Development of Rice Straw, Maize, and Giant Mimosa for Growing Mushrooms Instead of Sawdust

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Abstracts: The research aimed to investigate mushroom cultivation materials made from rice straw, maize, and giant mimosa to replace sawdust. It was discovered that the capacity of fibers to grow has been more valuable. The method that combines a 1:1:1 ratio of the sawdust, rice straw, and giant mimosa will produce the highest mycelium. The 100% maize seed material will have relatively low fiber mycelium. However, there was a statistically significant in mushroom growth at the 95% reliability level. It was found that the process consisting of 100% rice straw cultivation material had the highest number of blossoms on average 13.66 blossoms, while the method with the lowest average number of blossoms per bag was the sawdust combined with giant mimosa which had 7.33 blossoms on average. The blooms ranged in width from 6.83 - 7.53 cm, while the mushroom's peduncle length ranged from 5.83 - 6.84 cm. When the biological efficiency (B.E.) was calculated, it was found that the sawdust: rice straw: maize: giant mimosa ratio of 1:2:1:1 yielded the highest value of 68.48 %, followed by the Para rubber sawdust: rice straw: maize: giant mimosa. The ratio of 2:1:1:1 was 68.22%, and the seed material was 100% sawdust. The biological efficiency of the ecosystem was 66.39%.

Keywords: Giant mimosa, Maize, Sawdust, Rice straw, Substrate cultivation mushroom.

1. INTRODUCTION

Rice straw was a post-harvest agricultural waste material containing nitrogen 0.8%, phosphorus 0.16-0.27%, potassium 1.4-2.0%, sulfur 0.05-0.10%, and silicon 4-7%, when plowed into the stump. The remaining cobs and straw in the fields were useful in terms of their use as organic matter to improve soil fertility (Dobermann & Fairhurst, 2002). As a consequence, the quantity of soil microbes increased, and microorganisms became a particular measure of soil fertility. It can assist enhance soil structure, offer ventilation, and increase water absorption and storage (Mkhize et al., 2016). The amount of rice straw produced each year is substantial, although it varies according to the season, rice growing area, soil quality, fertilizer, and harvesting period (Binod, 2010). Rice straw is used for a variety of applications, including the manufacturing of ethanol for use as alternative energy sources, fossil fuels, and so on. This is accomplished by a fermentation process known as Saccharification and Fermentation (SSF) (Julianto et al., 2019). It is also utilized as a feedstock in the creation of mushroom cultivation material, imparting a delightful flavor to the mushrooms (Iqbal et al., 2016; Josephine and Sahana, 2014). Furthermore, maize is a large enough agricultural waste resource that may be employed. While in manufacture of mushroom cultivation material, which is a valuable commercial crop for the animal feed business. There have been a lot of husks, cobs, and corn stalks left over after harvesting. These wastes which were created by combining maize substances with Para rubber sawdust were employed as nutrient broth for the genus mushrooms and shown good biological effectiveness (Chen et al., 2021). Maize husks in *Pleurotus ostreatus (Fr.)* cultivation may convert up to 94% of dried corn husks into fresh mushrooms (B.E.=94%), and the Bhutan Fairy Mushroom (*Indian Oyster Mushroom*) could modify husks. Dried maize outperformed fresh mushrooms by 79% (B.E.=79%)(Srijumpa and Khayankan, 2011). The giant mimosa (*mimosa pigra* L.) is a spiny legume with a deep root structure that grows as a perennial. The seeds of the giant mimosa which may blossom all year and is extremely seed-bearing remain latent for several years before germinating (Witt et al., 2020). It's considered an invasive alien species. Like a result, it is comparable to the leaves of *Leucaena leucocepphala*, which may develop quickly and create a high amount of biomass. Other plants are lost when they fill a space (Joseph et al., 2013). A giant mimosa is a type of allelopathy plant that can produce chemicals that hinder the development of nearby plants (Jeznabadi et al., 2016). It was determined that the giant mimosa has compounds that instigate the allelopathy process. Among them are phenolic chemicals, alkaloids, tannins, flavonoids, and steroids. The nutritional value and chemical composition of giant mimosa leaf were also discovered to be crude protein 16.36-18.87 %, fat 9.81%, nitrogen-free extract (NFE) 25.53%, moisture 11.06 %, ash 8.99%, crude fiber 19.22 %, phosphorus 0.44 %, organic carbon 66.79%, and iron (Fe) 0.01 % (Gupta and Mita, 2015; Kaewwongsa, 2014; Witayakun et al., 2017).

