Utilization of Different Locally Abundant Materials as Substrates for Oyster Mushroom *(Pleurotus Ostreatus)* Production

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Abstract

These studies were conducted from June 17, 2019 to September 27, 2019 at the Tissue Culture Laboratory of Capiz State University, Tapaz Satellite College to determine the effects of using different locally abundant materials as substrates on the production of oyster mushroom under CAPSU Tapaz conditions. The experimental design used in the study was Completely Randomized Design with four treatments each replicated four times. The treatments for study 1 were as follows: A – 50% sawdust + 25% rice hull + 23% rice bran + 1% sugar + 1% lime (control), B – 78% sawdust + 20% rice bran + 1% sugar + 1% lime, C – 50% corn cob + 30% sawdust + 18% rice bran + 1% sugar + 1% lime, D – 50% rice hull + 28% sawdust + 20% rice bran + 1% sugar + 1% lime. For study 2 treatments consisted of: A – 50 % rice straw + 50 % sawdust (control); B – 78% rice straw + 20% rice bran + 1% brown sugar + 1% lime; C – 50% rice straw +29% sawdust + 20% rice bran + 1% lime; and D – 90% rice straw + 10% rice bran. The data gathered were analyzed using the Analysis of Variance and F-test for Completely Randomized Design. Differences among treatment means was determined using Least Significant Difference test, interpreted at 5% and 1% levels of significance.

Keywords: Oyster mushroom, Locally abundant materials, Substrates, Rice straw

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Introduction

Currently, Philippine population had reached over 100 million. This is a big number which poses a challenge to our government and to every Filipino family alike. The big challenge lies on how to sustainably feed them with a nutritious and balance diet. According to the report from the World Food Programme (2019), the nutrition situation in the Philippines is alarming. Thirty three percent of children under the age of 5 years (4 million children) are stunted and unlikely to reach their full mental and physical potential. Overweight and obesity rates of adults have nearly doubled over the last two decades (up to 31 percent) contributing significantly to public health problems.

Mushrooms with high nutritional value have been identified as excellent food source to reduce nutrition deficiency (Eswaran and Ramabadran, 2000). Mushrooms have the ability to convert cellulosic plant waste materials into highly nutritious fruit bodies (Quimio, 1998).

Oyster mushroom or Abalone mushroom is a kind of mushroom that could be grown indoors. It is scientifically known as Pleurotos ostreatus and belongs to family Agaricaceae. It is one of the most popular edible mushrooms grown locally because of its unique taste or oyster-like flavor when cooked. It contains a lot of protein, minerals, and essential vitamins for the maintenance of good health. According to Buckanan and Barnes (2003), average estimated yield of mushrooms from one square meter area is about 20 – 35 kg after a cultivation period of 4 – 7 weeks. It is low-calorie food and its nutritional value is 27 calories per 100 g of mushroom (USDA, 2010).

The growing of oyster mushroom is quite interesting since they grow and fruit on a variety of agricultural wastes. The growers can have a choice of the type of substrate to be used and the ease of growing. According to Marimutu (1995), cultivation of oyster mushroom on different agro wastes like cotton stalks, waste paper, maize cobs, cotton waste, wheat and paddy straw are utilized for achieving higher bioefficiency. Shahid et al. (2006) determined suitability of sawdust for the maximum yield (646.9 g), and the number of primordia formation (2:1). Ngezimana et al. (2008), studied various crop residues can be used in producing oyster mushrooms either as main substrates or in combinations with supplements.

Cultivation of oyster mushroom is environment-friendly or environment may be less harmed due to utilization and recycling of waste materials (Hayes, 1978). According to Naeem et al. (2014), cultivation of mushrooms on lignocellulosic wastes represents one of the most economic organic recycling processes. In addition, Dundar et al. (2008) mentioned that mushroom production can generate and enhance employment opportunities tremendously and offers vast export opportunities. Hence, the utilization of different locally abundant materials as substrates for oyster mushroom production under CAPSU-Tapaz conditions was conducted.

