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Low Cost Production of Mushroom using Agricultural Waste in a Controlled Environment for Economic Advancement

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Abstract

Mushroom (Oyster and Shiitake) were cultivated in controlled environment using agricultural wastes, Maize cob, rice bran, wheat bran and cotton waste as the substrates. 30.0 g each of the Mushrooms produced were dried at temperatures 60, 105 and 120°C, milled and packaged. Freshly harvested samples of both were frozen. The physical properties of freshly harvested mushrooms were determined and the Proximate Analysis revealed that the mushroom produced using this method is of high quality. The technology of production is relatively simple, cheaper and appropriate to our local condition. This paper examines how mushroom can be produced using agricultural waste in a controlled environment for economic advancement.

Keywords: Control building; Mushroom, Shiitake, Oyster; Cultivation; Processing

Introduction

There are hundreds of identified species of fungi which, since time immemorial, have made a significant global contribution to human food and medicine. Some estimate that the total number of useful fungi – defined as having edible and medicinal value – are over 2 300 species [1]. He also opined that, although this contribution has historically been made through the collection of wild edible fungi, there is a growing interest in cultivation to supplement, or replace, wild harvest. This is a result of the increased recognition of the nutritional value of many species, coupled with the realization of the income generating potential of fungi through trade.

Mushrooms are the fruiting bodies of macro fungi. They include both edible/medicinal and poisonous species. However, originally, the word “mushroom” was used for the edible members of macro fungi and “toadstools” for poisonous ones of the “gill” macro fungi. The function of this visible part of some fungi is to produce and disperse the largest possible number of spores in the shortest possible time. Spores create new individuals after being carried away on the wind and landing in a good place for growth. Mushrooms have been recognized as food rich in protein, folic acid as well as vitamin B12. Its characteristic meaty biting, texture, and flavour also contribute to mushroom demand; thus, cultivation of mushroom is now a big industry in industrialized countries of the World [2].

However, it is essential to note that some mushrooms are poisonous and may even be lethal, thus the need for extra caution in identifying those species that can be consumed as food. Indirectly, mushroom cultivation also provides opportunities for improving the sustainability of small farming systems through the recycling of organic matter, which can be used as a growing substrate, and then returned to the land as fertilizer. Through the provision of income and improved nutrition, successful cultivation and trade in mushrooms can strengthen livelihood assets, which cannot only reduce vulnerability to shocks, but enhance an individual’s and a community’s capacity to act upon other economic opportunities [1].

Mushroom is gradually becoming popular, as they are rich in minerals and vitamins with low fat and sugar. The technology of mushroom farming is based on the facts that composted manure which produces mushrooms could be used to inoculate new stack of compositing horse manure [3,4].

Mushroom development usually starts at the first sign of buttons, often on a 7-10 days cycle and may last for 1½ -2 months. Timing is important as mushroom grow quickly, doubling their size within 24 hours. Buttons are small unopened mushroom at the flat stage while the caps are the older buttons which has begun to open and have fully expanded to expose all the gills [3]. The fruiting bodies are harvested by hand with a twisting motion. The stem is trimmed and the mushroom is usually graded straight into boxes for transport and sale. Mushrooms are highly perishable and should be marketed as soon as possible after harvesting [3].

The nutritional value of product should be considered in relation to the complete menu. It is the combination of different food vitamins and protein. Some mushrooms are considered to healthy food because they contain vitamins B1, B2, C and Minerals and have a low content of fats. Mushroom cultivation can help reduce vulnerability to poverty and strengthens livelihoods through the generation of a fast yielding and nutritious source of food and a reliable source of income [5].

Since it does not require access to land, mushroom cultivation is a viable and attractive activity for both rural farmers and semi-urban dwellers. Small-scale growing does not include any significant capital investment: mushroom substrate can be prepared from any clean agricultural waste increasing food and income security through incorporating mushroom into livelihoods strategies. Case studies of successful outcomes from growing mushrooms as a livelihood demonstrate the benefits arising from mushroom production in terms of income, food security and consumption of healthy food [1].

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Materials and Methods

Construction of controlled environment

Controlled environment rooms were required for efficient product of high quality mushroom. They were grown in specially constructed shed.

Procedures for constructing controlled environment

The procedures for constructing the controlled environment for the mushroom included the following:

- Site selection and preparation.
- Building construction.

These included the following:

- Marking out the land using pegs, line, rope and tape rule.
- Digging of the foundation.
- Mixing and pouring of concrete to make the foundation of the building.
- Laying of the foundation.
- Setting of bricks.
- Setting of planks/timber.
- Roofing the building using Adex material.

