



MUSHROOM CULTIVATION: PANACEA FOR POVERTY ALLEVIATION

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Abstract

Mushroom is the most popular, delicious, nutritious and medicinal vegetable in the world. Recently, it is considered as the most promising concept for crop diversification. It has been regarded as an effective means for poverty alleviation in less developed countries due to its potential for a quick, high return of profit on a small investment. Nigeria is one of the most suitable countries in the world for Mushroom cultivation due to its favourable climate, cheap raw materials and labour cost and moderate market price. It is such an income generating concept that can alleviate poverty and eradicate malnutrition. It can also create employment opportunities for all classes of people, educated and uneducated youth, persons with disabilities and adolescent men and women respectively. The primary objective of this paper is to create awareness on poverty alleviation, unemployment and malnutrition through cultivating and selling mushroom. The review reveals that Mushroom cultivation can open a new opportunity for landless and unemployed people as it does not require any cultivable land and can be grown in a room by racking vertically. It is possible to make a handsome profit by investing a small amount of capital and labour in Mushroom cultivation.

Keywords: Mushroom, Poverty Alleviation, Unemployment, Malnutrition, Profitability.

Introduction

Mushroom resources have been exploited in most developed economies because of their huge agro-industrial, medicinal and commercial benefits. Nigerians utilized mushroom-forming fungi only for food and folk medicine for many decades. *Auricularia auricular Judae* (Bull.) Quél., *Lentinus squarrosulus* Mont., *Pleurotus tuberregium* (Fr.) Singer and *Volvariella volvacea* (Bull.) Singer were some of the common edible mushrooms that were successfully cultivated in Nigeria on small-scale basis. The mushroom resources in Nigeria are grossly under-studied and their attractive potentials under-exploited for addressing economic and industrial development. Resourceful biotechnological approach in the application of mushrooms in agriculture, medicine, industry and environment is inchoate and uncommon in the country.

Mushrooms are widespread in nature and they remain the earliest form of fungi known to mankind. In Nigeria, many people in both urban and rural areas are familiar with mushroom-forming fungi growing around them some of which they exploit for food and medicine.

This practice although reported all-over the country is more pronounced amongst the Yoruba speaking people (Alabi, 1991). Concomitant varieties of mushrooms i.e. lichenized, mycorrhizal, parasitic and saprotrophic that abound in Nigeria have continued to gain recognition and elicit different interests and questions as potentially resourceful tool in economic modulation pari passu prevailing reliance on leafy plants. It is saddening to see that people from all works of life associate mushrooms with negative events in Nigeria and most African countries (Yongabi et al., 2004; Akpaja et al., 2005). This image, in addition to the slow development of mushroom cultivation practices is changing due to reports elsewhere in the world that illuminate potentials of mushroom-forming fungi and mushroom products and their uses in different spheres of human welfare (Wainwright, 1992; Robert and Hajek, 1993; Wasser, 2007). This is apart from their hitherto pivotal roles in sustaining eco-energy balance in nature (Jumpponen et al., 2004).

In Africa, mushroom resource exploration and exploitation is fraught with lack of infrastructure and technical supports from national and international agencies, scarcity of mushroom scientists, poor political and legislative support, poor knowledge of mushroom biodiversity due to dearth of mushroom taxonomists and bad press reports amongst others (Laberere and Menini, 2000). The most popular edible mushroom in Nigeria is the sclerotium-forming *Pleurotus tuberregium* (Fr.) Singer which is eaten as food and/or used as food supplement (Gbolagade et al., 2006). The sporophore is used as a good substitute for meat protein in several suburban Nigerian soups by locals (Ene-Obong and Camovale, 1992). Its popularity as food in many rural villages especially in the south zone of the country is ascribed to its substrate propensity, rapid growth, fruit-body longevity, incidences and distribution pattern (Zoberi, 1973; Osemwegie et al., 2006). Other edible mushrooms consumed in Nigeria include *Agaricus* spp., *Auricularia auricular Judae* (Bull.) Quél., *Collybia butyracea* (Bull.) P. Kumm., *Coprinus atramentarius* (Bull.) Fr., *Coprinus picaceus* (Bull.) Gray, *Lactarius trivialis* Fr., *Lentinus squarrosulus* Mont., *Pleurotus pulmonarius* (Fr.) Quél., *Pleurotus ostreatus* Jacq., *Macrolepiota* sp., *Psathyrella atroumbonata* Pegler, *Schizophyllum commune* Fr., *Termitomyces clypeatus* Heim., *Termitomyces globules*