Materials and Methods

The materials and tools needed in the studies were: locally abundant materials as substrates (rice straw, sawdust, rice hull, corn cob, rice bran) brown sugar, agricultural lime, water, pail/basin, 6"x12" polypropylene bags, metal drum/ steamer, 5 cm in diameter PVC pipe, cotton/fiber fill , shelves, cloth, knife, bolo, rubber band, grain spawn/inoculants, weighing scale, measuring device, record book, ballpen, labelling materials.

Study 1 and 2 will be conducted using Completely Randomized Design with four treatments each replicated four times. Study 1 was composed of four treatments as follows: A – 50% sawdust + 25% rice hull + 23% rice bran + 1% sugar + 1% lime (control), B – 78% sawdust + 20% rice bran + 1% sugar + 1% lime, C – 50% corn cob + 30% sawdust + 18% rice bran + 1% sugar + 1% lime, D – 50% rice hull + 28% sawdust + 20% rice bran + 1% sugar + 1% lime. The treatments for Study 2 consisted as follows: A – 50 % rice straw + 50 % sawdust (control); B – 78% rice straw + 20% rice bran + 1% brown sugar + 1% lime; C – 50% rice straw +29% sawdust + 20% rice bran + 1% lime; and D – 90% rice straw + 10% rice bran.
Collection of rice straw, sawdust, rice hull, corn cob, rice bran and other materials were done at least two weeks before the conduct of the study. Rice straw was soaked in clean water inside the plastic drum overnight. It was drained early in the morning to remove excess water. Rice straw and corn cob were shredded separately. Since sawdust and rice hull were fresh, these were decomposed first by adding agricultural lime a week before bagging. In Study 1 and 2, packing/bagging of substrates differed with treatments as indicated previously. Substrates were packed in heat-resistant plastic bags or 6"x12" polypropylene bags. The PVC pipe (cut to about 2 cm thick) were inserted into the mouth and fold to provide opening. Then, the openings were plugged with cotton or fiber fill. At least fifteen bags were packed per treatment replicated four times.

The fruiting bags were placed inside the metal drum and were sterilized for a period of 8 hours. Banana stems were cut and placed at the bottom and sides of the drum to prevent the contact of plastics with the metal during sterilization. The level of water at the bottom of the drum was about 20 cm. Then, fruiting bags were allowed to cool. Inoculation or adding of grain spawn in each bag was done in a clean and sanitized area or room. A 10 % zonrox solution was sprinkled or used in cleaning to disinfect the surrounding area. Washing of hands with clean water and finally with alcohol was done to prevent contamination during inoculation. The shelves for fruiting bags were placed in a cool, dark room. Fruiting bags were arranged in the shelves according to treatments and replication. Incubation had lasted for 11/2 month or until the mycelium had fully penetrated the substrates. After 11/2 month or after the incubation period, the cotton plugs and the PVC pipe neck were removed. Then, the plastic bags were rolled down to the mouth of the bags. Fruiting bags were laid, and slits using a knife were made at the bottom portion of the bag to enhance more fruiting at a time.

The opened bags were placed in the growing area. The growing area was kept humid and cool by spraying with clean water but not directly on the opened portion of the bag every day except during cool or rainy days. The mushrooms were harvested when it has fully opened. by handpicking. After picking from both sides of the bags, 2 slits on the sides of the bags were made to enhance mushroom growth. Finally, the bags were rolled over and make maximum slits to allow more mushroom to grow, until fully exhausted or about 50 days after opening.

The data gathered from the study were as follows: number of fruit bodies, diameter of the cap (cm), length of the stalk (cm), weight of fruit bodies (g), total yield of mushroom (kg), time taken (in days) for the emergence of primordia, time taken (in days) for harvest stage, interval between flushes of mushroom (days), and number of flushes.

Determination of the Economics of Production

The economics of production was determined by dividing Mushroom Cost with Substrate Cost.

Statistical Tools and Analysis

The data was analyzed using the Analysis of Variance and F-test for Completely Randomized Design (CRD). Differences among treatment means were determined using Least Significant Difference (LSD) test, interpreted at 5% and 1% levels of significance.

