
Ethnostudy of mushrooms and establishment of pure culture of cantharellus species (Ero Umunwene) a newly discovered mushroom found in Ukwa-East, Abia State, Nigeria

Okigbo, R. N.* and Okigbo, J. E.

Department of Botany, NnamdiAzikiwe University, Awka, Nigeria.

Okigbo, R. N. and Okigbo, J. E. (2018). Ethnostudy of mushrooms and establishment of pure culture of cantharellus species (Ero Umunwene) a newly discovered mushroom found in Ukwa-East, Abia State, Nigeria. International Journal of Agricultural Technology 14(7): 1535-1560.

Abstract The investigation focused on indigenous knowledge of mushrooms and establishment of pure culture of *Cantharellus* species (Eroumunwene) a newly discovered mushroom found in Ukwa-East, Abia State. A well-structured questionnaire was designed to assist in obtaining crucial information from the people of the study area. Fresh mushrooms of *Cantharellus* species (Eroumunwene) were harvested from bush around Ohanso in Ukwa-East Local Government Area of Abia State. Mushroom samples were prepared for spore printing which were used in identification and characterization. Also establishment of pure culture using both tissue culture and spore culture methods were adopted. Descriptive statistics were adopted and relationships among some variable were checked with percentage error bars in MS EXCEL. Eighty-five (60.71%) of the 140 administered questionnaires successfully retrieved were fully responded to. The results were analyzed by gender, age groups, and locations. The people in the study area consume about fourteen mushroom species. The study showed that more than 85% of the respondents consume edible mushrooms because of its palatability and nutritional importance, also 23% respondents take them as substitute for meat, while 10% of the respondents consume mushrooms because of its medicinal purpose. The study also showed that more than 95% of respondents use sun drying, 13% use refrigeration, 9% make use of flaming, 1% oven dry while 2% of the respondents use salt solution to preserve harvested mushrooms. Over 87% and 54% of respondents regarded mushroom hunting as work for young women and children respectively. More than 84% of the respondents have interest in mushroom cultivation. Pure culture of *Cantharellus* species was not established. The residents of Ukwa-East Local Government Area of Abia State have indigenous knowledge of mushrooms and their uses. However, further studies on establishment of pure culture are highly recommended.

Keywords: mushrooms, ethnostudy, *Cantharellus* species, pure culture, Abia state

Introduction

Davis and Aegerter (2000) defined mushroom as the fruit of certain fungi analogous to apple on a tree. As a fungus, mushrooms lack chlorophyll and can

* **Coressponding Author:** Okigbo, R. N.; **Email:** okigborn17@yahoo.com

be found thriving on dead organic matter such as wood, rice straw, plantain leaves, and orange leaves (Okigbo *et al.*, 2012). Most mushrooms belong to the Basidiomycota division. The part of the organism that we see and call mushroom is really just the fruiting body. Unseen is the mycelium – tiny thread that grows throughout the substrate and collect nutrients by breaking down the organic materials (Ayman *et al.*, 2008). Okigbo and Nwatu (2015) defined ethno-study of mushrooms as the study of how people of a particular location and culture utilize indigenous mushrooms. Ethno-study also involves studying the description, biology, nutritional values, medicinal properties, cultivation, storage, and benefits of consumption of mushrooms to human beings (Okigbo and Nwatu, 2015).

Relative to plants and animals, information on diversity of fungi is scanty (Lodge *et al.*, 1995), especially in Africa (Osemwegie and Okhuoya, 2009; Musieba *et al.*, 2011). This has been attributed to the higher interest in plants and animals as sources of food and medicine for man (Osemwegie *et al.*, 2010). Wasser (2002), and Shelley and Geoffrey (2004) stated that about 140,000 mushroom species exist in the world, out of which only about 10% are taxonomically classified. Nigeria by virtue of its vantage tropical location is one of the world's potential hotspots for various forms of biological resources including mushrooms (Myers *et al.*, 2000; Akpaja *et al.*, 2003). This position is also derived from the diversity of vegetation, namely: Savannah, Rain forests, Riparian forests and Mangrooves that characterized Nigeria (Osemwegie *et al.*, 2006; Osemwegie and Okhuoya, 2009).

