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Mushroom Production for Food Security in Nigeria

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Abstract
This paper focused on mushroom production for food security in Nigeria. Mushroom cultivation has found a niche among small scale famers. Previously there were picked from wild forest, but now, many farmers are growing mushroom for their nutritional value as well as for medicinal purposes. The requirement for mushroom production which are spawn, substrate, and compost are identify and the categories of edible mushroom, the button mushroom (Agaricu Bisporus) and oyster mushroom (Pleurotus Sp.) were also identified. Constraints to production include lack of quality spawn, problem of pest and disease, complex process of obtaining loan and lack of proper skills in production. Recommendations were made around the aspects of training on mushroom cultivation, financial institutions should make loans flexible to farmers, government should encourage the use of laboratories to produce and distribute spawn and government should consider mushroom productions as an agricultural activities. It concluded that, mushroom farming may flourish like mushroom growth in the coming years; if the problems identified and attended urgently and remedial measures are undertaken at the earliest.
Keywords: Mushroom: Production: Food: Security: Food security.

INTRODUCTION

Mushrooms are fungi. They belong in a kingdom of their own called fungus, separate from plant and animals. Fungi differ from plant and animals in the way they obtain their nutrients. Mushrooms are fleshly fungi forming umbrella like fruiting body. They do not have green chlorophyll and so do not manufacture their own foods. It possess microscopic spores, which serves as a means of reproduction. Chang Shu-Ting and philop (2004) stated that mushroom are widely distributed in the temperate and tropical regions. Mushrooms are of different kinds. The edible mushroom have medicinal importance while the others are non-edible.

Mushroom are of various types and have various names. Some of them are known as filled mushroom, pore mushroom, tooth fungi and toadstool. Commonly edibles fungi are called mushroom while the poisonous are referred as toadstools. According to Chang and et al (2004) mushroom may seem to sprout overnight, it actually takes days or weeks for one to develop. Most of the growth of a fungus goes unnoticed because it occurs underground. The underground body of a fungus, called the mycelium, is made of moist thread like filaments. When growing conditions are good, little knots of hyphae called primordial are formed. As individual primordial grow larger, the hyphae within them grow and develop into two parts. One part will become a mushroom's cap, and the other, its stem. When the primordium gets large enough, the stem elongates and pushes the cap up above the ground. As the stem elongates, the cap expand, a little like an unfolding umbrella.

The food value of mushroom varies according to species. The chemical components of mushroom which include proteins, vitamins, fats, carbohydrates, amino acids and minerals (Chang, Shu-Ting and Philop, 2004).

According to Rambelli and Menini (1985), on an average, the protein value of mushroom is twice as that of potatoes and cabbage four-time as that of tomatoes and carrots, six-times as that of oranges. Analysis shows that 53 nitrogen compounds are found in a single strain of Agaricusbisporus. Mushrooms contains 206.27mg of vitamin C per 100mg of fresh fruiting body. Mushrooms contain thiamin, riboflavin, niacin and ascorbic acid, all essential for human health. The most common fats are also available in different mushrooms (Chang, 2004). The carbohydrate varies from three to 28 percent. The mineral content is superior to that of meat and fish and nearly twice as that of the most commonly used vegetables. Mushroom are medicinal, they serve as possible sources of antibodies and anticancer agents. Mushrooms has been used for healing purpose for thousands of years. The carbohydrate rate in mushroom is very low, therefore these are mainly recommended to diabetic and anemic patients, owing to their high folic acid content. (Hudler, 2000). Mushroom can be used for dyeing wool and other natural fibers. The chromophores of mushroom dyes are organic compounds and produce strong and vivid colours and all colours of the spectrum can be achieved with mushroom dyes. Before the invention of synthetic dyes, mushroom were the sources of many textile dyes (Mussak and Bechtold, 2009).