Heim & Gooss, *Termitomyces mammiformis* Heim., *Termitomyces microcarpus* (Berk. & Br.) Heim, *Termitomyces robustus* (Beeli.) Heim, *Tricholoma* sp., *Volvariella volvacea* (Bull.) Singer and *Volvariella esculenta* (Mass.) Singer (Amanita mushrooms which were labeled poisonous in many parts of the world have been reported in Nigeria by Zoberi (1973) and elsewhere in Africa (Morris, 1990) to have species that are consumed as food. In the same vein, *Chlorophyllum molybdites* also featured amongst edible mushrooms analyzed for their nutrient contents in Nigeria and considered safe for consumption (Fasidi and Kadiri, 1995; Aletor and Aladetimi, 1995). The edibility of Amanita and *Chlorophyllum* species earlier reported as poisonous elsewhere in the world by Nigerians is not totally understood but it is believed that the controversy may stem from any one or combination of factors relating to environment, genetic and physiological differences which were determinants of tolerance level to toxins amongst racially, geographically and traditionally varied people. The method of preparation of these mushrooms, insufficient expert taxonomist and/or poor identification method coupled with the use of monographic/taxonomic books on western mushroom taxa for naming indigenous African macro fungi may also have been responsible for this contention (Osemwegie and Okhuoya, 2009).

Mushroom (*Agaricus bisporus*) production is a lucrative and profitable cottage industry for low income rural households (Lelley, 1988) and this industry is providing full and part time employment to rural and urban poor and marginal people in many developing countries (Ferchak and Croucher, 2001). Now mushroom is being cultivated in more than 100 countries of the world and the estimated total production is over 12 million tons (Suman and Sharma, 2007).

Mushroom is considered as one of the important food items since ancient time and its consumption is being increased over the period for its significant role in human health, nutrition and diseases (Suzuki and Oshima, 1976; Uddin, et al., 2011).

The edible mushrooms are also good source of protein, vitamins and minerals (Khan et al., 1981). Recently, unemployment is increasing rapidly both in developed and developing countries. In this situation, self-employment can be one important way to increase employment rate for small, marginal poor farm households for generating employment and earning extra money. They can easily cultivate mushroom in their home yard because it requires small piece of land where mushrooms can be grown. However, market linkage is the most appropriate in the context of the farmers' involvement and the market to supply goods to consumers (KIT et al., 2006; and Shepherd, 2007). Usually, marketing channel links the producers and consumers, and thereby supplying goods from producers to consumers. A large number of intermediaries are involved in the marketing channels and they earn their daily livelihoods. A few studies have been conducted which have focused on the production system of mushroom in Bangladesh (Kamal et al., 2009; Zamil and Cadilhon, 2009; Amin, 2002; Amin and Ruhul 2008; Sarker et al., 2007; and Uddin et al., 2011). In addition, a large number of researchers have been conducting research on mushroom related production system and management (Bano et al., 1979; Block et al., 1958; Han et al., 1977; Jong and Peng, 1975; Khan et al., 1981) in India, Nepal, China, Philippines, Thailand, Taiwan, Hong Kong and Pakistan. Work is also being done on human health, nutrition and diseases in other countries in the world (Agrahar-Murugkar and Subbulakshmi, 2005; Cheung and Cheung, 2005; Gunde-Cimerman, 1999; Hawksworth, 2001).

Edible Mushroom Varieties in Nigeria

In Nigeria, a great quantity and variety of edible and medicinal mushrooms are sourced from the wild due to recent mushroom farming culture. This practice (mushroom scouting/hunting) existed for decades spanning generations and mostly embarked upon by children and women (Okhuoya, 1997). About twenty-five edible mushroom species of good repute whose knowledge were handed down generational lines via oral communication have been identified in Nigeria. (Labarere and Menini, 2000). Osemwegie et al. (2006) stated that edible mushrooms collected from various farmlands, forests and plantations may be sold or cooked fresh, after treatment with warm salt water, with the addition of essential ingredients like pulped pepper, tomatoes, onions, salt and oil or smoked and/or sun-dried for later use. The reliance on naturally growing edible mushrooms has greatly undermined the development of mushroom cultivation to a commercial scale despite available substrate materials in some African nations. Despite the fact that about 20% of the world's population was reported by Labarere and Menini (2000) as starving, African nations are still lacking amongst the mushroom exporting nations of the world. Tapping into the benefits of commercial mushroom production in Nigeria will reduce the country's unemployment rate; increase her food security and revenue base while bridging her rural-urban mycophagy gap. The number of cultivable edible mushrooms worldwide amounts to over a hundred with an annual production of over 4.5 million tons and still increasing (Flegg, 1992; Labarere and Menini, 2000; Mshigeni, 2005). The provision of safe sustainable access to edible and medicinal mushrooms in Nigeria can be achieved in a number of ways which may include:(i) by promoting opportunities for co-operation between all stakeholders such as the mushroom farmers, researchers/mycologists, politicians and other mushroom prospectors (marketer, NGOs and government agencies on agriculture, youths and women etc.) in the country;