Results and Discussion

Table 1.0 presents the parameters of oyster mushroom as influenced by different organic materials as substrates. Analysis of Variance reveals that the number of fruit bodies significantly differed with different materials used as substrates. This implies that oyster mushroom grown using different materials as substrates performed differently in terms of the number of fruit bodies. Least Significant Difference (LSD) test further revealed that oyster mushroom grown in sawdust, rice bran, sugar and lime or SRSL as substrates gave the most number of fruit bodies with a mean of 10.77. This was significantly higher than oyster mushroom grown is rice hull, sawdust, rice bran, sugar and lime or RSRSL and corn cob, sawdust, rice bran, sugar and lime or CSRSL as substrates with a mean of 8.60 and 7.97, respectively. However, oyster mushroom grown in corn cob, sawdust, rice bran, sugar and lime (CSRSL) gave statistically similar number of fruit bodies with mushroom grown in sawdust, rice hull, rice bran, sugar and lime or SRRSL with a mean of 7.97 (Figure 1.0).

Table 1.0. Parameters of oyster mushroom as influenced by different materials as substrates

PARAMETER	STUDY 1	
	F-test	CV
1.0 Number of fruit bodies	**	5.99
2.0 Diameter of the cap	ns	14.17
3.0 Length of the stalk	ns	12.02
4.0 Weight of fruit bodies (g)	ns	14.67
5.0 Total yield of mushroom (kg)	ns	14.51
6.0 Time taken (in days) for the emergence of primordia	ns	5.06
7.0 Time taken (in days) for harvest stage	ns	3.9
8.0 Interval between flushes of mushroom	ns	5.16
9.0 Number of flushes	ns	17.1

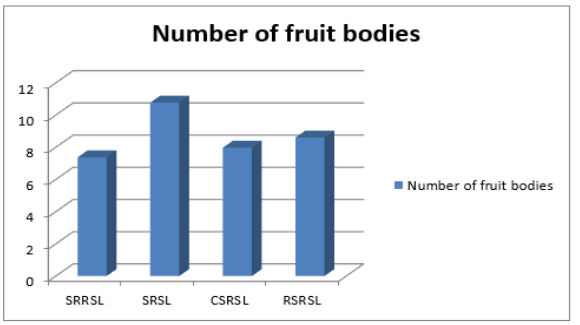

Figure 1.0 A graph showing the mean number of fruit bodies produced by oyster mushroom grown using different organic materials as substrates.
Legend: SRRSL = sawdust, ricehull, rice bran, sugar and lime (control); SRSL = sawdust, rice bran, sugar and lime; CSRSL = corn cob sawdust, rice bran, sugar and lime; RSRSL = rice hull, sawdust, rice bran, sugar and lime.

On the other hand, diameter of the cap, length of the stalk, weight of fruit bodies, total yield of mushroom, time taken (in days) for the emergence of primordia, time taken (in days) for harvest stage, interval between flushes of mushroom and number of flushes were not significantly influenced by the different organic materials used as substrates. The diameter of the cap ranged from 8.18 to 9.65 centimeters, the length of the stalk ranged from 5.90 – 7.18 centimeters, the weight of fruiting bodies ranged from 45.45 to 59.10 grams, the total yield of mushroom ranged from 0.454 to 0.591 kilograms, time taken from opening (in days) to the emergence of primordia ranged from 10.12 to 11.05 days, time taken from opening (in days) to harvest stage ranged from 13.22 to 14.00 days, the interval between flushes of mushroom ranged from 13.45 to 14.75 days, and number of flushes ranged from 2.25 to 2.62.

Table 2.0 presents the parameters of oyster mushroom as influenced by rice straw as main substrates. ANOVA results reveal that the number of fruit bodies, length of the stalk, weight of fruit bodies, total yield of mushroom, time taken (in days) for harvest stage, and interval between flushes of mushroom were significantly influenced by rice straw as main substrate in oyster mushroom production. This