Mushroom production create a zero emission, that is adjusting and maintaining a dynamic balance within the ecosystem by turning waste into something useful in a sustainable manner. Mushroom production provides gainful employment to youth and rural women. It can earn foreign exchange from exports as well as reducing food scarcity in the society. Production in the context of this paper is the process of growing mushroom for human consumption. It also involves the marketing and distribution of the products. Food scarcity on the other hand in the context of this paper is a situation when all people at all times have both physical and economic access to the basic food that meets their dietary requirement for healthy life. (Food and Agricultural Organization, 1992)

Mushroom are fleshy and edible fruits bodies of several species of macro fungi (fungi which have fruiting

structures they are large enough to be seen with the naked eye). They can appear either below ground or above ground where they may be picked by hand (Chang, 2004). Apart from the numerous benefits of mushroom, to man, the production of mushroom has not been fully patronized. People still depend on the wild grown mushroom which has made the commodity to be scarce and expensive. The production of mushroom by farmers would have helped to reduce food scarcity in the society.

Types of Mushroom

They are two types of mushrooms edible mushrooms and poisonous

Edible mushroom include many fungal species that are either harvested wild or cultivated. Easily cultivated mushroom and common wild mushroom are often available in market and those that are more difficult to obtain may be collected on a smaller scale by private gatherers. Some preparation may render certain poisonous mushroom fit for consumption. Before assuming that any wild mushroom is edible, it should be identified. Proper identification of a species is the only safe way to ensure edibility. Some mushroom that are edible for most people can cause allergic reaction in some individuals and old or improperly stored specimens can cause food poisoning.

How to Identify Poisonous Mushroom

If the mushroom is black in colour, this is suspected to be a poisonous mushroom

Any mushroom in the wild that is not eaten by insect or animals. Mushroom with milky juice when cut is suspected to be poisonous mushroom. Mushroom with bad odour or taste. When you spread local onions juice on a white mushroom and it turn black, it is suspected to be poisonous. Any mushroom that is stranger to you, before you eat it, let a second person see it. Take the mushroom for a test.

Most mushroom sold in the supermarkets have been commercially grown by mushroom farmers. The most popular of these is AgaricusBisporus is considered safe for most people to eat because it is grown in controlled, sterilized environment. Several varieties of Agaricusbisporus are grown commercially. Mushroom can be grown all year round given that the right factors for cultivating are in place. Mushroom are cultivated in at least 60 countries with Chinese, the United State, Netherland, France and Poland being the top five producers in the year 2000 (Koyyalamudi, Jeong, song, Cho and Pang, 2009).

Mushroom can be cultivated on a wide range of medium (substrate) depending on the species. They grow in certain seasons of the year. Mushroom can be grown by almost anyone and anywhere (Volk, 2001).

In recent years, increasing affluence in developing countries has led to a considered growth interest in mushroom cultivation which is now seen as a potentially important economic activity for small farmers (Haas and James 2009). Mushroom cultivating creates a zero emission situation that is adjusting and/or maintaining a dynamic balance within the ecosystem by turning waste into something useful in a sustainable manner. Mushroom cultivating provides gainful employment to youths and rural women. Mushroom can earn foreign exchange from exports (Venturella, 2006).

Mushroom production can provide sustainable income to the family. The family is a group of people affiliated by birth, marriage or co-residence. Members of the immediate family may include a spouse, parent, brother and sister, son and daughter. As a result of daily increasing expenses and inflation. The family need an extra income to sustain themselves. Therefore sustainable income means an income that is available for some time.

