https://doi.org/10.33472/AFJBS.6.11.2024.1670-1678

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

SUSTAINABILITY OF MUSHROOM FARMING AS A CO-CURRICULAR ACTIVITY IN TANZANIAN SECONDARY SCHOOLS

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Article Info

Volume 6, Issue 11, July 2024

Received: 21 May 2024

Accepted: 27 June 2024

Published: 12 July 2024

doi: 10.33472/AFJBS.6.11.2024.1670-1678

ABSTRACT:

The main goal of this project was to increase the students' knowledge of mushroom manual production outside of what they learned in the classroom. This project's methodology was an observational approach. Through experimentation, it involved a thorough examination of the specific case. In addition to the knowledge they have already learned in the classroom, we wanted our students to explore new information and skills related to artificial mushroom production. The first replicate generated a biological yield of 235 grams, followed by 255 grams in the second replicate and 220 grams in the third. Temperature, humidity, moisture, and light intensity variations all contributed to these variations. Based on the findings, it can be concluded that the current study can be made a requirement for inclusion in all school curricula as a fundamental training program to fight unemployment in the future.

Key words: Tanzania's ministry of agriculture, proteins, carbohydrates, Fat.

1. INTRODUCTION

There are numerous varieties of mushrooms that can be found almost everywhere in the world. Based on their observation of edible mushrooms that were naturally found in the forest and other places, people used to eat mushrooms. According to [1] report, there are roughly 14,000 recognized species of mushrooms, or 10% of the estimated total number of mushroom species on earth. Over 2000 species of the 10,000 species of macrofungi reported to be growing worldwide are edible mushrooms. The immortal plant: the mushroom? According to the hieroglyphics from 3000 years ago, that is what the ancient Egyptians believed.

In terms of formal mushroom cultivation, France was at the forefront. In France, a wide range of species were grown. According to some sources, Louis XIV (1683–1715) was the first person to cultivate mushrooms. At this time, mushrooms were being grown in Paris-area caves designated specifically for this unusual form of agriculture. The French introduced the English gardeners to mushrooms, which were very simple to grow and required little effort, money, or space.

Inquisitive home gardeners in the East tried their luck at growing this novel and unexplored crop in the United States in the late 19th century after the mushroom made its way across the Atlantic. However, growers were forced to rely on imported spawn from England, which was of poor quality by the time it arrived in the United States. This trade publication claimed that mushroom farming was ideal for florists. Since flowers were grown on benches, florists could easily slide mushroom beds underneath their flower benches and make money by growing two crops where only one could be grown.

Growing mushrooms at the time did not require skilled labor. Both as a home income source and a suggestion for housewives. The target audiences that growing was suitable for were developed in Falconer's book. Along with practical information on how to construct cultivation beds, the ideal growing temperature, and where mushroom markets were emerging, it also contained information on these topics. The American Spawn Company of St. Paul, Minnesota, led by French mycologist Louis F. Lambert, was the first manufacturer of virgin spawn grown exclusively in pure culture. With the slogan "Lambert's Pure Culture Spawn," he started producing brick spawn and marketed it all over the nation. It quickly established itself as a very well-liked item. At the 1904 World's Fair in St. Louis, this offspring won a silver medal.

The fact that English spawn soon began to be marketed as "English Pure Culture Spawn" is a sign of Lambert's success. According to the National Agricultural Statistics Service, 2007. By 1914, mushroom marketing had become much more important to the sector. According to one publication, four to five million pounds of mushrooms were grown in the United States. The price was between fifteen and twenty-five cents for the mushroom farmer. The cost per pound at retail was between 40 and 60 cents. A common theory was to cut out the middleman and target consumers directly, which led to the rise in importance of marketing. It was noted that appealing packaging would move goods and that only goods with a good appearance would be purchased according to the National Agricultural Statistics Service, 2007. In Tanzania, more than 80 different species of edible wild mushrooms have been identified [2]. On wheat straw, cotton, waste, and peanut shells, [3] cultivated selected wild and commercial strains of *Pleurotus ostreatus, Pleurotus eryngii, Pleurotus pulmonarius, Agrocybe aegerita*, and *Volvariella volvacea*.

The crop residues of cereals and legumes, corncobs, tree leaves, sawdust, coffee hulls, banana leaves, bagasse, cotton waste, cotton seed hulls, brewers waste, papyrus reeds, and elephant grass are examples of potential substrates for mushroom cultivation [4]. [5] reported that domestication of *Oudemensiella tanzanica* using sawdust, sisal waste, and paddy straw as substrates supplemented with chicken manure resulted in the highest biological efficiencies. The edible wild *Coprinus cinereus* mushroom was successfully cultivated by [6] in tropical settings on dried grasses supplemented with varying amounts of cow dung manure.