means that oyster mushroom grown using rice straw as main substrates performed differently in terms of the number of fruit bodies, length of the stalk, weight of fruit bodies, total yield of mushroom, time taken (in days) for harvest stage, and interval between flushes of mushroom. LSD test results indicate that the most number of fruit bodies was obtained from mushroom grown in rice straw and sawdust or RS with a mean of 13.62. This was significantly higher than mushroom grown in rice straw, sawdust, rice bran and lime or RSRL and rice straw, rice bran, sugar and lime or RRSL with a mean of 8.49 and 7.88, respectively. However, mushroom grown in rice straw, rice bran, sugar and lime (RRSL) gave statistically similar number of fruit bodies with mushroom grown in rice straw and rice bran or RR with a mean of 7.22 (Figure 2.0). The longest stalk was taken from mushroom grown in rice straw and sawdust (RS), rice straw, rice bran, sugar and lime (RRSL), and rice straw, sawdust, rice bran and lime (RSRL) with a mean of 6.62, 6.48, and 5.72 centimeters, respectively. The shortest stalk was obtained from mushroom grown in rice straw and rice bran (RR) with a mean of 5.32 centimeters (Figure 3.0). Mushroom grown in rice straw and sawdust (RS) produced the heaviest weight of fruit bodies with a mean of 58.58 grams. This was found similar with mushroom grown from rice straw, sawdust, rice bran and lime (RSRL) with a mean of 52.60 grams. Nevertheless, mushroom grown in rice straw, sawdust, rice bran and lime (RSRL) was also found similar with mushroom grown in rice straw, rice bran, sugar and lime (RRSL) with a mean of 48.35 grams. This was also found similar to mushroom grown in rice straw and rice bran (RR) with a mean of 41.40 grams (Figure 4.0).

Table 2.0 Parameters of oyster mushroom as influenced by rice straw as main substrate.

Treatment	Number of fruit bodies	Diameter of the cap (cm)	Length of the stalk (cm)	Weight of fruit bodies (g)	Total yield of mushroom (kg)	Time taken (in days) for the emergence of primordia	Time taken (in days) for harvest stage	Interval between flushes of mushroom	Number of flushes
A - RS	13.62a	7.92	6.62a	58.58a	0.586a	10.81	13.48a	14.50a	2.12
B - RRSL	7.88bc	7.80	6.48a	48.35bc	0.484b	9.82	12.58b	11.54b	2.15
C - RSRL	8.49 b	7.70	5.32b	52.60ab	0.526a	9.85	12.60b	12.55ab	2.00
D - RR	7.22c	8.20	5.72a	41.40c	0.414b	9.88	12.50b	11.81b	2.15
F-test (1%)	**	ns	**	**	**	ns	**	**	ns
CV	8.53%	5.94%	7.94%	8.66%	8.91%	5.69%	2.83%	8.47%	4.74%

ns – not significant; ** - highly significant; Means having the same letter are not statistically significantly using Least Significant Difference test.
Legend: RS = rice straw and sawdust; RRSL= rice straw, rice bran, sugar and lime; RSRL = rice straw, sawdust, rice bran and lime; RR = rice straw and rice bran.

In terms of the total yield, mushroom grown in rice straw and sawdust (RS) and rice straw, sawdust, rice bran and lime (RSRL) gave the heaviest yield of 0.586 and 0.526 kilograms, respectively. These were significantly heavier than mushroom grown in rice straw, rice bran, sugar and lime (RRSL) with 0.484 and rice straw and rice bran (RR) with a mean of 0.414 kilograms (Figure 5.0). For the time taken from opening (in days) to harvest stage, the longest number of days was recorded from mushroom grown in rice straw and sawdust (RS) with a mean of 13.43. This was

significantly longer than mushroom grown in rice straw, sawdust, rice bran and lime (RSRL), rice straw, rice bran, sugar and lime (RRSL), and rice straw and rice bran (RR) with a mean of 12.60, 12.58, and 12.50, respectively (Figure 6.0). In terms of the interval between flushes of mushroom, the most number of days was obtained from mushroom grown in rice straw and sawdust or RS with a mean of 14.50. This was closely followed by mushroom grown in rice straw, sawdust, rice bran and lime or RSRL with a mean of 12.55 days. However, mushroom grown in rice straw, sawdust, rice bran and lime (RSRL) was also found statistically similar with mushroom grown in rice straw and rice bran (RR) and rice straw, rice bran, sugar and lime (RRSL) with a mean of 11.81 and 11.54, respectively (Figure 7.0).