This days, there is high cost of living. Even those working their income cannot sustain them, they need extra income to survive. Example a teacher in Ebonyi State primary school earns 45 thousand naira per months and have a family size of 7, the income cannot sustain him/her, the needs extra income to survive that is why this paper is focus on the requirement for mushroom production, categories of mushroom, and the techniques of their production, identification of poisonous mushroom, problems of growing mushroom and possible solution to the identified proble

Cultivation of Mushroom

Requirements for Mushroom Cultivations

Spore (Spawn)

What spawn is to mushroom is like seed is to crop. Unlike spore, spawn is already at its mycelial stage growing on its own substrate such as sorghum, barley or sawdust. The life cycle of mushroom starts from spores, but growers inoculate mycelialorigin spawn rather than spore origin spawn because of possible variations and mutations. The quality of spawn is one of the most decisive factors for successful crop. Therefore, growers need to use qualified spawn for commercial production. Spawn should maintain the strain characteristics and is propagated by subcultures. New strains are developed with genetic methods such as variation and mating. The various types of mushroom spawn include grain, sawdust, plug and liquid (James 2009).

Substrate

Mushrooms can be classified into 3 categories by their tropic pattern; saprophytes, parasites or mycorrhizae. The most commonly grown mushrooms are saprophytes, decomposers in an ecosystem growing on organic matters like wood, leaves and straw in nature. Raw materials can be used as substrate for primary decomposers such as oyster mushroom and enokitake. On the other hand, secondary decomposers like button mushroom or straw mushroom require substrate degraded by bacteria or other fungi. Mushroom requires carbon, nitrogen and inorganic compounds as its nutritional sources and the main nutrients are carbon sources such as cellulose, hemicellulose and lignin. Thus, most organic matters containing cellulose, hemicellulose or lignin can be used as mushroom substrate. Examples are cotton, cottonseed hull, corncob, sugarcane waste, sawdust, and so on. However, demanded amount of each nutritional sources differs according to mushroom species. For example, button mushroom (Agaricusbisporus) requires relatively high nitrogen source, so the optimal C/N ratio of button mushroom compost is17. On the other hand, oyster mushroom and shiitake require less nitrogenand more carbon source(James 2009). Mushroom mycelia secrete digestive enzymes into the substrate and absorb the dissolved nutrients. Cellulose, the main nutritional source of mushroom is one of the most abundant organic matters on earth, but its digestive enzyme, cellulase is owned by several microorganisms including fungi. Here comes the reason mushroom is considered an important food source. Mushroom is the only one by which cellulose is dissolved and absorbed and transformed into food for mankind. Mushroom is also influenced by acidity of substrate. The optimal pH value of substrate ranges from 6 to 8, varying with mushroom species (James 2009).

Environment

The last important factor for mushroom growing is providing an appropriate environment both for vegetative and reproductive growth. Not being protected by a skin layer, fungi are easily affected by their growing conditions. So it can be said that the success or failure of mushroom cultivation depends on the control of growing conditions. Environmental factors affecting mushroom cultivation include temperature, humidity, light and ventilation. Optimal levels of them at vegetative stage differ from those at reproductive stage. Mushroom mycelia can survive between 5 and 40°Cdepending on the species. Mushroom mycelia grow well with the temperature range between 20 and 30°C. Pins form at 10-20°C, lower than that of mycelial growth by 10 °C. Over 80% of the fluid body is water. Substrate moisture content should be 60-75% (James 2009). During fruiting, different relative humidity levels, ranging from 80-95%, are needed at the early, mid and later stage. Though mycelia can grow without light, somespecies require light for fruit body formation. Being aerobic fungi, mushrooms need fresh air during growing, butventilation is more required for reproductive stage.

Among the three factors, the most important is environmental control. By maintaining optimal conditions at each growing stage and for each species,growers can produce the desired yield of quality mushrooms, (James, 2009).

Steps in Mushroom Cultivation

1. **Choosing the mushroom to be cultivated.**
   - Prevailing climate conditions
   - Availability of substrate for growing the chosen mushroom species (distance in obtaining substrate, cost etc.
   - Acceptability of the mushroom
   - Market for the mushroom
2. **Preparation of spawn**
   - Mushroom spawn is the mushroom mycelium growing in a given substrate.
   - It serves as the planting material in mushroom cultivation
   - Production of spawn is a separate activity from the actual mushroom cultivation.
3. **Preparing the Compost**
   - Pile up substrate material for a period of time to produce a selective medium for growth of the mushroom mycelium.
   - In some cases, complete sterilization or pasteurization of the substrate is done to eliminate organisms that will compete with the mushroom mycelium.
4. **Spawning/Spawn Run**
   - During spawn run, the mushroom mycelium will further break down the substrate and absorb simple molecules into the mycelium for further growth and development.
   - Length of time for spawn run differ from mushroom to mushroom.
5. **Harvesting**
   - After full mycelia development when the substrate has been fully colonized or penetrated by the mushroom mycelium, mushroom begin to form (Lull 2005).

