.43±0.05[b] | 9.40±0.20[bcd] |
| Bagasse : Giant mimosa (50:50%) | 3.46±0.11[bcd] | 6.06±0.11[f] | 8.53±0.15[e] |
| Bagasse : Giant mimosa (75:25%) | 3.43±0.05[bcd] | 7.40±0.10[b] | 9.46±0.50[bcd] |
| Bagasse : Rice straw: Giant mimosa (25:35:40%) | 3.66±0.15[bcd] | 7.43±0.11[b] | 9.70±0.26[abc] |
| Bagasse : Rice straw : Giant mimosa (50:25:25%) | 3.46±0.05[bcd] | 7.40±0.17[b] | 9.43±0.05[bcd] |
| Bagasse : Rice straw : Giant mimosa (75:15:10%) | 3.40±0.10[bcd] | 7.43±0.11[b] | 9.76±0.25[ab] |
| Rice straw 100% | 3.10±0.69[d] | 7.70±0.26[ab] | 9.26±0.32[cd] |
| Giant mimosa 100% | 4.33±0.15[a] | 8.00±0.20[a] | 10.06±0.51[a] |
| Sawdust 100% | 3.20±0.20[cd] | 5.66±0.20[g] | 8.33±0.28[e] |
| C.V. (%) | 6.37 | 3.20 | 2.69 |

Significant ($p<0.05$); According to Duncan's multiple range test, the various letters along each column within each substrate have a substantial variation in the mean.

The length of *P.sajor-caju* mushrooms cultivated using different substrates determined the growth impact of mycelium. It was discovered that the growth changes with the number of days. However, as the number of days increases, so does the average fiber growth capacity at 30 days. The treatment resulted in a mean maximum fiber growth rate of 9.76 cm, which enhanced the average fiber growth capacity. The ratio of 75:15:10 by adding bagasse to giant mimosa may be attributed to the giant mimosa as a rich nutrition medium, and the gap where the mycelium develops nicely. The lowest fiber growth rate of 8.23 cm was used of 100% bagasse. This could be because the Para rubber wood sawdust is more compact during briquetting than other materials, and also because it has a fine size and is not a fermented culture material which conforms to the same method as Yohannes et al. (2020) believed that those culture material that has not undergone the mushroom fermentation process cannot effectively use the feed from the culture material. The sacs were placed in the open environment after the mycelium had grown till the sac was full and had been allowed for three days for the mycelium to condense. According to the findings, the average number of mushrooms, stem length, and fresh weight of the mushrooms were born. At the 95 % confidence interval, there was a statistically significant difference in seed material.

The average quantity of mushrooms per bag was shown to be statistically different ($p<0.05$). The use of bagasse: rice straw: giant mimosa provided the greatest average number of mushrooms per bag of 8.25. (25:30:40%). The approach that resulted in the lowest average number of mushrooms per bag of 5.50 was 100 giant mimosas. diameter of pileus and stripe length did not differ in a statistically meaningful way. As indicated in Table 2, the average diameter of pileus was between 5.93 and 6.77 cm, and the mushroom stripe length was between 3.12 and 3.75 cm, respectively.

**Table 2** Growth of *P. sajor-caju*

| **Treatment** | **Number of mushrooms** | **diameter of pileus (cm)** | **Stripe length (cm)** |
|---|---|---|---|
| Bagasse 100 % | 7.12$^{abc}$ | 5.98 | 3.37 |
| Bagasse: Rice straw (25:75%) | 7.75$^{ab}$ | 5.93 | 3.62 |
| Bagasse : Rice straw (50:50%) | 6.50$^{bc}$ | 6.23 | 3.75 |
| Bagasse : Rice straw (75:25%) | 6.75$^{abc}$ | 6.77 | 3.62 |
| Bagasse : Giant mimosa (25:75%) | 7.95$^{ab}$ | 6.52 | 3.12 |
| Bagasse : Giant mimosa (50:50%) | 7.50$^{ab}$ | 6.24 | 3.25 |
| Bagasse : Giant mimosa (75:25%) | 7.75$^{ab}$ | 6.36 | 3.25 |
| Bagasse : Rice straw: Giant mimosa (25:35:40%) | 8.25$^{a}$ | 6.59 | 3.50 |
| Bagasse : Rice straw : Giant mimosa (50:25:25%) | 7.75$^{ab}$ | 6.24 | 3.50 |
| Bagasse : Rice straw : Giant mimosa (75:15:10%) | 7.50$^{ab}$ | 6.65 | 3.25 |
| Rice straw 100% | 7.75$^{ab}$ | 6.76 | 3.50 |
| Giant mimosa 100% | 5.50$^{c}$ | 6.73 | 3.25 |
| Sawdust 100% | 6.87$^{abc}$ | 6.65 | 3.45 |
| C.V. (%) | 14.05 | 7.97 | 13.38 |

Significant ($p<0.05$); According to Duncan's multiple range test, the various letters along each column within each substrate demonstrated a significant difference in the mean.