World Bank (1992) noted that the widespread of malnutrition with ever increasing protein gap in our country has necessitated the search for alternative sources of protein. This is due to the high population growth, the production of pulses has not kept pace with our requirements, and the animal protein is beyond the reach of most people in this country; owing to the fact that most of the people (over 86%) live below poverty level. Edible mushrooms are recommended by the Food and Agriculture Organization (FAO) as food, contributing to protein nutrition of developing countries dependent largely on cereals (FAO, 2006). Oei (2003) maintained that edible mushrooms are highly nutritious and can be compared with eggs, milk and meat. Mushrooms are however economically useful not only for their splendid taste but also serve as good healthy supplement (Gbolagade *et al.*, 2006). Studies have been carried out on the application of mushrooms as sources of mineral (Iron, Calcium and Phosphorus), Vitamins (B, C, and D) and treatment of certain diseases of mankind such as cancer, asthma, coughs and diabetes in some parts of Nigeria (Akpaja *et al.*, 2005; Ayodele *et al.*, 2007; Oghenekaro *et al.*, 2010).

The practice of traditional mushroom hunting from the wild, when in season is still prevalent (Bilal *et al.*, 2010; Ayodele *et al.*, 2011) and the harvest is either used fresh by the locales for nutritional and medicinal purposes (Odebode, 2005; Okhuoya *et al.*, 2010) or retailed in local markets to augment family income (Osemwegie and Okhuoya, 2009; Okhuoya *et al.*, 2010; Osemwegie *et al.*, 2010). However, cultivation of indigenous species of edible and medicinal mushrooms has become very urgent in order to prevent them from extinction caused by indiscriminate bush burning, urbanization, over exploitation and deforestation (Okigbo and Nwatu, 2015). Okhuoya *et al.* (2010), stated that vigorous researches overlook these forest members which might evolve an accidental source of drugs that would resolve the world's cancer, and Leukemia problems. Mushrooms are low in cholesterol and offer promising opportunity to discover anti-cancer genes and pathways (Borchers *et al.*, 2004) thereby improving the quality of the diet of the people and also provide remedy for some killer diseases. The level of mushroom nutraceuticals on a global scale confirms that mushrooms are good health food and information 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; Idu *et al.*, 2007) improving the treatment of diseases using fungal drugs.

Apart from the nutritional value and the medicinal uses, many workers like Atlas and Bartha (1992); Isikhuehmen *et al.* (2003) and Adenipekun (2008) have cited the uses of mushroom in bioremediation exercises. Also mushroom cultivation serves as the most efficient and economically viable biotechnology for the conversion of lingo-cellulose waste materials into high quality protein food (Fasidi and Ekuere, 1993; Hussain, 2001; Okigbo *et al.*, 2015). With this, new job opportunities will naturally open up especially in rural areas. The growth of mushroom production industries and the use of agro-industrial substrates as the major raw materials may provide a partial solution to the nation's waste management problems and pollution challenges, poverty and rising youth unemployment (Nwordu *et al.*, 2013) and though knowledge of mushroom ecology and distribution are not only important for the successful conservation and management of the ecosystem but also for the optimum exploitation of the many benefits to mankind.

In FAO (2006) documentation on mushroom, indigenous mushrooms have been named based on size of basidiocarp, structure, substrate, season they appear or any other unique features. However, scientific classification using coloured photographs, written description of the macro-morphology, microscopic examination of spore prints, tissues and spore forming structures have been reported by FAO to be more globally acceptable. Akpaja *et al.* (2014)

observed that with the large number of tribes in Nigeria with different traditional, cultural and linguistic inclinations, that there is a dearth of information in the scientific literature on the indigenous uses and knowledge of mushrooms. There is also a poor documentation of ethno-knowledge among our people, which is still contributing to the loss of vital information (Okhuoya and Akpaja, 2005). The dearth of such information on Nigeria's rich mycoflora contributed in some part of the poor status of the mushroom industries in the country (Okhuoya and Iskhuemhen, 1999).

