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Indoor Production of Shiitake Mushroom in Southwest Mississippi

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Abstract

One of the primary goals of agricultural research at Alcorn State University is to provide opportunities for limited-resource farmers in Mississippi to improve their income and quality of life through alternative crop productions and utilization. An indoor study conducted at the Alcorn Experiment Station was therefore used to determine the effect of block supplement compositions on shiitake mushroom yield potential and quality. Block supplement compositions (treatments) include, corn/soy pellets (CSP), Cotton Pellets (CP), and peanut pellets (PP). The blocks were randomly arranged on three separate rows of metal racks in the "grow room" at a within-row block spacing of six inches on both top and bottom levels of each row, 15 feet long and 15 inches apart. Harvested mushrooms were used for yield and quality determinations. Marketable shiitake mushroom numbers and weights were significantly highest ($P \leq 0.05$) for the corn/soy block supplement compared with cotton and peanut block supplement at the both top and low metal rack levels. Marketable shiitake macroelements (Potassium and Calcium) and microelement (Manganese) contents were also significantly highest ($P \leq 0.05$) for blocks with corn/soy supplements.

Keywords: Shiitake Mushroom, Indoor Production, Block Supplement Compositions, Yield Potential, Elemental Compositions and Block placements.

1.0 Introduction

Producing safe and nutritious food for the consumers, ensuring profitability of farming enterprises, and maintaining the viability of rural agricultural communities through environmentally sound and sustainable agricultural practices are some of the major challenges facing world Agriculture today. Currently both large and small scale farmers face tremendous fluctuations in net farm income. Long-term decline in the number of farms, limited employment opportunities, and gap in per capital income between the rural and metropolitan communities contribute to current increase in the migration of human resources to the urban centers. The State of Mississippi has the highest poverty rate (19.3%) in the United States, just ahead of Louisiana. Critical poverty rates in Mississippi has left many counties with low number of available jobs, low-quality education, and low-quality health care (Boston, 2008). The solution may include the development of economic and social activities that penetrate all communities and population groups. This could mean that full-time year-round employment, among other farm activities would enable many Mississippians to escape poverty, and enhance their income potential and quality of life.

Fungi in mycological landscapes can be designed to fruit according to the seasons. As with other plants, the timing of "fruiting" can be organized so that mushrooms are available throughout much of the year. Community mushroom gardens, like any other fruit or vegetable garden can increase access to fresh mushrooms thereby providing numerous health benefits, including improved nutrition, health related issues such as childhood and adult obesity, childhood and adult diabetes, and childhood and adult heart disease. (Wakefield *et al.,* 2007).

Scientific studies have concluded that mushroom is of economic importance in food and medicine preparations (Oso, 1997, and Chen, 2004). Pleurotus species are a rich source of protein, minerals (P, Ca, Fe, K, and Na) and vitamins (thiamine, riboflavin, folic acid, and niacin) (Szabova et al; 2013). Apart from food value, their medicinal value for diabetes and in cancer therapy has been emphasized (Sivrikaya *et al*., 2002). Numerous mushroom species contain a wide range of metabolites as antitumor, antigenotoric, antioxidant, antimicrobial and antiviral activities (Chang, 2007).

African herbalists have used pleurotus tuberregium sclerotia to solve a variety of health problems, ranging from skin disease to small pox and even in embalmment of bodies (Chen, 2004; Akpaja, 2003; Oso, 1997). Many studies have reported the use of pleurotus species in bioremediation exercises; P. tuberregium has been reported to ameliorate crude oil polluted soils and the resulting soil sample supported the germination and seeding of Vigna ungu 'iculata (Tsikhuehmen *et al.*, 2003). Some shiitake health benefits include its ability to aid weight loss, support cardiovascular health, fight cancer cells, improve energy levels and brain function, reduce inflammation, and support the immune system (Axc, 2016).

Unfortunately, small producers have limited resources, inadequate education and management skill, are more dependent on off-farm income and have more difficulty using the technology being developed for production and marketing. Walker and Lin (1979) reported that it is possible to improve food production levels and incomes on most small farms if available resources are fully utilized and if adoptable technology is used.

2.0 Purpose and Objective

This study was therefore, used to determine the effect of block supplement composition and block placement in grow room on shiitake mushroom yield potential and quality.