Co-curricular activities, also known as extracurricular activities, are found at all levels of the educational system, but are particularly prevalent in secondary schools (Foster, 2008). Because the few experts who have knowledge and expertise in mushroom production are not supported by the national agricultural policies, artificial manual production has not been fully implemented. Commercial production of mushrooms boosted the economies of nations like China and India. This implies that, in order to replace seasonal outgrow, mushrooms can even be artificially produced in Tanzania. This served as a co-curricular activity in schools and helped students learn more about mushroom cultivation in general.

This project's aim was to investigate the role that mushroom cultivation plays as a co-curricular activity in secondary schools in Tanzania.The present study was conducted based on the following specific objectives. 1. To produce the mushroom artificially as a co-curricular activity and demonstrate the mushroom's economic and biological yield. 2. To encourage students to start their own businesses after their final exams (graduation) and to give society's citizens a healthy diet.

Almost all ethnic groups in Tanzania have a traditional understanding of the mushrooms that grow wild, and during the rainy seasons, members of each group gather, consume, and sell them (Härkönen et al., 2003). Due to the paucity of studies on the cultivation of these mushrooms, the project's goal is to make mushroom cultivation a co-curricular activity in Tanzanian secondary schools. This will examine the students' knowledge of mushroom production outside of what they have learned in the classroom.

2. MATERIALS AND METHODS

2.1 Study site

The location of this study is Dar-es-Salaam, Tanzania. Students, teachers, and society were the target populations for our project. A sample is the total of all parts, portions, or quantities meant to represent the entire.

2.2 Conditions

We used a variety of tools for our project, including: i. Trays or wooden cases, ii. Spoons. iv. Spawn, v. Chemicals (formalin, pesticide, insecticide), vi. Parking material, and vii. A special room for cultivation. iii. Compost (rice straw, sugar, gypus, and corn bran). viii. A cutting device. Oil drum, tree trunk, and (panga).

We produced mushrooms as part of our project using experimental techniques. The steps for producing an artificial mushroom, are as follows: Phase I: involves gathering the necessary materials, including spawn (mushroom seeds). Markets had plenty of spawns for sale. The same can be created upon request.

Phase II: Making compost:There are a number of mixtures for compost formation, but the entrepreneur can select one based on the compost's accessibility. We cooked with rice straw that had been supplemented with various nutrients. Wheat straw is supplemented with organic and inorganic nitrogen nutrients in synthetic compost. Good compost is dark brown, free of ammonia, barely greasy, and between 65 and 70 percent moist. Third Stage: Packaging After preparing the compost, we stored it in Kenyan-made plastic bags measuring 8 by 16 inches.

Pasteurization, third stage For two hours, the plastic bags containing the compost were sterilized in the oil drum. The compost is then cooled over the course of an hour-long cooling process.

Fourth Stage: Spawning. Mushroom compost was inoculated with mushroom spawn (Latin expandere = to spread out). The fruit of a plant, like tomato plants, is the mushroom itself. One seed is present in each tomato, and these are used to plant the crop for the following season. Spawn is spread out over the compost and then thoroughly mixed in. The spawn was spread over the compost's surface and ruffled in with a tiny rake-like tool by hand, year after year. Once the spawn has been evenly distributed throughout the compost and the surface has been leveled, the temperature is kept at 750 F and the relative humidity is kept high to prevent the spawn from drying out.

Fifth Stage: Incubation The compost was placed in plastic bags and placed in a dedicated space that had been set up for mushroom cultivation. The length of time it takes for spawn to colonize the compost depends on the rate and distribution of spawning, the temperature and moisture of the compost, and the type or quality of the compost. Typically, a full spawn run takes 14 to 21 days.

After rhizomorphs had developed in the casing, the mushroom initials had emerged. The initials were very small, but they can be recognized as a rhizomorphs' outgrowth. Through the button, pins keep growing and expanding, eventually enlarging to the size of a mushroom. About 17–30 days after casing, the pinning mushroom appears. Depending on the cultivar, pins only grow when the carbon dioxide level in the space is reduced to 0.08 percent or less by bringing in fresh air. Only through experience can one learn the importance of fresh air introduction timing. Harvesting mushrooms began between 30 and 42 days ago, and it continued for 60 days. For best results, the air temperature during cropping was kept between 570 and 620 F. Not only were mushrooms favored by this temperature range, but cooler temperatures also prolonged the life cycles of both pathogens and pest insects.