Despite all these, the indigenous knowledge about edible mushrooms, as well as their uses in food and medicine has not been given significant attention in Nigeria and in Africa at large (Akpaja *et al.*, 2014). However, the ethno-mycology of mushrooms of some tribes have been reported by various authors in Nigeria. Ethno-mycology of edible and medicinal mushrooms are reported among the Igbos (Akpaja *et al.*, 2003; Okigbo and Nwatu, 2015), Yoruba's (Oso, 1975; Alabi, 1990), Igalas (Ayodele *et al.*, 2011), Binis (Akpaja *et al.*, 2005, 2014; Okhuoya and Osagualekhor, 2005) Gbagyis (Asemota *et al.*, 2015) and Hausas (Okhuoya *et al.*, 2010). A catalogue and identification of some wild edible macro-fungi occurring in Nigeria has also been carried out by Nwordu *et al.* (2013).

The present investigation focused on the indigenous knowledge of mushrooms found in Ukwa-East, Abia State, Nigeria and establishment of pure culture of *Cantharellus* species (Eroumunwene) a newly discovered mushroom.

Materials and methods

Ethnostudy of Mushroom

The method of Akpaja *et al.* (2003) was used in the study area which involved the use of a well-structured questionnaire to obtain vital information from the respondents.

Study Area

The study area was Ukwa-East Local Government Area of Abia State, South-eastern Nigeria. Its Local Government Secretariat is in the town of Awkete. Its geographical co-ordinates is located between 4° 51' N and 7° 21' E. Ukwa-East has an area of 280km² and a population of 58, 865 at the 2006 census (Anon, 2016). The vegetation is that of a low-lying tropical rain forest with some oil-palm trees and also the annual rainfall is 2400mm especially intense between the months of April through October (Hoiberg, 2010). The soil

type is coastal plain sand with the texture being loamy sand with a pH of about 4.7 (Akpaja *et al.*, 2003).

Sampling Frame

The respondents to questionnaires were the people of Ukwa-East Local Government Area of Abia State, Nigeria. In this local government, all the people spoke Igbo as their language and they had similar cultural and traditional beliefs.

Questionnaire Administration

A well-structured questionnaire was designed to assist in obtaining crucial information from the people of the study area. Twenty (20) questionnaires were distributed each to the seven (7) different age groups making a total of one hundred and forty (140) questionnaires used in this survey. The age of respondents ranged from 25 to 85 years old. The questionnaires were constructed to get vital information as follows:

- a. Personal details of the respondents such as age, sex and educational qualification.
- b. Awareness of the possibility of mushroom cultivation.
- c. Interest in learning mushroom cultivation.
- d. Reasons for mushroom consumption.
- e. Mode of preparation and administration of medicinal mushroom and ailment treated.
- f. Number of mushroom consumed as food, their local names, meaning of the names and period during the year mushroom species are available or found in the wild.
- g. Methods of mushroom preservation and notable precaution taken before cooking.
- h. The age range that hunt mushroom most.
- i. Whether mushrooms are used as substitute for meat.
- j. Whether mushrooms are consumed by poor people alone.
- k. Whether mushrooms are used in religious rites.

Collection of Mushroom Samples

Fresh mushrooms of *Cantharellus* species (Eroumunwene) (Plate 1a) were harvested from bush around Ohanso in Ukwa-East Local Government Area of Abia State (Plate 1b-d).