When the yield was investigated, it was discovered that the mushrooms were produced using Bagasse: Rice straw: Giant mimosa (25:35:40%) produced the most averaging 148 grams/bag. The highest average output of 146.75 grams per bag was obtained from 100% Para rubber wood sawdust.

However, no statistical difference was shown. Furthermore, giant mimosa seed material produces the lowest average yield of 84 grams per bag when grown entirely from seed. In terms of biological efficiency (B.E.), it was discovered that bagasse: chopped straw: chopped giant mimosa (25:35:40%) had the greatest value of 58.96%. It would have a poor value if made entirely of giant mimosa seed material. As seen in the table, the highest is 20.79 % (Table 3).

**Table 3** Biological efficiency analysis (B.E.)

| Treatment | Fresh weight of mushroom (g/bag) | Dry weight of substrate (g) | B.E. (%) |
|---|---|---|---|
| Bagasse 100 % | 95.50$^{e}$ | 415.25$^{b}$ | 22.87 |
| Bagasse : Rice straw (25:75%) | 107.75$^{d}$ | 221.50$^{dc}$ | 48.64 |
| Bagasse : Rice straw (50:50%) | 103.75$^{dc}$ | 290.25$^{c}$ | 34.74 |
| Bagasse : Rice straw (75:25%) | 103.75$^{dc}$ | 394.75$^{b}$ | 26.21 |
| Bagasse : Giant mimosa (25:75%) | 127.75$^{bc}$ | 265.25$^{cd}$ | 47.87 |
| Bagasse : Giant mimosa (50:50%) | 138.75$^{ab}$ | 303.25$^{c}$ | 45.75 |
| Bagasse : Giant mimosa (75:25%) | 127.25$^{bc}$ | 300.25$^{c}$ | 42.41 |
| Bagasse : Rice straw: Giant mimosa (25:35:40%) | 148.00$^{a}$ | 251.00$^{cd}$ | 58.96 |
| Bagasse : Rice straw : Giant mimosa (50:25:25%) | 129.00$^{bc}$ | 278.50$^{c}$ | 46.31 |
| Bagasse : Rice straw : Giant mimosa (75:15:10%) | 125.75$^{c}$ | 282.25$^{c}$ | 44.55 |
| Rice straw 100% | 111.50$^{d}$ | 195.25$^{c}$ | 27.59 |
| Giant mimosa 100% | 84.00$^{f}$ | 404.00$^{b}$ | 20.79 |
| Sawdust 100% | 146.75$^{a}$ | 455.75$^{a}$ | 32.19 |
| C.V. (%) | 6.38 | 10.39 | |

Significant ($p<0.05$); According to Duncan's multiple range test, the various letters along each column within each substrate demonstrated a significant difference in the mean.

Rice straw instance is a locally produced substance derived from rice harvesting waste in Thailand. In agricultural regions, roughly 70 million plantations of rice are grown each year. Each year, an average of 27 million tons of rice straw and roughly 18 million tons of rice stubble are left behind in rice fields. This crop has the most straw and stubble of any crop. As a necessary consequence, most farmers choose to burn rice stubble to facilitate soil preparation, but this causes changes in soil structure, which results in the loss of soil water, organic matter, and vital nutrients (Zikriyani et al. 2018). As well as the destruction of microbes and beneficial insects in the soil. Rice straw is increasingly being utilized in mushroom growing (Michael et al. 2019). In addition to aiding with soil improvement to lower production costs and improve the flavor of the mushrooms, it is sometimes combined with sawdust from rubber wood or softwood. Thus, according to Nguyen-V-Hung et al. (2016), the use of rice straw as a mushroom cultivation material yielded the highest biological efficiency of 68.16%, and Liang et al. (2019) discovered that rice straw mushroom cultivation yielded biological efficiency of up to 84.30%, and Patel and Trivedi (2016) discovered that using rice straw as a mushroom cultivation material yielded the highest biological efficiency of 86.62%, and the use of conventional farming.

Lini et al. (2021) discovered that rice straw contained 32-47% hemicellulose, 19-27% of which was able to convert to sugar to be a nutrient necessary for the growth of the hemicellulose. Mushrooms are compatible with research by Patel and Trivedi (2016) who discovered that utilizing rice straw in fairy mushroom growth had a biological effectiveness of 86.62%. Agricultural waste may be used to grow mushrooms while also lowering production expenses (Table 4).