The compost and mushroom spawn mixture was placed in plastic bags, and the inoculated bags were kept in a dark area to promote mycelia growth. Parts of the bags were cut off to create perforations to aid in the development of fruiting bodies after mycelia growth in the bags became prolific and/or pinheads began to emerge. Substrates that were fully colonized were then moved to the growth room and arranged on racks with a spacing of 15-20 cm made of wood and nylon rope. By occasionally (every two to three days) opening the door, the growth room's proper ventilation was ensured. To keep the mycelia moist, inoculated bags or the floor were watered two to three times per day. By misting the space with a fine mist, relative humidity (RH) and room temperature were measured and maintained.

Daily observations of the mushroom's growth and development were made. It was noted how many days it took from inoculation to the point at which the mycelium was fully developed, how long it took from the time the plastic bags were opened to the formation of pinheads, and how long it took from the time the plastic bags were opened to the first round of harvesting. When the mushrooms were being harvested, yield parameters like the quantity of fruiting bodies per bunch and the total fresh weight (g) of the mushrooms were also noted. Sharply cutting the base just above the substrate's surface, mature fruiting bodies (white in color, with an upward-curving pileus) were harvested. Consequently, the weight of the entire cluster of fruiting bodies without removing the stalks' bases was used to calculate the biological yield (g), and the weight of the fruiting bodies alone was used to calculate the economic yield (g).

3. RESULTS

We discover that the three replicates had different growth rates based on this goal. Results regarding the duration of mycelia running, pin-head formation (primordial initiation), and fruiting body maturity are shown. Fungal hyphae are spreading and colonizing the substrate in the first replicate of mycelia running. Between three and fifteen days are needed for mycelia to grow in rice straw. Between 14 and 32 days after the seeding of spawns is when pin-head formation occurs and 36 days for maturation. The second replicate demonstrates day colonization after 13 days, pin-head formation after 26 days, and maturation after 31 days. The third replicate demonstrates 16 days for colonization, 29 days for pin-head formation, and 34 days for maturation (Figure 1).