Preparation of Mushroom Samples for Spore Printing

Harkonen *et al.* (2015) methods were adopted. Some mushrooms were separated into pileus and stipes. The pileus were used by placing the gills (fertile side) down on a white papers, covered with bowls to prevent air currents and left to stand in a corner for 24 hours.

Identification and Characterization of Mushroom Samples

The spore print and wild species of the mushroom (Plate 1e-g) were sent to Dr. E.O. Akpaja at University of Benin, Edo State for identification and classification of the mushroom.



Figure 1. Mushroom seen and harvested in the study area. [A] Freshly harvested *Cantharellus* species. [B-D] *Cantharellus* species growing in Ohanso forest floor. [E-G] Relative size measurement of *Cantharellus* species

Preparation of Media

The method of Cheesbrough (2004) was used in preparation of Malt Extract Agar (MEA) and Potato Dextrose Agar (PDA).

Pure Culture Establishment of the Mushroom

The method of Narh-Mensah and Obodai (2014) was used in establishment of pure culture using both tissue culture and spore culture methods.

Tissue Culture

Freshly harvested mushrooms were surface sterilized with 75% alcohol. Mushrooms were cut open longitudinally with sterilized blade. With the help of sterilized needle, tissues were taken from the upper part of the stipe and placed centrally on the surface of MEA and PDA media. The plates were closed, dated and incubated at room temperature of $29\pm 2^{\circ}\text{C}$ for mushroom mycelia to grow.

Spore Culture

The spores were scraped with sterilized blade from the spore print and put into a test-tube containing distilled water. The test-tube was shook and serial dilution was carried out. One millilitre was taken from the fifth dilution point (10^{-5}) and poured into each of MEA and PDA media. Sterilized hockey stick was used to spread the mixture and incubated at room temperature of $29\pm 2^{\circ}\text{C}$ for mushroom mycelia to grow.

Data Analysis

Descriptive statistics based on percentage of respondents, mean and standard deviation were used in analysing the results. Relationships among some variable were checked in MS EXCEL with Error bars using percentage bars.

Results

Table 1 shows the list of the mushrooms mentioned by the respondents of the questionnaire, it equally indicated their vernacular names, nearest in meaning or translation of such names in English, scientific names and availability of the mushrooms in the wild.

Eighty-five (60.71%) of the 140 administered questionnaires successfully retrieved were fully responded to. Figure 1 shows the percentage response by gender, having 40% response from male and 60% response from female.

From the questionnaires, respondents gave numerous reasons for consumption of edible mushrooms found in their communities, which include: substitute for meat, palatable taste, soup thickener, medicinal purpose and

Table1. Some edible and medicinal mushrooms found in the study area

Vernacular name	Closest meaning of the name	Botanical name	Time found in the wild
(<i>Eroosu</i>)	Produces from nowhere	<i>Pleurotus tuberregium</i>	Jan – Dec
(<i>Erobelebelentioke</i>)	Very soft and looks like rat eat	<i>Auricularia auricular-judae</i>	June – September
(<i>Eroami</i>)	Very beautiful with a chicken taste	<i>Termitomyces robustus</i>	Aug – September
(<i>Eromgbawala</i>)	Ground breaker, shows readiness of the land towards rainy season	<i>Termitomyces</i> sp	March
(<i>Eronkwu</i>)	Palm tree mushroom	<i>Volvariella volvacea</i>	Jan – December
(<i>Eroichikirichikwakwam</i>)	Sound it produces when chewed or hard when chewed	<i>Schizophyllum commune</i>	May – August
(<i>Eroogbammiriara</i>)	Produces substances like breast milk	<i>Lactarius</i> sp	January – March
(<i>Eroumunwene</i>)	It grows like elephant	<i>Cantharellus</i> sp	June – August
(<i>Erommanummanu</i>)	It is reddish like palm fruit		
(<i>Eroatachichianya</i>)	Hard and looking sideways when chewing	<i>Lentinus squarrosulus</i>	January – May
(<i>Eroatakataeloo</i>)			
(<i>Eroububa</i>)	Found on ububa tree	Unknown	January – June
(<i>Eroukwuijiji</i>)	Has tiny stem like mosquito legs	Unknown	Sept – November
(<i>Erodaamgbede</i>)	Beautiful like the evening sun	Unknown	March
(<i>Eronjatado</i>)	-	Unknown	December-March
(<i>Erokpumpum</i>)	-	Unknown	December