On the other hand, diameter of the cap, time taken (in days) for the emergence of primordia, and number of flushes were not influenced by rice straw as main substrate in oyster mushroom production. The diameter of the cap ranged from 7.70 to 8.20 centimeters, time taken from opening (in days) to emergence of primordia ranged from 9.82 to 10.81 days, and the number of flushes ranged from 2.0 to 2.15.

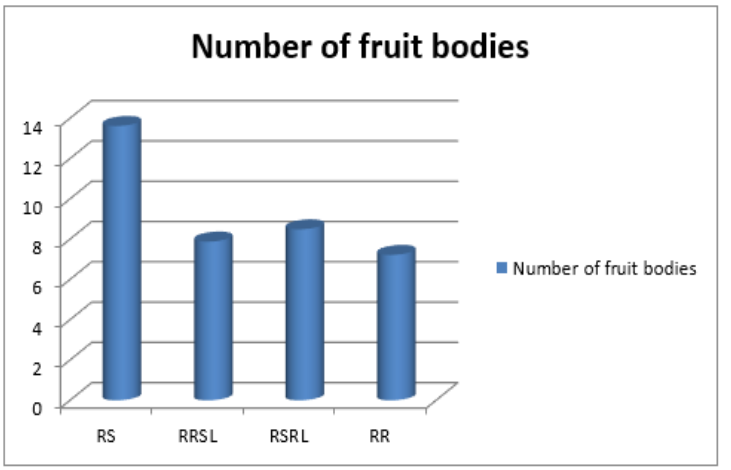

Figure 2.0 A graph showing the number of fruit bodies produced by oyster mushroom using rice straw as main substrate.
Legend: RS = rice straw and sawdust; RRSL= rice straw, rice bran, sugar and lime; RSRL = rice straw, sawdust, rice bran and lime; RR = rice straw and rice bran.

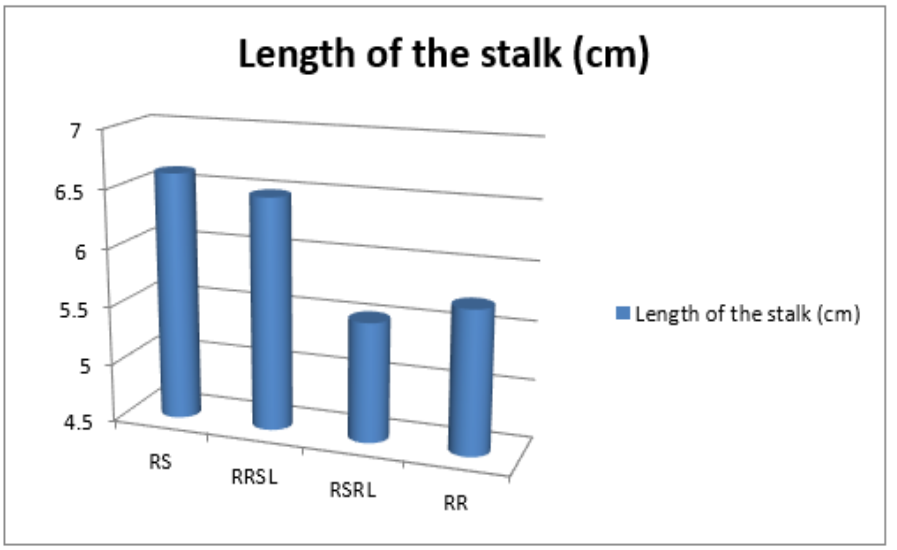

Figure 3.0 A graph showing the length of stalk of oyster mushroom grown in rice straw as main substrate.

Legend: RS = rice straw and sawdust; RRSL= rice straw, rice bran, sugar and lime; RSRL = rice straw, sawdust, rice bran and lime; RR = rice straw and rice bran.