Categories of Mushroom

Button mushroom (AgaricusBisporus)

Oyster Mushroom (Pleurotus Species)

http//www.foodreference.com/htm/a.mushrooms-ff0408.html

The button mushroom (AgaricusBisporus) and Oyster Mushroom (Peurotus Species)

This variety mushroom grows on piles of decaying sawdust, coffee pulp, sugar cane bagasse, oil palm waste, cassava wastes etc. The mycelium grows outward towards the sunlight, which stimulates the growth of small nodules called pin-heads. The pin-heads eventually grow into the fruity body. The young mushroom has an egg shape and it is covered with a thin membrane called volva.

Low temperatures (25-27^{0}C)

Slow development and high temperature (28-35^{0}C) hastens the rate of growth (Hass and James, 2009).

Methods of growing straw mushrooms

1. Traditional method

Materials needed:

- Mature mushroom for seed (spawn)
- Substrate/culture materials:
- Cassava wastes
- Dried banana leaves
- Oil palm waste (bunch waste and fibre waste)
- Dried rice straw
- Cotton waste
- Cocoa placenta
- Chopped coca pods
- Sugar cane bagasse etc.
- Water, Boxes-60cm long, 45cm wide, 20cm deep
- Shovel, pick-axe or hoe

- Fresh banana leaves.
- Transparent plastic sheet (Fereira 2010)

Techniques

According to Lull, (2005), make a bed foundation made from soil, bamboo or wood. The soil foundation is made by elevating 5cm surface area with a width of 50-60cm and an approximate length of 2-3cm. soak the culture materials in water for about 3-4 hours then allow to drain (combination of the culture materials) place the substrate on the bed or wooden frame, press to a height of 10cm, for the first layer.

1. Mushroom spawn (seed preparations). Mash the mushroom caps and dissolve in one gallon of water sprinkle the solution on the substrate.
2. Place another layer of substrate and still sprinkle the solution. Repeat to have 4-6 layers.
3. Water the bed and repeat water application weekly.
4. Cover the bed with transparent plastic sheet and straw on top of the sheet on the 7th day, raise the plastic sheet and other covering materials 15-20cm (6-8inches) above the bed to allow more air in and to reduce internal temperature.

Note- for spawn run, optimal temperature range is 35-38^{o}C in the middle of the beds for 4-6 days.
Alternatively, cover the beds with and bamboo frame stretched with plastic sheet.

5. Wait for 2-3 weeks to harvest. Harvest of the first flush lasts for about 3 days. The second flush will appear 7 days after.

Note-A block of 30cm x 100cm x 30cm can yield 1kg/block in a harvest of 2-3 times yield depends on the substrate material used. When the mushroom pin-head appears stop watering to avoid destroying the mycelium.

2. Modern Method of Growing Mushroom

Materials needed:

- Culture material listed above
- Wood frame or basket with no bottom
- Transparent plastic sheet
- Mushroom spawn

Techniques

1. Place the wooden frame (any size) in the cultivating site i.e. open field, bare ground or in a shed with a cement floor.
2. Soak the culture material /substrate for 4 hours or overnight depending on the material.
3. Allow to drain and place in a wooden frame. Press to a height of 10cms.
4. Sprinkle spawn along the edges. This is the first layer.
5. Add another layer of culture materials and repeat the spawn application.
6. For the third and final layer, add more culture materials and sprinkle the spawn over the entire surface.
7. Remove the frame and repeat the procedure to make more beds.
8. Cover the set of beds with the plastic sheet.
9. Place dry straw, grass or straw mat over the plastic sheet to protect the beds from sunlight and wind.
10. On the 7th day, raise the plastic sheet to 15-20cms (6-8inches) above the beds to allow more air in and to reduce the internal temperature.
11. 4-7 days later, mushrooms should be ready to harvest. The second flush will appear 7 days later.