3.0 Materials and Methods

Indoor experiment was used to compare the effect of block nutrient compositions on shiitake mushroom yield potential and quality. This study was conducted at the Alcorn Experiment Station mushroom facility. The nutrient compositions for the blocks which represented treatments in this study included (1) corn/soy pellets (CSP), (2) cotton pellets (CP), and (3) Peanut pellets (PP). These pellets were purchased from the Mississippi Natural Product Association (MNPA) in New Hebron, Mississippi.

The blocks which were received on the 9th day of September 2013 were randomly placed on three separate rows of metal racks at a within-row block spacing of 6 inches on both top and bottom levels of each row. The rows of the metal racks were assigned numerical values of 1, 2, or 3 for corn/soy pellets, cotton pellets, and peanut pellets, respectively. Each row 15 feet long and 15 inches apart contained 15 test block pellets. The pellets were assigned to positions on the racks at a set of 5 pellets resulting in 3 replications of each test row at both top and bottom rack levels.

Efforts were made to ensure that the standard maintenance schedule in the "grow room" was maintained during the study period (Table 1). The growroom temperature at the initiation of this study was 74^0F, whereas the average weight of the blocks used in the study was 4.5 to 5.0 pounds. The bags used to cover each block were promptly removed and the temperature in the growroom dropped to 58^0F while the humidity was at 75%. This requirement was maintained from March 5 to March 6 (2 days). From March 7 to March 21 (15 days) the temperature was increased to 65ÚF, while the humidity was set at 85%. From March 22 to March 25 (4 days) the temperature was increased to 74ÚF and humidity was set at 70%. On March 26 the blocks were soaked in cold water for about 3 hours to conclude the study period, and to begin the second cycle. For quality evaluations equal marketable mushroom samples from the top rack for each treatment were oven dried at 70ÚF for 24 hours. They were ground with Wiley mill grinder to pass 2 mm serve, and used to determine their elemental contents.

Data collections were on shiitake mushroom produced and harvested from each block during each harvesting date. The harvested crops were graded as "premium" for marketable yields 1.5 inches in diameter; "Baby" for those less than 1.5 inches in diameter, and "Others" for those that are not marketable or misshaped. Both the numbers and weight for combined grades were determined for each supplement for both top and bottom rack levels. The elemental compositions of mushroom harvested from the top racks only were determined for both macro-and micro-elemental compositions. All data were analyzed by the analysis of variance (ANOVA), and means were separated by the Least significant difference (LSD) test procedure. The 5% probability level was used to determine the extent of mean variations (Steele and Torrie, 1980).

4.0 Results

4.1 Yield Potential

The maintenance schedule in the growroom when the blocks were in production is reported in Table 1. The data show that as the number of days the blocks were in the growroom increased, the temperature was generally increased, while the humidity was generally decreased. Data also indicate that 21 days are adequate length of growing cycle for shiitake mushroom production if temperature and humidity in the growroom are not limiting.

Table 1: Maintenance schedule in the grow room[X]

Maintenance Period (Days)	**Temperature (ºF)**	**Humidity (%)**	**Length of Treatment (Days)**
March 5-6	58	75	2
March 7-21	65	85	15
March 22-25	74	70	4
March 26	65-70	65	--

[X]Values represent the expected growroom environment during each period the blocks were placed in the room.

Treatment effect on shiitake mushroom number from the top rack is reported in Table 2. The corn/soy block pellets had the highest shiitake mushroom number during each of the six harvest dates. However, the effects were significant during 4/19/13, 5/10/13, and 5/13/13 harvesting dates. During 4/19/13 harvesting date, the 3.3 reported for corn/soy pellet was significantly higher than 0.0 and 0.3 reported for cotton and peanut pellets, respectively, which were not different from each other significantly. During the 5/10/13 harvesting date 8.0 reported for corn/soy pellet was significantly higher than 0.7 and 0.0 reported for cotton and peanut pellets respectively; however, both were not different from each other. During the 5/13/13 harvesting date, the 8.7 reported for corn/soy pellets was significantly greater than 5.7 and 4.3 reported for the peanut and cotton pellets, respectively.

For the bottom racks, the corn/soy block pellets had the highest shiitake numbers during each of the six harvesting dates. The effects were significant for the 4/30/13, 5/9/13, 5/10/13, and 5/13/13 harvesting dates. Their respective highest values of 5.7, 10.0, 20.3, and 31.7 were for the corn/soy block pellets. The corresponding lower values were either for cotton or peanut block pellets or both.