**Table 4** Production day and number of contaminated products

| **Treatment** | **Day of production (day)** | **Number of contaminated (bag)** |
|---|---|---|
| Bagasse 100 % | 45.50$^{b}$ | 7.00$^{a}$ |
| Bagasse : Rice straw (25:75%) | 41.00$^{c}$ | 7.00$^{a}$ |
| Bagasse : Rice straw (50:50%) | 39.25$^{c}$ | 6.75$^{ab}$ |
| Bagasse : Rice straw (75:25%) | 41.00$^{c}$ | 5.25$^{cd}$ |
| Bagasse : Giant mimosa (25:75%) | 41.00$^{c}$ | 5.50$^{cd}$ |
| Bagasse : Giant mimosa (50:50%) | 40.25$^{c}$ | 4.75$^{d}$ |
| Bagasse : Giant mimosa (75:25%) | 40.75$^{c}$ | 5.25$^{cd}$ |
| Bagasse : Rice straw: Giant mimosa (25:35:40%) | 40.75$^{c}$ | 5.50$^{cd}$ |
| Bagasse : Rice straw : Giant mimosa (50:25:25%) | 41.50$^{c}$ | 5.75$^{bcd}$ |
| Bagasse : Rice straw : Giant mimosa (75:15:10%) | 36.00$^{d}$ | 5.25$^{cd}$ |
| Rice straw 100% | 33.25$^{d}$ | 5.00$^{cd}$ |
| Giant mimosa 100% | 28.75$^{e}$ | 5.50$^{cd}$ |
| Sawdust 100% | 53.00$^{a}$ | 6.00$^{abc}$ |
| C.V. (%) | 4.95 | 14.88 |

Significant ($p<0.05$); According to Duncan's multiple range test, the various letters along each column within each substrate demonstrated a significant difference in the mean.

Consistent with the research findings of Koodkaew and Rottasa (2017), the giant mimosa was a plant that grows well in nature and has bioactive chemicals in its leaves. It has proteins but no mimosine, unlike *Leucaena leucocephala*, which has proteins in the seeds, young leaves, flowers, pods, petioles, stems, and roots (Wittayakun et al. 2017). According to Miller (2002), proteins accumulate in all regions of the enormous mycelium and the mushroom can be used as the resources contained in the protein for development. If the host has a high protein content but lacks mimosin (Buranawit and Punyatong 2016), it will be an intriguing plant that may be cut and crushed into little pieces and used as an element in mushroom culture material or animal feed. From the findings of Sanaye et al. (2015), the usage of gigantic mimosa as a substitute for soybean meal in quail farming. Although it has less protein than soybean meal, it improves the usage of weeds in the region and lowers food expenses. It also included the clearance of weeds that grew along the sides of roadways, canals, and irrigation systems.

Bagasse would be a form of waste material created during the sugar manufacturing process that can be utilized to grow mushrooms. It was a substance containing nitrogen, phosphorous, and potassium as the major nutrients and also a secondary element as an important element that plants and microorganisms may utilize for growth that has more nutrients than rubber sawdust (Maheswari et al. 2021). Bagasse composition investigation revealed that it comprises 33-36 % cellulose, 28-30 % hemicellulose, and 22% linen. These were agricultural leftovers that may be utilized as mushroom culture materials, lowering costs. Bagasse was now employed for mushroom growing, revealing that bagasse was the most productive mushroom cultivation medium per bale, and mycelium circulation was good (Fatimah et al. 2018). According to Belay et al. (2020), carbon and nitrogen were crucial elements of cells that create energy for growth due to their nutritional content Maheswari et al. (2019).

## Conclusion

The average fiber growth capacity increased with the number of days, with bagasse to giant mimosa at a ratio of 25 to 75 having the highest fiber growth rate and 100% para rubber sawdust having the lowest fiber growth rate. When the Biological Efficiency (B.E.) was analyzed, it was discovered that bagasse: chopped straw: giant mimosa (25:35:40 %) produced the greatest value of 58.96 %, making it a good approach for mushroom production and suggested to farmers.

When considering the biological efficiency (B.E.) by analyzing the percentage. The average yield per dry weight of the material which is a measure of the establishment's bioavailability was discovered to be extremely beneficial to mushroom producers. Because the value of biological efficiency of the material may be taken into account when considering the material to be cultivated and compared to the cost necessary to get that material. The criteria are to configure a material with high biological efficiency, but relatively low cost, to identify the material with the most benefit, and to experiment with the results of calculating the biological efficiency of various techniques. It may also be determined that *P.sajor-caju* mushroom mycelium developed from bagasse: chopped straw: chopped giant mimosa (25:35:40%) produced the best value (58.96%), and outperformed rubber wood sawdust seed material (32.44%).

Simultaneously, when examining the seed material from the giant mimosa (*Mimosa pigra* L.) which is a legume that may cultivate in Thailand's environment. Giant mimosa may be found in canals, rivers, and other bodies of water. It is a plant with a deep root system that is capable of fixing nitrogen well, and it has been utilized as a mushroom culture material by combining it with rubber wood sawdust to enhance productivity over the usage of simply rubber wood sawdust.

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## Compliance with ethical standards

Conflict of interest The authors declare that there are no conflicts of interest associated with this study.



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