(ii) through the creation of public enlightenment initiatives via talk shows on the positive potentials of mushrooms and mushroom products in radio and television programs, monthly newsletter, seminars and workshops. This will remove the negative publicity associated with mushrooms, increase market sources of edible mushrooms, limit the dangers associated with mushroom hunting from the wild and improve awareness on both the nutrient quality and benefits of mushroom consumption; (iii) by developing a model that allows for spawn availability to farmers and steady flow and/or exchange of proprietary culture (mother cultures and pure-lines). This is in addition to the cross fertilization of cultivation technologies between developing and industrial nations, and creation of recognized indigenous mushroom growers association. The establishment of sustainable regional mushroom germplasm banks and research centers to maintain mushroom genetic stability, quality control of mushroom culture collections and spawn, and preservation of cultures of extant and extinct mycoresources can also enhance the overall uses of mushrooms in the country. One cannot but add that the elevation of mushrooms to a cash-crop status in Nigeria requires improved political will and solid infrastructural (steady electricity, flowing water, buildings etc.) setting. These will have unprecedented impact on the development of the country's mushroom industries in providing food, drugs and chemicals. It will equally offer opportunity for conservation strategies and preservation of mushrooms that will add value to medicine, pharmacy, industries and agriculture.

Despite the high level of progress made through the Global Network on Mushroom Research and Development under the aegis of Food and Agricultural Organization (F.A.O.) and the advancement of mushroom cultivation industries in many developed nations, growing mushrooms in homes or even on a commercial scale is still uncommon in Nigeria. Researchers are therefore challenged to reduce dependence on naturally occurring mushrooms, the incidences of mushroom poisoning and expand the nation's edible and medicinal mushroom base. Many indigenous edible mushrooms heritage and knowledge may have escaped recognition and documentation and/or completely lost over the years. Although, few works such as Akpaja et al. (2003, 2005), Okhuoya and Akpaja (2005) and Osemwegie et al. (2006), a long-term study on the ethno mycological, taxonomic and myco-diversity profile of indigenous mushroom resources on a national scale will form the inertia for mushroom prospecting initiatives and successful exploitation in developmental economic issues in Nigeria.

Mythological and Medicinal Mushrooms: Traditionally, mushrooms are used for nutritional, medicinal and mythological benefits in Nigeria (Alabi, 1991; Akpaja et al., 2005; Osemwegie et al., 2006). Labarere and Menini (2000) acknowledged that the uses of mushroom genetic resources are not only of high interest in agronomy, agriculture, human food and animal feed but also for the discovery, production and development of molecules or components with high added value in industries such as chemical and pharmaceutical industries. A model that shows the interaction between maximal utilization of mushroom resources that yields economic benefits and their exploration is attempted. This emphasized the relative significance of field study and effective documentations as the bedrock for efficient mushroom exploitation. The nutrients and toxicological profile of edible wild mushrooms in Nigeria have been studied (Aletor, 1995; Fasidi and Kadiri, 1995). There is however dearth of information on the anti-oxidant property of edible and medicinal mushrooms indigenous to Nigeria.