Problems of Growing Mushroom

All though the nature of problems varies with the extent and type of mushroom growing. The general problems being faced by mushroom growers and farmers could be;

1. Lack of good quality spawn: The yield of mushroom to a great extent depends upon quality of spawn. Spawn is not easily available and it is being produced by very few government departments and private producers. The mushroom growers have to travel 300-500km to procure it. Thus, spawn is usually procured by mushroom growers with great difficulties.
2. Problems of pests: Insect are another pest that can significantly affect mushroom production. Ants and termites are the two main insect pests of mushroom. They can cause problems for farmers growing mushroom by eating the growing substrate and, in some cases, the spawn, greatly reducing potential mushroom production. Insect problems are easily prevented by following good sanitation practices at the cultivation site. To maintain hygienic condition in the village situation, is very difficult and thus chance of occurrence of pests.
3. Complex process of obtaining loan: Mushroom growers who want to expand their temporary mushroom farms and those who want to start a fresh are usually unable to invest the required amount of money from

his own pocket. Therefore, they approach the financial organization to obtain loan for this purpose.

4. Lack of low cost mushroom farm design: A scientifically designed mushroom farm needs heavy investment and hence is out of reach of small & marginal mushroom growers/farmers. Therefore, there should be a low cost mushroom farm design available, based on locally available material and as per local climatic conditions (Borchers, Krishnamurthy, Keen, Meyers and Gershwin 2008).

Conclusion

In view of above facts, mushroom farming in our country may flourish like mushroom growth in the coming years if the problems identified and attended urgently and remedial measures are undertaken at the earliest. The process has already begun and gained momentum during the last three years. The rural and urban masses are showing much interest in mushroom cultivation and eager to adopt it as an occupation. The States having tropical climate are also coming forward for growing other kinds of mushroom.

The prospects of mushroom farming will be much brighter in the coming years, if the interest of people is sustained and the problems being faced by established mushroom growers are addressed in the ways suggested here.

Possible Solution and Recommendations to the problems of mushroom production

1. As the spawn production process is complex and laboratory based activity hence, the government can make best use of already establish laboratories to produce and distribute spawn in the locality. The university are already producing and providing seeds of cereals, vegetables and fruits to the farmers. Thus mushroom seed (spawn) can also be included in their existing system.
2. Training on mushroom cultivation is a pre-requisite to start mushroom cultivation. Hence, ministry of agriculture (Department of Horticulture) should organize at least on training programme every year at the Local Government level with the help of trained S.M.S
3. The financial institution should make their loan sanctioning system flexible to suit the farmers. These organizations and N.G.Os should also work to motivate farming community to form "self-help groups" which will act as local body to assist financing organization as well as farming community to obtain and repay the loans in time.
4. A notification should be issued to all the Government Institutions/Department and financial Institutions to consider the mushroom growing as an agricultural activity so that mushroom could avail the facilities being provided in the agricultural sector like crop loans.
5. Even after receiving the training, the farmer is not so confident that he could prepare compost himself. In this situation, he will always prefer to buy readymade compost. The State Department of horticulture can fulfil this requirement by setting up a mother composting unit at the ministry of Agriculture which will also provide an opportunity to the trainees to learn through work experience.

These suggestions will certainly help in diffusing the mushroom cultivation at a faster rate among urban and rural masses if the government organization take care of them. Since the government organizations have their well establish networks, they can exploit the system for encouraging mushroom farming as an income generating activity among the urban/rural masses to alleviate poverty at the grass-root level (Borchers et al, 2008).

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