The reason for using adex is to control the heat transfer and to raise the humidity within the building.

Factors considered in constructing the controlled environment for mushroom

According to the literature review, there is no standard size or design of building for mushroom culture:

- Door was designed to suit all and equipment that is used.
- Construction cost.
- Rodent proof.
- Provision of darkness.

Material selections

In selecting mushroom for this project work, mushroom was grown under controlled environment. The following factors were considered for species of mushroom grown:

- The waste material readily available to use as growth medium.
- What kind of facility or environment is available.
- Cost of production.

Experimentation

The spawn mother used for this work was Pleuroteus species sourced from the Mycology Department, faculty of Microbiology, University of Ibadan (UI), Ibadan, Oyo State. Nigeria.

Bottles were washed with detergent and drained. They were then sterilized in an autoclave at temperature 2000°C for 30 minutes. After the completion of the sterilization, the bottles were removed from the autoclave and placed on a sterile board to cool.

Cotton waste was soaked for 15 minutes in clean water and then washed, squeezed to remove water from the cotton waste until it barely produces droplet of water. 1200 g of cotton waste was weighed, filled inside the sterilized bottle, the mouth were then covered with aluminium foil paper and carefully tight with rubber band. These were taken into autoclave and sterilized at 121°C for 15 minutes and then allowed to cool in sterile board. This was in the inoculating room where inoculating loop was flamed with Bunsen burner to kill the microorganism that might have attached to the material which can contaminate the spawn. The flame loop was cleaned with spirit, dipped into the spawn bottle and mixed with already prepared cotton waste.

Rice bran, wheat bran and Cotton waste were also soaked in water overnight in a different clean basin with water covered the waste. The soaked materials or waste were filled and drained by squeezing it between palms to flush out the water this was done until the materials or waste produced droplets of water, 1200 g of the each materials were weighed, bagged and sterilized or autoclaved for 15 minutes at 121°C. Then was allow to cool in an inoculating room and inoculated with spawn mothers.

Maize cob was grinded using mortar and pestle in order to break it into pieces. The grinded maize cob were then soaked in water overnight and drained by squeezing it between palm until the cob were able barely produced droplet of water 1200 g of grinded maize cob were weighed, bagged and autoclaved or sterilized for 15 minutes at 121°C, and allow the autoclaved material to cooled then inoculated with spawn mother.

Rice bran was mixed with maize cob in equal proportion of percentage 50%, each of the resultant mixture was wet with water until it was handful just barely produced droplet of water between the palms. Hence 1200 g of the wet mixture were weighed and bagged; it was then autoclaved for one hour at 121°C to kill the microscopic spore that may be present. The autoclaved mixture was then taken into the inoculating room and also allowed to cool, then inoculated with spawn mother.

The sterilized cotton waste was filled into the bottle and inoculated with spawn mother, cover with foil paper and stored in an incubator for two-three weeks (2-3 weeks) as shown in Figure 1. Pleurotus Sajuca jar used in this project was tested on the different substrate in other to know its suitability.

Harvesting

Mushroom were ready for harvesting when it has finally matured, the period of maturation was indicated by folding of the tip of the pileus, harvesting was done with the aid of hand and scissors to prevent tearing of substrate with mushroom when harvesting. The mature mushrooms were ready to be picked up after 2-3 weeks of first appear as shown in Figure 2.

Mushroom Processing

After harvested the mushroom it was transported to where it will be processed immediately. Once selected the mushroom are prepare for the processing. The mushroom can be eaten freshly by cooking or by preserving it for future use.

Processing of fresh mushroom storage

The fresh mushroom (Figures 3-5), were stored in two ways to know the best way for storing the mushroom:

a. By refrigerating

b. By drying

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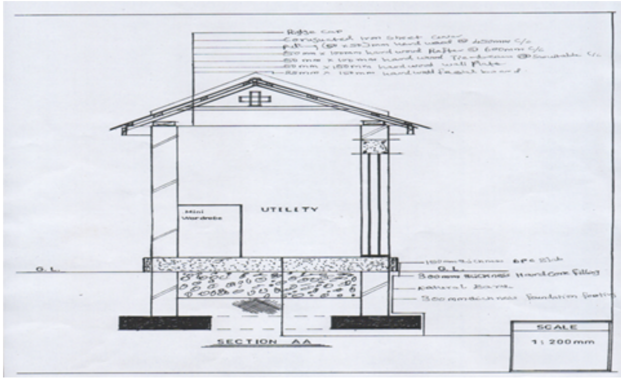

Figure 1: Cross sectional view of the constructed building.