The level of mushroom nutraceuticals on a global scale confirmed that mushrooms are good health food and reports abound in Nigeria on their use for the treatment of malnutrition in infants, diabetes, obesity or hyperlipidemia, sterility, anemia, mumps, fever and protein deficiency (Akpaja et al., 2005; Okhuoya and Akpaja, 2005; Idu et al., 2007). Zadrazil (1984) reported that mushrooms can also be used in improving the digestibility in ruminant animals. Recently, Ganoderma species have been successfully tested in poultry farming for the improvement of egg-laying and disease resistant capacity of birds in Nigeria (Ogbe et al., 2008). Although the locals and other folk medicine practitioners demonstrated deep knowledge of the medicinal use of mushrooms (Osemwegie, et al, 2006; Idu et al., 2007), they are however ignorant of the active principle(s) responsible for the remedy observed. This inherited knowledge has been a source of wealth and reference for practitioners. Prolific discoveries of value added products e.g. ergot, cordycepin, cyclosporine, griseofulvin and other antitumour, antiviral, immuno-modulator, hormonal and antimicrobial products used in medicine and/or pharmacopeias elsewhere in the world are however challenging (Wainwright, 1992; Jonathan and Fasidi, 2005; Gbolagade et al., 2007). Furthermore, the 2009, 2nd African Conference on Edible and Medicinal Mushrooms revealed that Beta-glucan based dietary supplements of mushroom origin are effective for the treatment of Buruli ulcer caused by *Mycobacterium ulcerans* in Ghana while *Ganoderma lucidum* (Leyss.) Karst. tested in separate study for the treatment of *Eimeria tenella* infected broiler chickens in Nigeria (unpublished). Documentations of their uses in the treatment of both human and animal ailments and/or on the production of drugs (molecules) in Nigeria are scanty.

Nigeria by virtue of its vantage tropical location is one of the world's potential hotspots for various forms of biological resources including mushroom (Myers et al., 2000; Akpaja et al., 2003). This position is also derived from the diversity of vegetation i.e. savannah, rainforests, riparian forests and mangroves that characterized Nigeria (Osemwegie et al., 2006; Osemwegie and Okhuoya, 2009). Currently, the exploitation of indigenous

Nigerian mycoresources is still over-shadowed by the preponderance of green plants. Vigorous researches on these easily-overlooked forest members might evolve an accidental source of drugs that would resolve the world's cancer, AIDS and leukemia problems. The poor knowledge and documentation of mushroom uses in health-care delivery coupled with the lack of up-to-date inventory on mushroom taxa in Nigeria impairs government efforts at developing complimentary (folk) medicine practices to the level witnessed in China and other Asian countries (Chang and Miles, 1991). Mushrooms are great source of vitamin B including riboflavin, niacin and pantothenic acid which help to provide energy by breaking down proteins, fats and carbohydrates. Vitamin B also plays a significant role in the nervous system.

Agro-Industrial Wastes, Agriculture, Poverty Alleviation and Mycorestoration: One of the strongest technical points recently advancing mushroom production in Nigeria besides improving food options is the conversion of ordinarily valueless or toxic wastes of diverse origin to value added products via a perm culture system. Nigeria by virtue of her population size generate several tons of agricultural, industrial, municipal and domestic wastes that overwhelms the nation's waste disposal machinery and are potentially degradable by mushrooms (Okhuoya and Okogbo, 1991; Okhuoya et al., 1998; Osemwegie et al., 2002). These wastes are tried as substrates or solid-waste substrate supplements and/or ingredients for compost in mushroom cultivation.

Mushroom-forming fungi are gaining global popularity in both liquid fermentation of industrial effluents and many lignocellulosic wastes such as waste papers, banana and plantain leaves, and/or peelings, sawdust of different tree origin, oil palm fruit fibres, bunches and cakes, (Oei, 1991; Okhuoya and Okogbo, 1991; Okhuoya et al., 1998; Osemwegie et al., 2002;). There are huge potential socio-economic benefits associated with the effective and efficient bioconversion of agro-industrial wastes to valued edible sporocarps (Chang and Miles, 1991). The growth of mushroom production industries and the use of agro-industrial based substrate as the major raw material may provide a partial solution to the nation's waste management problems and pollution challenges, poverty and rising youth unemployment. The potential use of spent substrates in crop farming as soil conditioner and/or mycorrhization practices have also been emphasized by Labarere and Menini (2000) and Wasser (2007). Mycorrhization by spore has been successfully adopted in Congo and South Africa in *Pinus* agroforestry with *Pisolithus tinctorius* (Marx et al., 1993). Documented account in forest and/or agro forest management in Nigeria is dearth despite high incidence of mycorrhiza mushrooms. To fully tap into the verse mycorrhization potentials of mushrooms, it is significant to improve the nation's knowledge of mycorrhizae diversity and mycorrhizian status of many indigenous Nigerian trees via further studies. Spent substrates derived from a few small-scale mushroom cultivation farms across the country also have been poorly exploited as sources of single-cell protein, animal feeds, organic manure, soil amendments/conditioner and biofuel in Nigeria as observed in some developed nations of the world (Zadrazil, 1984; Labarere and Menini, 2000). This is attributed to inchoate mushroom production, accessible alternatives such as fertile lands, manure from animal dung and chemical fertilizer, annual national output of used composts and substrates coupled with a lack of technical knowledge on sustainable re-use of spent substrates in the country.