Farmers were currently confronted with the issue of production costs with just the raw materials needed in each mushroom lump manufacturing. That instance, farmers must purchase Para rubber sawdust from an industrial company at a cost of 2,000 - 3,000 Baht per ton. When transportation expenditures were factored in based on distance, the average automobile excursion costs between 20,000 - 25,000 Baht. Furthermore, these raw materials must be ordered in substantial volumes at a time, which is a productivity expense that farmers must consistently suffer. In the existing situation, rubber farmers have begun to chop down the rubber trees and sell them in order to clear the land so that other crops could well be planted instead, and if the Para rubber sawdust becomes more costly in the future. The manufacture of inoculum lumps may be disrupted, harming farmers' mushroom growing. As a consequence, the researchers created a mushroom cultivation material composition using rice straw, maize, and a native plant called giant mimosa. By experimenting with different ratios of Para rubber sawdust to determine the optimum formula and creating a guideline for utilizing alternative materials to substitute Para rubber sawdust, farmers' production costs may be reduced.

2. METHODOLOGY

1. Bringing in local agricultural waste such as rice straw, maize, and giant mimosa to be minced with a shredder to be smaller than 1-2 cm in size using a one horsepower shredder. Then bring it inside to aerate and allow the giant mimosa and maize to dry thoroughly before using.

2. The 12 treatments of ten components each were used to prepare the experimental materials. These mushroom cubes compress to a weight of 1.5 kg each. Contains 100% sawdust, 100% giant mimosa, 100% rice straw, 100% maize, and 100% combined the sawdust. The giant mimosa ratio 1:1. The sawdust: maize: giant mimosa were mixed in a 1:1:1 ratio. The ratio of the sawdust to giant mimosa was 1:1:1. The ratio of Para rubber sawdust: rice straw: maize in the giant mimosa was 1:1:1:1. The ratio of sawdust: rice straw: giant mimosa was 2:1:1:1. The ratio of sawdust to rice straw to giant mimosa was 1:2:1:1. The ratio of the sawdust: rice straw: maize: giant mimosa was 1:1:2:1, and the ratio of the Para rubber sawdust: rice straw: maize: giant mimosa was 1:1:1:2.

3. Mix the ingredients in each ratio with the finely powdered bran, lime, and Epsom salt then marinade for 24 hours. Four kilograms of bran per 100 kilograms of cultured material, one kilogram of lime per 100 kilograms of cultured material, and 0.2 kilograms of Epsom salt ($MgSO_4.7H_2O$) per 100 kilograms of cultivation material.

4. The compacting process, bring the mushroom cultivation material as directed and thoroughly mixed with water before testing it with your hands. It is appropriate and may be utilized if it sticks together and that there was no water flowing between the prongs. Then, according to the ratio provided, store the seed material for each procedure in a plastic bag measuring 8 x 15 inches. Commodity packed to a weight of 1,500 gram each bag, and then placed on the top of the bottle and sealed with a plastic stopper.

5. The steaming process of sterilizing the mycelium, placing the mushroom inoculation on the plate, and arranging the mushroom inoculated starting from the bottom up may then be grouped into 120-150 pieces. Then cover with a plastic towel and heat the water to 100 °C. Drill a hole to lighten the load, next set the two-hour steaming timer and let it to cool overnight.

6. Placing the mushroom treatment in a sealed home begins the process of sterilizing mushrooms, opening blossoms, and moving into the sealed house. Wash your hands and chopsticks with 95% alcohol before using the chopsticks to break the germs apart, open the lids of the germs, and implant the germs in moderation. After that, completely cover them for 25-30 days before encouraging blossoming. Once the mushrooms have begun to blossom, they should be relocated to a plant for 5-10 days and recorded for three months.

2.1. Data Collection

1. Determine the mycelium length and rate it. One day after installation, fiber the mycelium was measured, and then every seven days for a total of 30 days.