Figure 2: Sterilized cotton waste.

Figure 3: After two-three (2-3) weeks in incubating room.

Figure 4: Matured mushroom.

Figure 5: Harvested fresh mushroom.

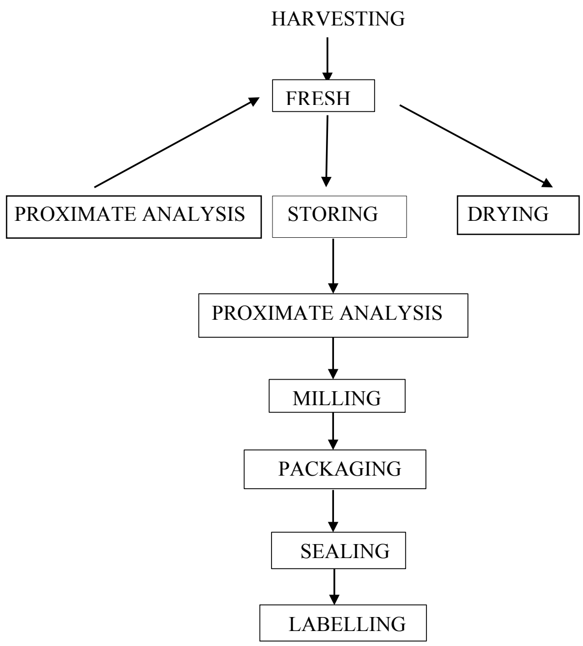

Figure 6: Flow chart of processing of mushroom.

By refrigerating: 2 g of freshly harvested mushroom was taken immediately into refrigerator for freezing.

By drying: Two method of drying were employed on the freshly harvested mushroom which are sundry and oven drying.

Sun drying: 3 g of freshly harvested mushroom was sun dried and the rate of weight loss at regular interval was monitor and recorded.

Oven drying: Laboratory oven was used to carry out drying at three levels of temperature 60°C, 105°C and 120°C for 3 g of freshly harvested mushroom.

Milling of dry mushroom

The dried products obtained from the oven were further milled into powdering form-using blender.

Packaging and sealing

After harvesting, drying and when subjected to grounding. The dried grinded mushrooms were weighed 10 g each, packed inside transparent nylon, and sealed using sealing machine. Thus, stored in a dust-free environment (Figure 6).

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Determination of the engineering properties of mushroom

The following engineering properties of the mushroom were determined:

1. Physical properties of mushroom.
2. Biochemical properties.

Physical properties of mushroom: The following properties were determined on mushroom, which are:

- Mass
- Volume
- Density
- Surface Area
- Sphericity
- Shape
- Diameter
- Thickness
- Height

Biochemical properties:

Proximate analysis: The proximate analysis of fresh, dried and frozen mushroom was carried out. The following parameters were tested under the proximate analysis.

1. Moisture content: This was determine using the relationship:

$$Percentage\ moisture\ = \frac{\text{initial weight} - \text{final weight}}{\text{Initial weight}} \times 100$$

$$\%MC_{wb} = \frac{W1 - W2}{W1} \times 100$$

2. Ash content:

$$Percentage\ Ash\ = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

3. Fat content

$$Percentage\ Fat\ = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

4. Crude protein: This was given using the relation 1 ml of 0.1 M + HCl = 0.0014 gN

   D = Dilution factors

$$= \frac{\text{Dilution of Digest}}{\text{Weight of Acid used}}$$

5. Carbohydrate: Percentage available carbohydrate

= 100 – (%moisture + %Ash + %protein + %fibre)

Results and Discussion

The physical properties determined on the harvested mushroom, which were: Sphericity, Shape, Diameter, Mass, Thickness, Density and height. The cost implications were estimated.

The following properties were determined on mushroom and also the cost of cultivating mushroom, which are shown in Tables 1-4.

Biochemical Properties

Proximate analysis

The nutritive value of fresh, dried, and frozen mushroom were carried out as shown in Table 2.

Discussion

From Table 1, the total cost for the construction of the controlled environment for the experimental set-up for the mushroom was #48,000. The average mass of mushroom harvested was 0.278 kg while 0.005 kg of mushroom was found to be #250 in Afe Babalola Farms. That means that, for 0.278 kg, it`s selling cost is going to be #13,900 as compared to the production cost of #9,950. The profit realized from the initial production, is going to be #3,950. But for subsequent production, the profit realized would be higher. This is because some items purchased can be used more than once and there are some that are fixed such as the sterile bottles.