Treatment effect on shiitake mushroom number from the bottom racks is reported in Table 3. The corn/soy block pellets had the highest shiitake numbers during each of the six harvesting dates. The effects were significant for the 4/30/13, 5/9/13, 5/10/13, and 5/13/13 harvesting dates. Their respective highest values of 5.7, 10.0, 20.3, and 31.7 were for the corn/soy block pellets. The corresponding lower values were either for cotton or peanut block pellets or both.

Table 2: Treatment effect on shiitake mushroom number from top and bottom racks (2015)[X]

Treatment (Block Supplement Compositions)	**Harvesting Dates** 4/19	4/30	5/2		5/9	5/10	5/13	5/16		5/21
Top Rack Level (Number)										
Corn/Soy (CSP)	3.3	1.7		0.0	5.0	8.0	8.7	0.0		1.3
Cotton (CP)	0.0	0.0		0.0	0.0	0.7	4.3		0.0	0.0
Peanut (PP)	0.3	0.3		0.0	0.0	0.0	5.7		0.0	0.0
LSD, 5%	0.4	NS		-	NS	6.4	0.1		-	NS
Bottom Rack Level (Number)										
Corn/Soy (CSP)	3.7	5.7		1.0	10.0	20.3	31.7		1.3	0.0
Cotton (CP)	0.0	0.0		0.0	0.0	0.0	0.3		0.7	0.0
Peanut (PP)	0.0	0.7		0.7	0.0	0.0	6.3		0.0	0.0
LSD, 5%	NS	1.7	NS		1.9	5.4	10.5		NS	-

[X]Values represent average number for marketable mushroom harvested from each set of five block pellets from both top and bottom racks.

For the bottom racks, the corn/soy block pellets had the highest significant shiitake mushroom weight values during each of the six harvesting dates. The values were 212.9, 11.0.162.9, 145.3, 16.1, and 5.1 for 4/30/13, 5/2/13, 5/9/13, 5/16/13 and 5/21/13 harvesting dates, respectively. The corresponding lowest value were either from cotton or peanut pellets or both.

Treatment effect on the overall marketable shiitake mushroom production is reported in Table 4. Elemental composition of the block pellets influenced the overall marketable shiitake mushroom number and weight at both top and bottom rack levels.

For the top rack, the average marketable shiitake mushroom number was highest (28.10) for corn/soy block pellets and lowest (5.00) for cotton block pellets, which was not different from 6.00 reported for peanut block pellets at 5% probability level only. Similarly, the average marketable shiitake weight was highest (0.97 lb) for corn/soy block pellets and lowest (0.18 lb) for cotton block pellets, which was not different from 0.28 lbs reported for peanut pellets at both 5% and 1% probability levels.

For the bottom rack, the average marketable shiitake mushroom number was highest (74.33) for corn/soy block pellets and lowest (1.33) for cotton block pellets, which was not different from 7.00 reported for peanut block pellets at both 5% and 1% probability levels. Average marketable shiitake block pellet weight was highest (1.73 lbs), for corn/soy block pellets, and lowest (0.06 lbs) for cotton block pellets which was not different from 0.13 lbs reported for peanut block pellets.

4.2 Elemental Compositions

Treatment effects on elemental contents of marketable mushroom from top racks are reported in (Figure 1 and 2). Marketable shiitake macro-element contents were significantly highest for potassium (1.8%) and calcium (0.31%) due to corn/soy supplement application (Figure 1). The micro-

Table 3: Treatment effect on shiitake mushroom number from top and bottom racks (2015)^{X}

Treatment (Block Supplement Compositions)	Harvesting Dates							
	4/19	4/30	5/2	5/9	5/10	5/13	5/16	5/21
	Top Rack Level (gm)							
Corn/Soy (CSP)	33.7	53.6	0.0	5.0	63.1	340.4	0.0	1.3
Cotton (CP)	0.0	0.0	0.0	0.0	2.6	2.6	0.0	0.0
Peanut (PP)	0.0	0.0	0.0	0.0	0.0	120.4	0.0	0.0
LSD, 5%	12.8	7.6	-	NS	42.9	135.4	-	NS
	Bottom Rack Level (gm)							
Corn/Soy (CSP)	40.1	212.9	11.6	162.9	145.3	340.4	16.1	5.1
Cotton (CP)	0.0	0.0	0.0	0.0	0.0	2.6	29.7	0.0
Peanut (PP)	0.0	18.7	16.7	0.0	0.0	120.4	0.0	0.0
LSD, 5%	15.6	144.2	8.0	76.7	60.4	135.4	NS	NS

^{X}Values represent average number for marketable mushroom harvested from each set of five block pellets from both top and bottom racks.