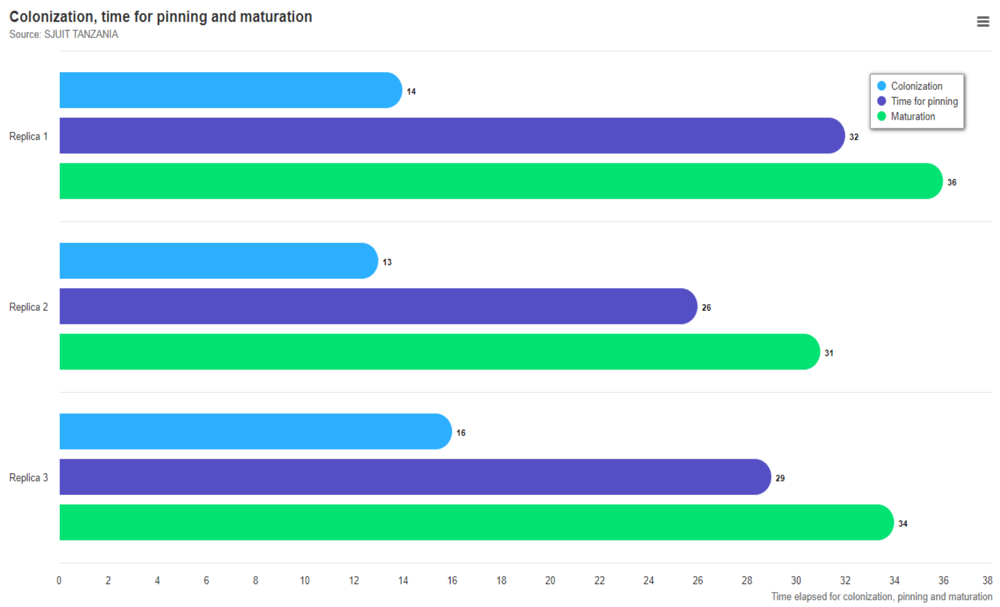

Figure 1. Colonization, Time for pinning and Maturation

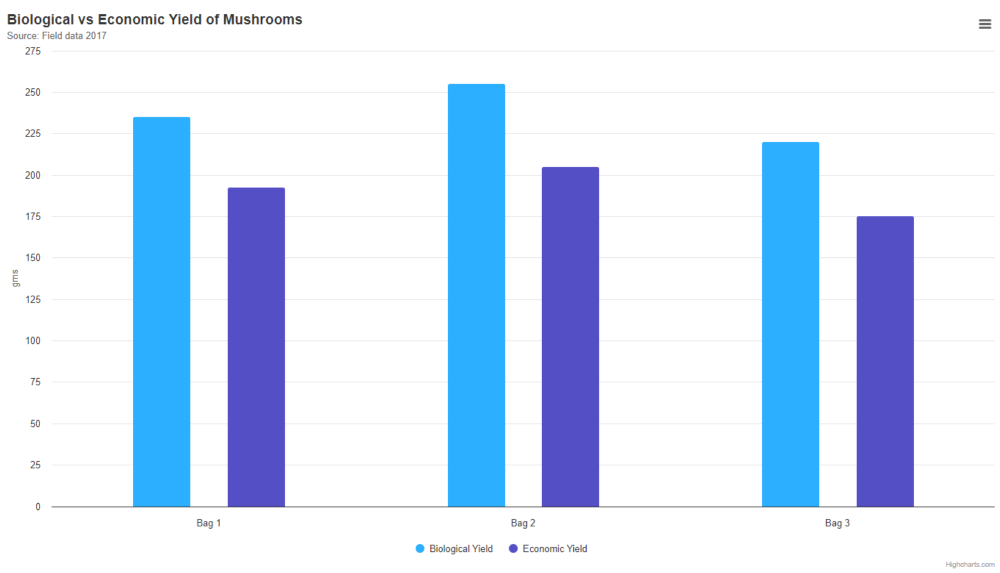

Figure 2. Biological Vs Economic yield of Mushrooms

The entire mushroom is considered to be the biological yield. Mushroom without hyphae with a good yield. The yield of mature oyster mushroom fruiting bodies, which were harvested in three replicates and weighed to determine biological and economic yield, is shown in the Figure 2 above. The biological yield (g) in the first replicate was 235, while the economical yield (g) was 192.7; the biological yield (g) in the second and third replicates, however, were 255 and 205, respectively.

Table 1: Biological Efficiency of Mushroom.

Plastic bag	Weight of dry substrate (gm) Biological yield (gm)
1	500 235
2	500 255
3	500 220

SOURCE. Field data 2017

The differences in biological yield were caused by a number of factors, including temperature, moisture content, and light intensity (Table 1).The biological efficiency, which is used to assess the effectiveness of substrate conversion in the mushroom cultivation process, was calculated as the ratio of the harvested biological yield to the dry weight of the substrate package after three replications. A biological yield of 235 grams was produced by the first replicate, 255 grams by the second, and 220 grams by the third. These variations were brought on by variations in temperature, humidity, moisture, and light intensity.

The students' motivation to work for themselves after their final exam (graduation) was our second goal, along with giving society's members nutritional value. Between 20 and 30 years old, approximately 50% of the sampled producers' ages ranged, followed by 30 to 40% of producers. Among all producers, only 10% were between the ages of 40 and over 50. This gave the impression that young generations are interested in mushroom production (Table 2).

Table 2 Age Samples of the Mushroom Producers.

Age	Number	Percent (%)
Age below 20	1	3
20-30	15	50
30-40	9	30
40-50	3	10
Above 50	2	7
Total	30	100

SOURCE: Field data 2017

According to internet sources, who examined various nutritional contents, mushrooms have significant nutritional value for human health. Protein - The majority of mushrooms have a high protein content; this ranges from 17 to 42 g per 100 g of dry weight. Anyone looking to increase their diet's protein content, including vegetarians, may find this helpful. In addition to being beneficial for the digestive system, fiber also helps lower cholesterol. About 100 grams of mushrooms have 24-31 grams. The dried mushroom's carbohydrate content is 37–48 g per 100 g. Per 100 grams of dried mushroom, lipid-mushroom contains 0.5 to 5 g.

Table 3 Macronutrients of Oyster Mushroom

Nutrients		Content (g/100g dried mushroom)
Protein		17-42
Carbohydrate		37-48
Lipids		0.5-5
Fibers		24-31
Minerals		4-10
Moisture		85-87%

SOURCE: internet

Per 100g of dried mushroom, mineral-mushroom contains 4–10 g. There is 85-87% moisture in mushrooms. Mushrooms can be further developed into a variety of products, including mushroom pickles, cosmetics made with mushrooms, medicine, and herbal trees (Table 3).