2. Measure the length of the mushroom's width and the blossom stalk's length.

3. Determine biological efficiency (B.E.) by weighing fresh mushrooms and mushroom cultivation material after drying (Adewoyin and Ayandele, 2018; Biswas and Layak, 2014).

$$\text{Biological Efficiency (\%)} \frac{Freshroom\ wt.mushroom}{Dried\ wt.substrates} \times 100$$

2.2. Data Analysis

The accumulated data were analyzed using a computer program and the Completely Randomized Design (CRD) experimental design to compare the mean values of each experimental phase using Duncan's Multiple Range Test (DMRT).

3. RESULTS

3.1. Measurement of the Mycelium of Bhutanese Fairy Mushrooms (Indian Oyster Mushroom)

The mycelium of mushrooms revealed that the majority of mycelium development in each procedure was full and uniform, with the exception of 100% maize seed material, which had full and uneven mycelium (Table 1).

Table 1. Mycelium Density of Mushroom (During 30 Days).

Treatment	**Mycelium density of mushroom***
1. Sawdust 100%	+++
2. Giant mimosa (*mimosa pigra* L.) 100%	++
3. Rice straw 100%	+++
4. Maize 100%	+
5. Sawdust: Giant mimosa ratio 1:1	+++
6. Sawdust: Maize: Giant mimosa ratio 1:1:1	+++
7. Sawdust: Rice straw: Giant mimosa ratio 1:1:1	++++
8. Sawdust: Rice straw: Maize: Giant mimosa ratio 1:1:1:1	+++
9. Sawdust: Rice straw: Maize: Giant mimosa ratio 2:1:1:1	+++
10. Sawdust: Rice straw: Maize: Giant mimosa ratio 1:2:1:1	+++
11. Sawdust: Rice straw: Maize: Giant mimosa ratio 1:1:2:1	+++
12. Sawdust: Rice straw: Maize: Giant mimosa ratio 1:1:1:2	+++

Note: * Level of Fiber Concentration +++ = Fibers Expand Consistently Throughout the Bag and have A White Appearance. ++ = Fibers Expand Throughout the Bag, But in an Inconsistent White Appearance. + = Poor Growth.

3.2. *A comparison of the Growth Rates of Bhutanese Fairy Mushrooms (Indian Oyster Mushroom)*

The average mushroom growth per bag revealed that the rice straw material had the highest average number of blooms at 13.66, while the Sawdust combined with giant mimosa at a 1:1 ratio had the lowest average number of blooms. The largest number of blooms was 7.33, which was statistically significant (p<.05). Sawdust: rice straw: maize: giant mimosa in a 1:1:1:2 ratio. The average flower diameter was 7.60 cm. The smallest blossom diameter in maize was 5.90 cm, and the stem length was statistically significant (p<.05) level. In terms of stalk length, the most frequent were Sawdust: rice straw: maize: giant mimosa at a 1:1:2:1 ratio of 6.83 cm. As demonstrated in the 1:1:1 ratio equaled 5.66. (Table 2).

Table 2. The Growth of Mushrooms.

Treatment	Number of pileus	Pileus diameter (cm)	Length stalk
1. Sawdust 100%	9.00b	7.16abc	6.20ab
2. Giant mimosa (*mimosa pigra* L.) 100%	7.66bc	7.16abc	6.33ab
3. Rice straw 100%	13.66a	6.00d	6.00ab
4. Maize 100%	6.66c	5.90d	6.33ab
5. Sawdust: Giant mimosa ratio 1:1	7.33c	7.16abc	6.26ab
6. Sawdust: Maize: Giant mimosa ratio 1:1:1	7.66bc	7.33bc	5.83ab
7. Sawdust: Giant mimosa ratio 1:1:1	8.00bc	7.53a	5.66b
8. Sawdust: Rice straw: Maize: Giant mimosa ratio 1:1:1:1	8.00bc	7.46ab	6.16ab
9. Sawdust: Rice straw: Maize: Giant mimosa ratio 2:1:1:1	8.33bc	6.83c	6.00ab
10. Sawdust: Rice straw: Maize: Giant mimosa ratio 1:2:1:1	8.00bc	7.16abc	6.33ab
11. Sawdust: Rice straw: Maize: Giant mimosa ratio 1:1:2:1	9.00b	7.50ab	6.83a
12 Sawdust: Rice straw: Maize: Giant mimosa ratio 1:1:1:2	8.00bc	7.60a	6.00ab