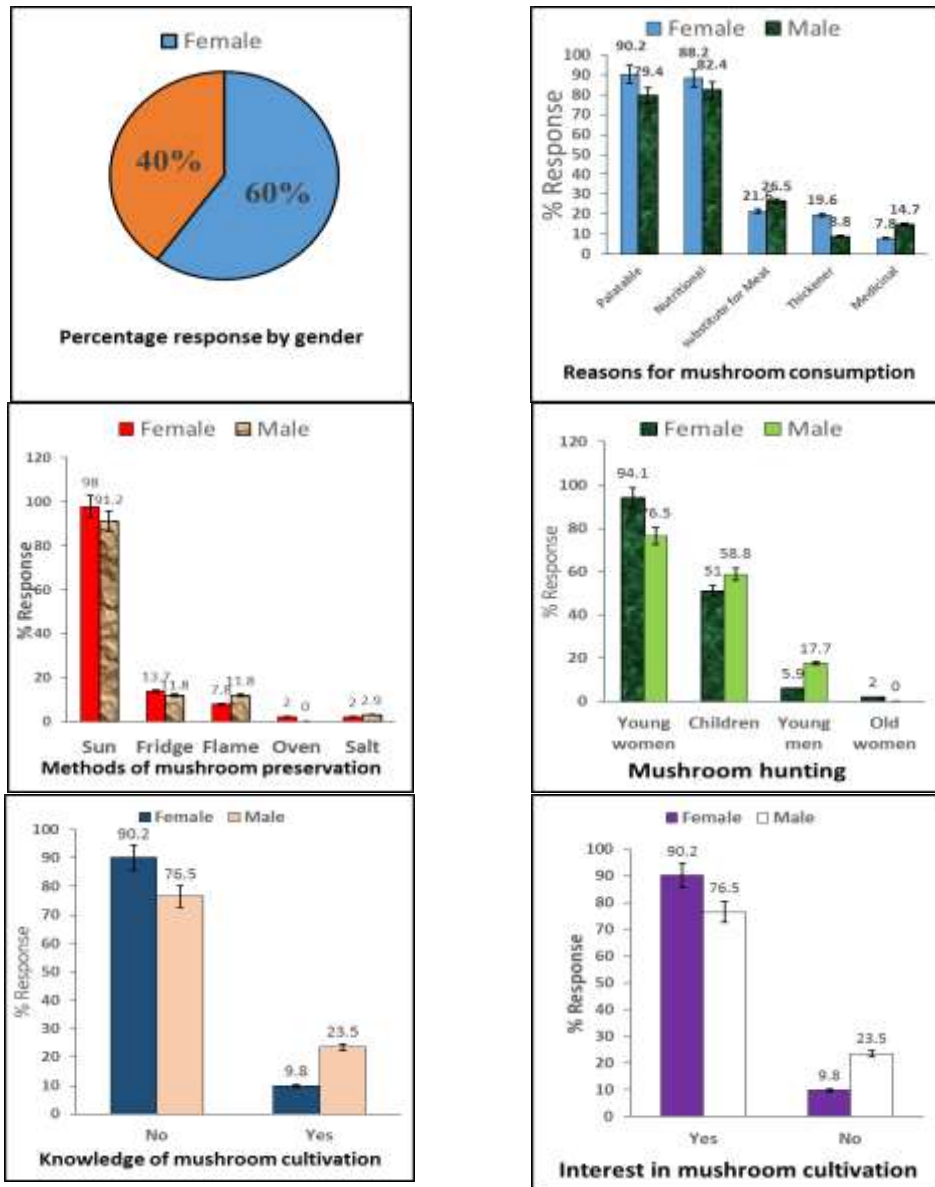


Figure 1. Percentage total response by gender; **Figure 1a.** Percentage consumption of mushroom for any reason by gender studied at 5% error bars; **Figure 1b.** Percentage of different methods of mushroom preservation by gender studied at 5% error bars; **Figure 1c.** Percentage opinion by gender on those involved in mushroom hunting at 5%; **Figure 1d.** Percentage response by gender on the knowledge of mushroom cultivation at 5% error bars; **Figure 1e.** Percentage response by gender on the interest in mushroom cultivation at 5% error

nutritional importance (Figure 1a). Palatable taste and nutritional importance were above 80% response in both gender while substitute for meat, soup thickener and medicinal purpose were below 30% response in both gender. There is a significant difference between reasons that were above 80% response and those that were below 30% response at 5% level of significant. Also there is no significance different between male and female responses among various reasons for mushroom consumption.

The indigenous knowledge of people on how to preserve mushrooms were studied which include: sun drying, over flame, refrigeration, oven drying and salt solution (Figure 1b). Sun drying is the highest in both gender with above 90% response while the rest of the methods have below 20% response in both gender. There is significant difference between sun drying and the rest of the methods in both gender at 5% level of significant. Also there is no significant difference between male and female responses among various methods of mushroom preservation.

Opinions of the residents on those particularly involved in the mushroom hunting were investigated. Young women tend to have the highest responses in both gender, though there is significant difference between female response and male response on young women (Figure 1c). There is no significant difference between female response and male response on the rest of the group that involve in mushroom hunting (children, young men and old women), though there is significant difference between response on young women and the rest of the group that involve in mushroom hunting in both gender at 5% error bar (Figure 1c).