4. DISCUSSION

Growing artificial mushrooms as a co-curricular activity and economic and biological yield. According to the research, it took *P. ostreatus* mycelia 17 days to grow in paddy straw. Comparable studies have been conducted elsewhere.

4.1 Moisture

One of the key elements affecting the success of mushroom growth is water. The fruiting body will perish due to low moisture content. The organism and the substrate being used for cultivation determine the ideal moisture content for growth and substrate utilization.

It is thought that raising the moisture level will decrease the substrate's porosity and limit oxygen transfer. Because of this, using a high moisture content restricted growth throughout the entire substrate, leading to surface growth [7]. Similar to this, [8] and [9] also grew *P. eryngii* in environments with a moisture level of 65–68%. Diseases and competing molds can develop in environments with moisture levels above 70%.

P. ostreatus is widely cultivable and adaptable to a range of temperatures. It exists on all continents with the exception of Antarctica and expands all year long [10]. According to [11] the substrate containing the inoculum was subsequently kept at 23 °C in a darkened spawn-running room. [12] state that the culture house's temperature was kept between 22 and 25 °C for the cultivation of *P. high-king, P. ostreatus,* and *P. geesteranus*.

According to [12] *P. high-king, P. ostreatus*, and *P. geesteranus* were grown in a culture house that was kept between 22 and 25 °C. As a potential opportunity to develop oyster mushroom production in underdeveloped and developing nations, this optimal temperature result showed that *Pleurotus* species were able to grow better during the summer and autumn in subtropical and tropical regions [13]. For mycelial growth and the subsequent fruiting, the ideal environmental conditions are typically very distinct. Development of fruiting bodies is frequently induced following a significant change in the environment [14].

[11] claim that for *Pleurotus* spp. to grow to their full potential, the environment's humidity during the darkened spawn-running and mycelia stimulation should fall within the ranges of 60-75% and 85-97%, respectively. According to Panday et al. (2008), high humidity is ideal for fruiting and pining. The relative humidity of the culture room was kept at 80–85% by misting water three times daily during the *P. high-king, P. ostreatus,* and *P. geesteranus* growth on wheat bran–supplemented sawdust [12].

The variations in the substrates' chemical make-up and Carbon to Nitrogen ratio (C: N) may be responsible for this variation. Oei (2003) asserts that certain nutrients are necessary for the mushroom mycelia's growth, and that these nutrients can be provided by supplements, which will increase the amount of mushrooms that are produced. After substrates had been colonized by mycelia growth, pin-head formation (premordium initiation) was noticed. Pin-head formation of oyster mushrooms grown in paddy straw substrates ranged between 17 and 30 days from spawning, whereas [15] stated that it was 20-23 days. Pin-heads, on the other hand, started to appear after about 6 days, according to Shah et al. (2004).

These variations in mycelia growth rate, colonization, and primordial initiation have been noted when a mushroom species was grown on a variety of substrates, including sawdust, bagasse, and banana leaves [16], [17]. Generally speaking, it was found from this study that the oyster mushroom cropping period ranged from 30 to 42 days, depending on the maturity of the fruiting bodies at the time of harvest. Although oyster mushrooms grown on paddy straw can be harvested in as little as 104 days. These variations in cropping times might result from differences in the physiological requirements for mushroom cultivation, such as the constant temperature, humidity, and lighting configurations, as well as differences in the growing environment (controlled versus semi-controlled conditions).

4.2 Yield

Measuring the various yield components (yield attributes) was done before the yield of oyster mushrooms could be determined. The yield components (also known as yield attributes) of *P. ostreatus* were discovered to be influenced by a variety of factors, including fungi infections that result in the growth of mold, temperature (low or high temperature), humidity, nutrients, and specialized incubation facilities.

5. CONCLUSION

The technology for mushroom cultivation is underdeveloped in many developing nations. Tanzania is one of these nations, where there is a well-known unemployment crisis and a poor educational system. Therefore, the current study was conducted to address unemployment issues and give school students access to skill-based learning opportunities. The results are encouraging and made possible by the fact that the mushrooms used in the current study were highly remarkable. The study can be required to be included in all school curricula as a fundamental training program to combat unemployment in the future, according to the findings, which support this conclusion.

Acknowledgement

The corresponding author would like to thank the management of St. Joseph University in Tanzania for extending cooperation in the success of this project. The authors deeply express their gratitude to all the students and the management for their help.

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