3.3. The Comparison of Yield and Biological Efficiency Values

The fresh weight/bag experiment revealed that the sawdust treatment: rice straw: maize: giant mimosa in the ratio 2:1:1:1 had the greatest mean fresh weight 655.00 g, while the least was maize 100% at 417.00 g. The yield (p<.05) was statistically significant. The most valuable treatment was 100% maize, with an average weight of 988.66 g, while the least value was Sawdust: rice straw, maize: giant mimosa, with a rate ratio of 1:2:1:1, with an average weight of 955.01 g. Considering the statistically different biological efficiency (B.E.) values (p<.05), it was discovered that Sawdust: rice straw, maize: giant mimosa at 1:2:1:1 ratio, the highest was 68.48 %, and the lowest was maize 100%, with the average being 42.18 %, as shown in the table 3.

Table 3. The Comparison of Yield and Biological Efficiency Values.

Treatment	Fresh weight/bag (G)	Dry weight/bag (G)	B.E. (%)
1. Sawdust 100%	644.00a	970.00b	66.39
2. Giant mimosa (*mimosa pigra* L.) 100%	483.33d	962.21bc	50.23
3. Rice straw 100%	440.00e	982.10a	44.80
4. Maize 100%	417.00f	988.66a	42.18
5 Sawdust: Giant mimosa ratio 1:1	524.00c	966.00bc	54.24
6. Sawdust: Maize: Giant mimosa ratio 1:1:1	525.00c	971.00b	54.06
7. Sawdust: Rice straw: Giant mimosa ratio 1:1:1	560.00b	964.00bc	58.09
8. Sawdust: Rice straw: Maize: Giant mimosa ratio 1:1:1:1	646.00a	956.02c	67.57
9. Sawdust: Rice straw: Maize: Giant mimosa ratio 2:1:1:1	655.00a	960.02bc	68.22
10. Sawdust: Rice straw: Maize: Giant mimosa ratio 1:2:1:1	654.00a	955.01c	68.48
11. Sawdust: Rice straw: Maize: Giant mimosa ratio 1:1:2:1	651.04a	965.00bc	67.46
12. Sawdust: Rice straw: Maize: Giant mimosa ratio 1:1:1:2	651.33a	964.03bc	67.56
C.V. (%)	2.17	0.63	

4. DISCUSSION

The chemical composition of the seed substrate revealed that when additional materials were applied to the sawdust, the total nitrogen pH, phosphorus, and potassium content varied. The pH of the Para rubber sawdust was 7.23, the organic carbon content was 0.29%, the phosphorus level was 0.30%, and the potassium content was 0.53%. The total nitrogen, organic carbon, and potassium content of the rice straw, maize, and giant mimosa combinations were higher than those of the other procedures. Its main constituents account for approximately 32-47 % weight. Cellulose has been frequently utilized in industrial purposes such as the production of paper, textiles, or synthetic cellulose derivatives for the production of adhesives, humectant, films, Biopolymers, etc. Agriculture, on the other hand, prefer to burn rice straw to prepare planting sites since it is a quick and easy approach. As a result of the carbon dioxide produced during combustion, the effect of burning rice straw adds to global warming (Kanokkanjana and Garivait , 2013). As a consequence, enhancing the value of rice straw would be an innovative strategy for managing excess rice straw. Based on previous study on the chemical composition of rice straw, farmers now incinerate the straw, rice stubble, and other field trash to prepare the fields for the upcoming season. Animal feed also was made from rice straw (Inthata and Khankham, 2015). Also as result, rice straw was insufficient to fulfill farmers' demands for straw mushroom growing, raising the cost of straw mushroom manufacturing. Furthermore, in certain localities, cultivation was done just once, making rice straw as a material for cultivating straw mushrooms more difficult to obtain. Therefore, it is needed to acquire additional equipment to be utilized as substitutes for straw mushroom growth by selecting materials that have been comparable to rice straw and thus are conveniently available and inexpensive.