Knowledge of the possibility of cultivating edible mushrooms which the residents in the study area collect from forest and consume revealed that male had more knowledge of mushroom cultivation when compared with female counterpart, therefore there is a significant difference between male response and female response on those that have knowledge of mushroom cultivation (Figure 1d). Equally there is a significant difference between those that have knowledge of mushroom cultivation and those that have no knowledge of mushroom cultivation in both gender at 5% error bar.

The interests of respondents in learning how to cultivate edible mushrooms they consume were surveyed. Female respondents have more interest in learning how to cultivate mushroom having 90.2% response compared to male that have 76.5% response. There is a significant difference between female response and male response at 5% error bar (Figure 1e). Also those that have interest in mushroom cultivation and those that have no interest in mushroom cultivation were significantly different in gender.

Figure 2 shows the percentage response by age group, responses between 30-79 years old had no significant difference but there is significant difference between age group (≤ 29 years, ≥ 80 years) and the rest of the age group.

On the numerous reasons for consumption of edible mushrooms found in their communities by the age group, palatable taste and nutritional importance were high across the age group and had no significant difference among them but were significantly different from the rest of the reasons across the age group (Figure 2a). Substitute for meat was high in age group ≥ 80 years old, also below 50% response between 30-79 years old and not noted in age group of ≤ 29 years old. Mushroom serves as thickener was observed only between 40-69 years old with below 40% response. Medicinal purpose as a reason was noted only within 40-49 years old and between 60- ≥ 80 years old with below 40% response (Figure 2a).

Based on different ways of preserving mushroom, sun drying had the highest response across the age group having above 80% response (Figure 2b). Refrigeration was high with 80% response within ≤ 29 years old, below 20% between 30-69 years old and absent from 70 years upwards. It implies that there is significant difference between ≤ 29 years old and the rest of the age group. Flaming cut across all age group with below 20% response except between 50-59 years old. Oven drying was only recorded within 50-59 years group having below 10% response. Equally using salt solution as a preservation method was only seen between 40-59 years old with below 10% response. There is significant difference between sun drying and the rest of the methods across all age group at 5% error bar (Figure 2b).