Table 4: Treatment effect on the overall marketable shiitake mushroom production

Treatment^{Y} (Block Pellets)	Marketable Shiitake Mushroom^{X}			
	Top Rack		Bottom Rack	
	Number^{Z}	Weight (lb)	Number	Weight (lb)
Corn/Soy CSP	28.10	0.97	74.33	1.73
Cotton (CP)	5.00	0.18	1.33	0.06
Peanut (PP)	6.30	0.28	7.00	0.13
LSD, 5%	12.70	0.29	28.20	0.55
LSD, 1%	NS	0.49	46.78	0.92
CV, %	42.77	27.50	45.14	38.27

^{X} Values represent overall average for marketable mushrooms harvested from 5 block from the top and bottom racks element contents were not significantly different except for manganese which was also highest (25 ppm) due to corn/soy supplement application (Figure 2). Data indicate that both macro-and micro-elemental levels in the dry shiitake samples were comparable to levels considered adequate for plant growth and development (Epstein, 2004). Findings suggest that shiitake mushroom could play a major role in human nutrition in the State of Mississippi.

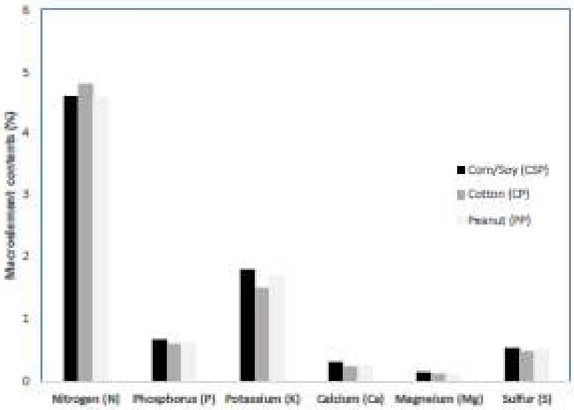

Figure 1: Treatment effect on shiitake mushroom macroelement contents (%).

(Values are averages for 15 samples from each top treatment analyzed for macroelement contents).

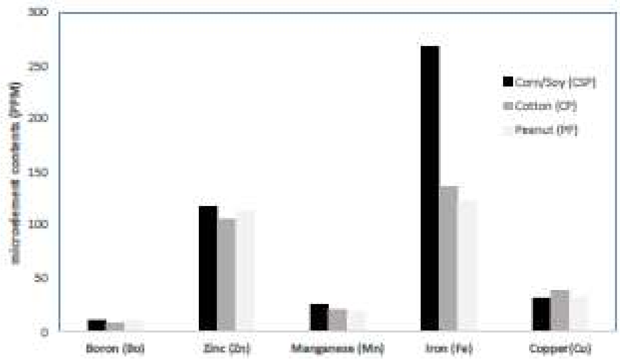

Figure 2: Treatment effect on shiitake mushroom microlement contents (PPM).

(Values are averages for 15 samples from each top treatment analyzed for microelement contents).

5.0 Conclusion

Findings from the study on the effect of block pellet nutrient compositions on shiitake mushroom growth and yield potential indicate that the environment within the mushroom facility at Alcorn State University will support shiitake mushroom growth on block however, their performances will vary with the block nutrient compositions. The corn/soy pellets will clearly support shiitake mushroom growth on blocks. It is obvious that although shiitake mushroom will grow on sawdust blocks, the performance will vary with the block nutrient compositions. The corn/soy pellets will clearly support shiitake mushroom production on blocks more than both cotton and peanut pellets. It is also to be noted that marketable shiitake mushroom can be harvested from blocks in a supporting environment within 21 days the blocks are introduced into the growroom. The yield from blocks within the facility will be comparable if the top and bottom racks are 15 inches or less from each other. Maintaining a disease-free environment inside and around a mushroom facility is essential for successful indoor production of shiitake mushroom on blocks. Limited-resource farmers can successfully produce shiitake mushroom in their home basements for consumption or for niche market if the environments within the basement are comparable to those recommended for commercial production. Shiitake mushroom could play a major role in human nutrition because of its comparable elemental contents to those considered adequate in flowering plants.

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