Bhutanese fairy mushrooms (Indian Oyster Mushroom) mycelium expansion effect from material developed by mixing method with sawdust: rice straw: giant mimosa at a ratio of 1:1:1 will have a much higher inclination to wander of the fibers than other processes. However, the growth capacity of mushroom mycelium varies with the number of days, so if the number of days was more, for example at 30 days, the average fiber growth capacity is also increased. It might be due to giant mimosa as a high nutritional substrate and a gap in which the mycelium develops effectively, which is made up entirely of the sawdust. That may be because during briquette, it is more compact than other materials due to the fine size of the shavings sawed from the Para rubber sawdust. When the Bhutanese fairy mushroom mycelium has fully grown into the bag then leave it for three days to allow the mycelium to congregate. As a result, the bag of mushrooms was carried inside the nursery in order to open the blossoms. It was found that the mean number of mushrooms, stem length, and fresh weight of mushrooms born on the media was a statistical difference in mushroom growth at the 95% reliability level. Rice straw produced the most blooms per bag, with an average of 13.66 blossoms per bag. The treatment including the sawdust, rice straw, maize, and giant mimosa tended to have quite large stalk diameter and length, average 6.83- 7.53 cm and 5.83-6.83 cm, respectively.

When analyzing the biological efficiency (B.E.), the average yield per dry weight of the growth media was being used. This is a number that reflects the bioavailability of the culture material and is thus extremely valuable to mushroom farmers. Because the value percent (B.E.) of the material may be used to consider the material to be farmed and compared to the cost necessary to obtain that material. The criterion is to select a material with high biological efficiency but cheap cost, or to select a material with the best benefit and based on experimental findings estimating the biological efficiency of various processes. The biological efficiency of the sawdust, rice straw, maize, and giant mimosa in the ratios of 1:1:2:1 and 2:1:1:1 was 68.48% and 68.22%, respectively. The biological efficiency of the Sawdust was 66.39%.This might occur because the rice straw and giant mimosa different chemical compositions. Rice straw, in instance was a native substance derived from rice harvesting wastes in agricultural areas. Every year there was a lot of rice straw and waste left over in the rice fields. Most farmers prefer to burn rice husk to improve soil preparation since it contains more straw and waste than other crops. However, this resulted in changes in soil structure, which resulted in the loss of water, organic matter, and critical nutrients. In addition to damaging beneficial microbes and insects in the soil. In addition to aiding in soil improvement which has been used as a mushroom cultivation material with good yields (Neupane et al., 2018) and rice straw has been utilized for a variety of other purposes. For example, rice straw was increasingly being used in mushroom growing. According to Nithyarani and Kavitha (2018) research, it was occasionally blended with the Para rubber sawdust or softwood sawdust. It was found that using rice straw as a material for mushroom cultivation resulted in high biological efficiency values of maize stalks and maize plants, and (Mohamed et al., 2018) found that using rice straw as a material for mushroom cultivation resulted in the highest biological efficiency of 84.30%. Similarly, Patel and Trivedi (2016) found that using rice straw as a mushroom cultivation material had the highest biological efficiency at 86.62%, as well as being a useful utilization of agricultural waste, and Karimi et al. (2006) revealed that rice straw contains 32-47% cellulose and 19-27% hemicellulose, which can be converted to sugar for the nutrients required for mushroom growth. Furthermore, Iwuagwu et al. (2020). have experimented with using agricultural waste maize, bagasse as material for mushroom cultivation, which has an excellent yield and may be used as a substitute for the sawdust mushroom cultivation material, lowering farmer production costs.

5. CONCLUSION

According to the results of the trial, the method employing the sawdust: rice straw: giant mimosa at a ratio of 1:1:1 produced the best fiber mycelium. When the statistically significant growth of mushrooms was considered, it was found that the treatment consisting of 100% cultivation material from rice straw will have the maximum number of blossoms, averaging 13.66 blooms. Sawdust combined with giant mimosa produced the lowest average number of blossoms per bag, with an average value of 7.33. The mushroom's bloom width ranged from 6.83 to 7.53 cm, while its stem length ranged from 5.83 to 6.84 cm. When the biological efficiency (B.E.) value was considered, it was found that sawdust: rice straw: maize: giant mimosa, ratio 1:2:1:1 yielded the highest value 68.48%, followed by the sawdust: rice straw: maize: giant mimosa. The 2:1:1:1 ratio is 68.22%. The biological efficiency rating for seed material made entirely of the sawdust was 66.39%.

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