In mushroom hunting, all the age group recorded high for young women as those that involve in mushroom hunting. Children also recorded high across the groups though there is significant difference among the age groups. Young men had below 40% response between 30-49 years and 60-69 years but absent within groups of ≤ 29 years, 50-59 years and 70- ≤ 80 years. There is significant difference between age group 60-69 years and the rest of the groups. Old women was only seen in group 40-49 years with below 10% response. There is significant difference between responses on young women and the rest of the response across the age group (Figure 2c).

Knowledge of mushroom cultivation was surveyed among the age groups, 30-79 years old had the knowledge that mushroom can be cultivated having below 40% response with the highest occurring within 40-49 years group. There is significant difference between 40-49 years group and rest of the group that had knowledge of mushroom cultivation. In other hand, responses on the people that do not have knowledge of mushroom cultivation were high across the age groups. Therefore there is significant difference between the people that

have knowledge of mushroom cultivation and those that do not have at 5% error bar (Figure 2d).

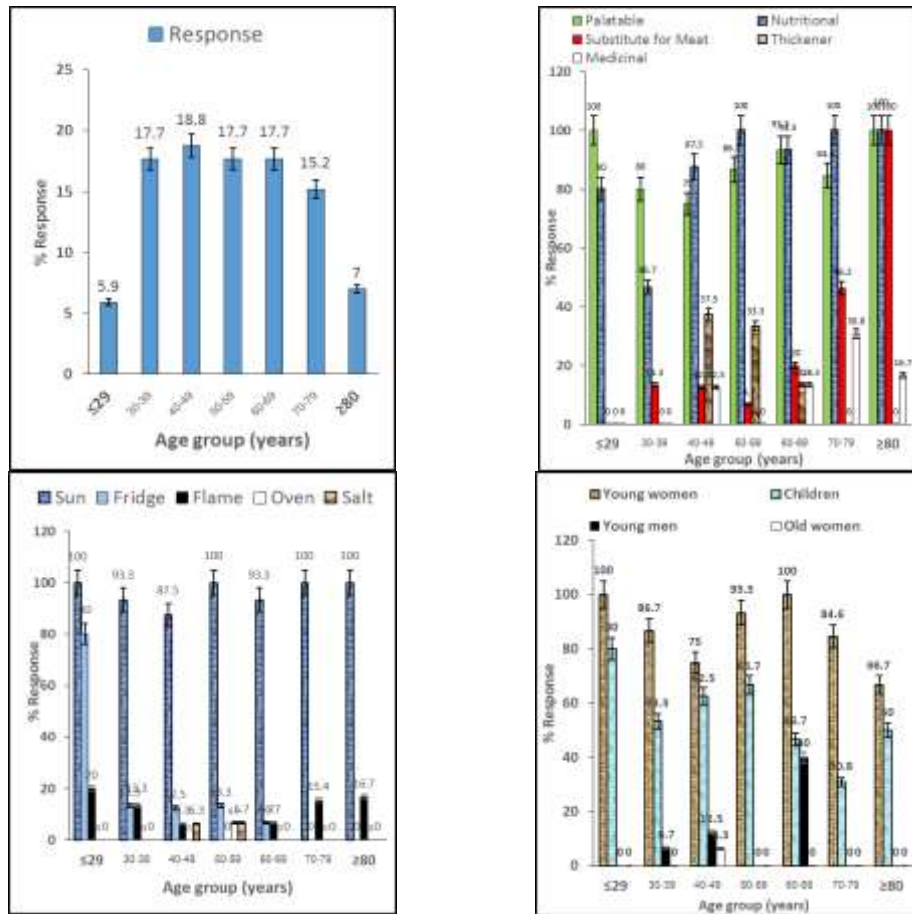


Figure 2. Percentage total response by age group at 5% error bars; **Figure 2a.** Percentage consumption of mushroom for any reason by age group studied at 5% error; **Figure 2b.** Percentage of different methods of mushroom preservation by age group studied at 5% error bar; **Figure 2c.** Percentage opinion by age group on those involved in mushroom hunting at 5% error bars