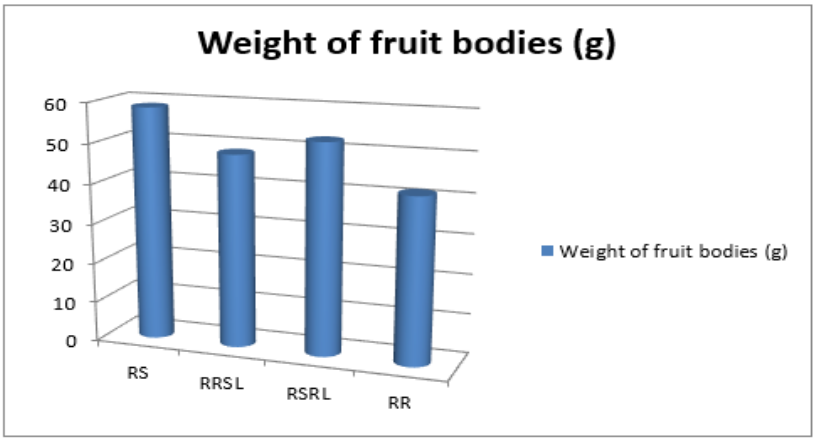

Figure 4.0 A graph showing the weight of fruit bodies produced by oyster mushroom grown in rice straw as main substrate.

Legend: RS = rice straw and sawdust; RRSL= rice straw, rice bran, sugar and lime; RSRL = rice straw, sawdust, rice bran and lime; RR = rice straw and rice bran.

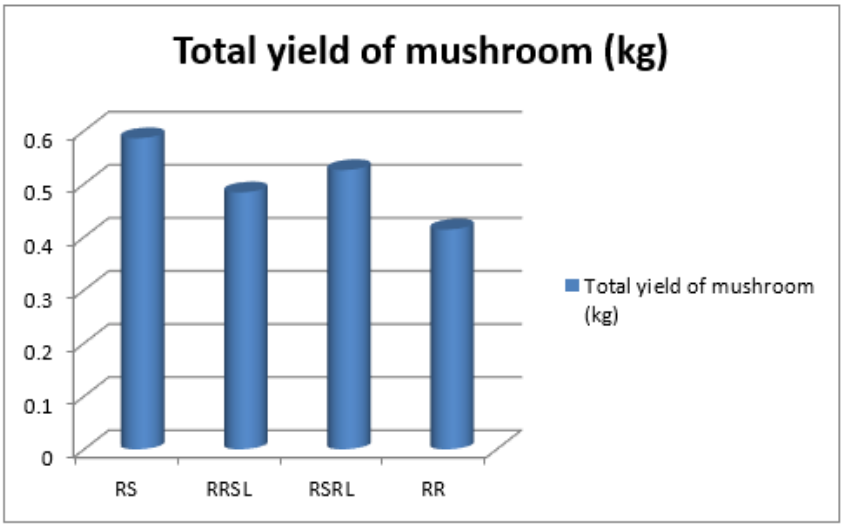

Figure 5.0 A graph showing the total yield of oyster mushroom grown in rice straw as main substrate.
Legend: RS = rice straw and sawdust; RRSL= rice straw, rice bran, sugar and lime; RSRL = rice straw, sawdust, rice bran and lime; RR = rice straw and rice bran.