During drying, the heat does not have effect on nutritive value when dried at lower temperature preferably 60°C but when the temperature is higher, it loose some of its nutrients [6]. At lower temperature, there is slight change in colour, but when subjected to high temperature the colour of the samples were changed from grayish to chocolate colour. The heat does not have effect on nutritive value when dried at lower temperature preferably 60°C. For the purpose of this research work, indirect expenses were not incurred such as transportation; in the sense that where the spawn were procured was nearby and in terms of labour, it was carried by us with thorough supervision.

S/N	Item	Quantity	Unit price(₦)	Amount(₦)
1	Blocks	300	100.00	30000:00
2	Cement	2	2500:00	5000:00
3	Nail	½ pack	1000:00	1000:00
4	Adex Roofing sheet	6	1500:00	9000:00
5	Plan	1	_	2500.00
6	Disinfectants	2	_	500.00
	Net total			**48,000**

Table 1: Bill of engineering material (cost of building materials).

Parameter	Result
Height (mm)	0.00497
Volume of mushroom top (mm^3)	2.95×10^{-11}
Volume mushroom stem (mm^3)	9.85×10^{-12} -7
Surface area of the con (mm^2)	4.61×10
Average mass of fresh mushroom harvested (kg)	0.278
Density (kg/m^3)	7.083×10^{-9}

Table 2: The physical properties of the harvested mushroom.

Samples	%Ash	%Protein	%Fat	%Crude fibre	%Moisture Content	%Carbohydrate
Fresh	2.0	4.0	5.0	3.0	85.0	1.0
Dried	3.0	6.0	6.0	4.0		
Frozen	1.0	4.0	5.2	2.9	86.3	0.6

Table 3: Nutritive value.

S/N	Item	Quantity	Unit price(₦)	Amount(₦)
1	Sterile bottle	40	50:00	2000:00
2	Polyethylene	½ roll	_	_
3	Spawn mother	9 bottles	700:00	6300:00
4	Substrate	_	_	_
5	Sack bag	5	50:00	250:00
6	Cotton waste	2 bag	250:00	500:00
7	Wheat bran	5 kg	50:00	250:00
8	Spirit	1	150:00	150:00
9	Foil paper	_	_	500:00
	Net total			9,950:00

Table 4: Cost of mushroom cultivation.

Conclusion

Since mushroom cultivation is a profitable agro-industrial activity, it could have great economic and social impact by generating income and employment for both women and youth, particularly in rural areas in developing countries. The mushroom industry can also have even broader positive spill-overs, generating complementary employment in areas such as accommodation, restaurant services etc.

Conclusively, the total cost for the construction of the controlled environment for the experimental set-up for the mushroom was #48,000 while the total selling cost for the harvested mushroom was found to be #13,900 as compared to the production cost of #9,950 thus, making a profit of #3,950. For subsequent productions, the profit realized would be higher.

Recommendations

For the production of mushroom to serve as means of solving economic challenges in Nigeria, the following recommendations were made:

i. Select appropriate target strains of different mushrooms grown on seasonal basis so that an attempt could be made to obtain yields all year-round.

ii. Make use of existing lignocellulosic residues and waste from agricultural activities and agro industries.

iii. Create employment opportunities, particularly for women and the youth in rural areas, and control/reduce pollution.

iv. Emphasize quick-investment-return mushrooms, and select relatively fast growing species that can be harvested within 3 to 4 weeks after spawning, thus generating immediate benefits.

v. Promote mushrooms species demonstrated to generate potent nutriceuticals with superior immune-enhancing attributes: species whose natural products include unique bioactive compounds that can make people healthier and fitter.

References

1. Elaine M, Nair NG (2009) Make money by growing mushroom. Rural Infrastructure and Agro-Industries Division Food and Agriculture Organization of the United Nations FAO.
2. http://www.agrodep.org/sites/default/files/Adetola%20Adeoti_0.pdf
3. Duggar VS (2000) Growing Shiitake Mushroom in a continental climate (2nd edn.). Field and Forest Products, Peshtigo, WI.
4. Oei P (2003) Manual on mushroom cultivation: Technique species and opportunities for commercial application in development countries. TOOL Publications, Amsterdam, The Netherlands.
5. Roger W (2000) Medicinal mushrooms you can grow. The Cariaga Publishing House, London.
6. Manoj K, Anupama S, Deepti, Vipul (2009) Effect of drying conditions on mushroom quality. G. B. Pant University of Agriculture & Technology, India.