Human activities have been reported to impact negatively on arable lands contaminating them with pesticides, petroleum hydrocarbons, heavy metals and waste engine oil pollutants, and consequently causing arable land shortage and other environmental challenges. A survey of land use practices in Nigeria revealed that bush fallowing is more popular in addressing the problems of contaminated (polluted) and/or low-yield agricultural lands. This practice according to Adedokun and Ataga (2006) allows for the slow process of natural restoration or remediation. Other strategies reportedly used in recovering contaminated farmlands are capital and labour intensive and this include excavation followed by incineration and/or secured land-filling (Adedokun and Ataga, 2006). These methods currently undermine bioremediation posed varying degree of environmental problems to humans. Therefore, the replacement of bush-fallow system with bioremediation in rehabilitating polluted arable land is slowly being embraced as a faster, cheaper and more environment friendly method in Nigeria. Mushrooms through the evolution of specialized feeding habit or saprotrophism along with other plant resources have been tested in this regards. *P. tuberregium* and *P. pulmonarius* were the most widely used mushrooms in bioremediation studies in the country (Anoliefo et al., 2003; Isikhuemhen et al., 2003, Adedokun and Ataga, 2006). There is however no documentation on the use of indigenous Nigerian mushrooms bio pulping and delignification process. The observation made by Okolie and Gbuji (2002) that some indigenous mushrooms recorded non-toxic level of cyanide gave credence to the bioaccumulation potential of mushrooms. Ukpebor et al. (2007) has also implicated mushrooms in cassava processing. The ex situ application of mushrooms in tackling various oil-spill and heavy metal contamination challenges in Nigeria is uncommon due to failure of field trials of laboratory results (Oghenekaro et al., 2008).

The use of mushroom-forming fungi in Nigerian agricultural practices is still undefined in the areas of pest and disease control despite reports that *Cordiceps*, *Gibellula*, *Beauveria bassiana*, *Leptinortarsa decenliniata*, *Pseudogibellula* are entomogenous (Thorn and Barron, 1983). Some wood-decaying fungi occurring in Nigeria e.g. *Pleurotus*, *Schizophyllum* and *Hohenbuehelaria* are nematophagous - utilize the nutrient in nematodes to

supplement the low level of accessible Nitrogen in their wood substrate (Robert and Hajek, 1993). Few achievements have been recorded using different species of Nigerian mushrooms as antagonist of other harmful pathogens of both plants and animals.

Sources of information on African mushroom germplasm collections, taxonomy of African mushroom taxa and how they have been exploited are scanty (Labarere and Menini, 2000). This lends credence to the fact that systematic documentation of mushroom diversity and conserved data will inspire maximum utilization of mycoresources in Nigeria. Data on mushrooms do not yet compare to those of plant genetic resources around the globe. Although, Nigeria actively contributed to the global plan of action on the state of the world's plant genetic resources, it is still ranked low amongst the few nations of Africa yet to place national ex situ collections under the auspices of the F.A.O and develop their own gene bank. The reason for this may be political or attributed to lack of technical knowledge and assistance in the areas of sampling, identifying and preserving mushrooms. Indigenous Nigerian mushrooms are limited to food and folk medicinal uses as well as for income through their sales in village markets. This may have been the reason why conservatively speaking, only roughly less than 20% of the potentials inherent in Nigerian mushroom genetic resources have been tapped. A well established and sustainable national mushroom culture/germplasm bank will improve accessibility to strains that can add value to the growth of industries, economy, medicines, pharmacy, environment and agriculture while encouraging mushroom researches and explorations for human benefits.

Nigerian mycologists are therefore challenged to collaborate with mycological herbaria and international agencies such as the United Nations and Food and Agricultural Organization (FAO) for educational, scientific and technical support in the areas of training mushroom taxonomists and improving food security. This is primordial to solving national problems associated with hunger, poverty, economic development, diseases and unemployment using mushroom-forming fungi as veritable tool.

Conclusion

Since the soil and climatic condition of Nigeria are very suitable for mushroom cultivation, there is a very good prospect for Mushroom cultivation with the aim of earning income from the venture. It will serve as a source of food supplement to stem the tide of malnutrition also as a source of employment opportunities for educated and uneducated youths, persons with disabilities and every other category of persons. It can also serve as source of earning foreign currency by exporting Mushroom which will significantly contribute to the economy of the country. Therefore, government and private initiative are required to encourage people in Mushroom farming.

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