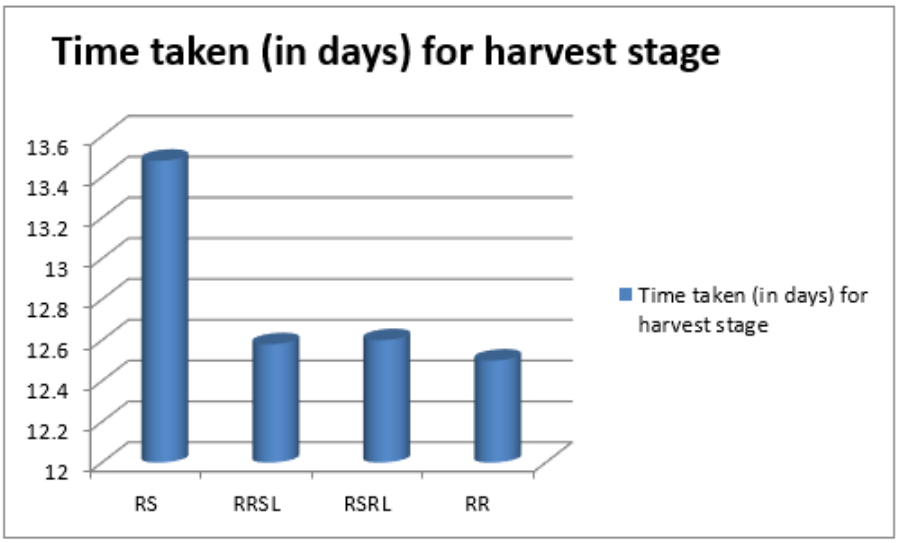

Figure 6.0 A graph showing the time taken from opening (in days) to harvest stage of oyster mushroom grown in rice straw as main substrate.
Legend: RS = rice straw and sawdust; RRSL= rice straw, rice bran, sugar and lime; RSRL = rice straw, sawdust, rice bran and lime; RR = rice straw and rice bran.

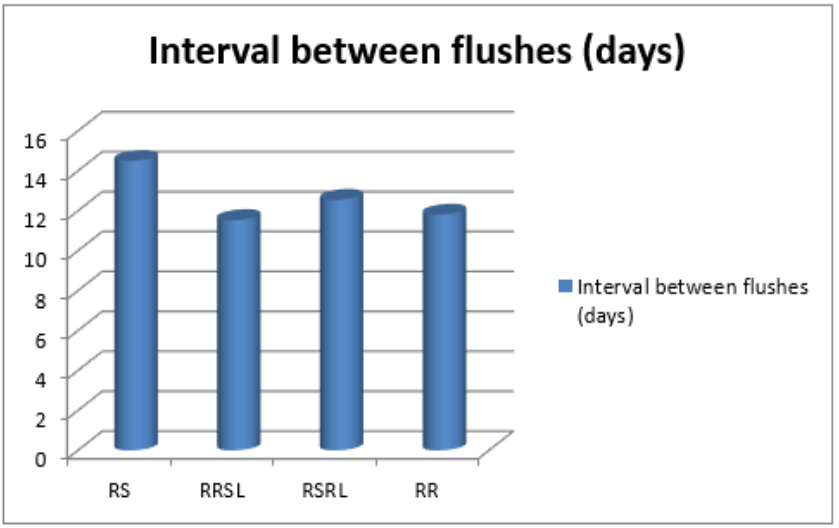

Figure 7.0 A graph showing the interval between flushes of oyster mushroom grown in rice straw as main substrate.
Legend: RS = rice straw and sawdust; RRSL= rice straw, rice bran, sugar and lime; RSRL = rice straw, sawdust, rice bran and lime; RR = rice straw and rice bran.

Conclusions and Recommendations

In study 1, the number of fruit bodies significantly differed with different materials used as substrates.

Oyster mushroom grown in 78% sawdust, 20% rice bran, 1% sugar and 1% lime or SRSL as substrates gave the most number of fruit bodies

Diameter of the cap, length of the stalk, weight of fruit bodies, total yield of mushroom, time taken (in days) for the emergence of primordia, time taken (in days) for harvest stage, interval between flushes of mushroom and number of flushes did not differ with different materials used as substrates.

In study 2, the number of fruit bodies, length of the stalk, weight of fruit bodies, total yield of mushroom, time taken (in days) for harvest stage, and interval between flushes of mushroom (days) differ with mushroom grown in rice straw as main substrate.

Mushroom grown in substrate with 50% rice straw and 50% sawdust produced the most number of fruit bodies, gave the longest stalk (cm), gave the heaviest fruit bodies (g), and heaviest total yield (kg). Similarly, this gave the longest time taken from opening (in days) to harvest stage and the longest interval between flushes of mushroom (days).

The diameter of the cap (cm), time taken from opening (in days) to emergence of primordia, and number of flushes of mushroom grown in rice straw as main substrate did not vary.

Therefore, the researchers recommmend future researchers to do the following: Grow mushroom using 78% sawdust, 20% rice bran, 1% sugar and 1% lime for more number of fruit bodies; grow oyster mushroom using any of the organic materials used in Study 1; use a combination of 50 % rice straw + 50 % sawdust for more number of fruit bodies, longer stalk (cm), heaviest fruit bodies (g), and total yield (kg); and, conduct other relevant studies using other substrates or substrate combinations, in other locations and other time of the year to gather more comprehensive information.

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