In the same way, interest in mushrooms cultivation was also checked. All groups had interest in mushrooms cultivation but there is significant difference between age group ≤ 29 -69 years and 70 years upwards. There are also people that do not have interest in mushrooms cultivation, group ≥ 80 years recorded high with above 60% response while group ≤ 29 years and 60-69 years recorded 0%. There is significant difference between people that have interest in mushrooms cultivation and those that do not have at 5% error bar (Figure 2e).

Responses that mushrooms consumption are food by poor people alone were only observed between 30-49 years having below 20% response. Also those that said mushrooms consumption are not food by poor people alone were high across the groups with above 80% response. There is a significant difference between responses that mushrooms consumption are food by poor people alone and those that said mushrooms consumption are not food by poor people alone across the age groups at 5% error bar (Figure 2f).

There is no knowledge of mushrooms used in religious rites across the age group. Therefore there is a significant difference between knowledge of mushrooms used in religious rites and no knowledge of mushroom used in religious rites across the age groups at 5% error bar (Figure 2g).

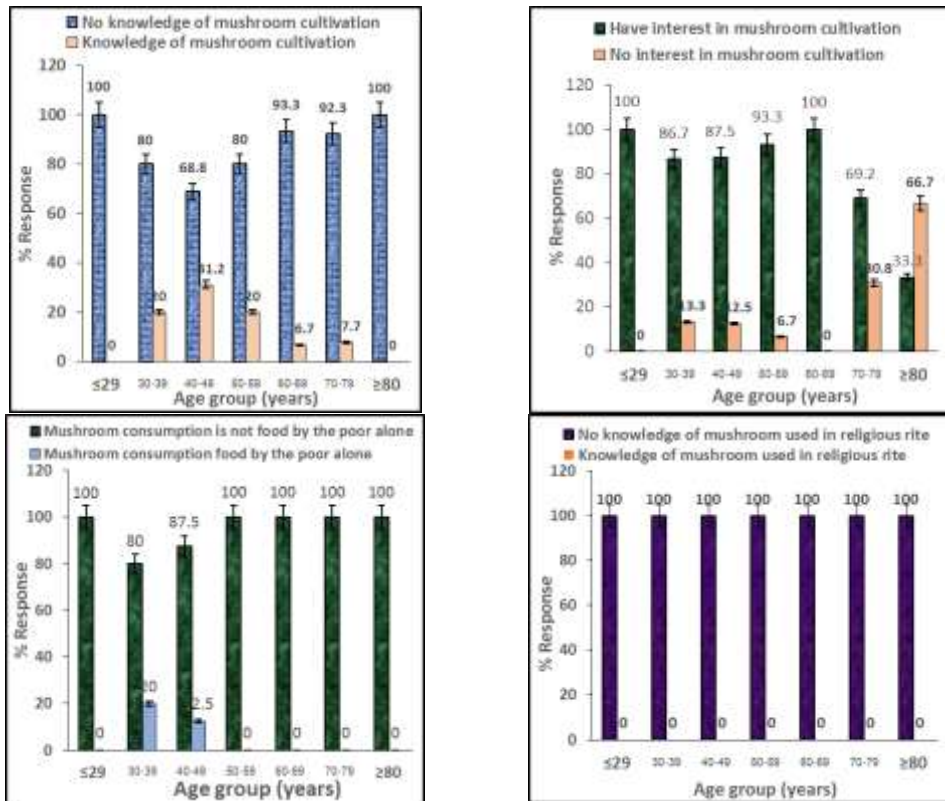


Figure 2d. Percentage response by age group on the knowledge of mushroom cultivation at 5% error bars; **Figure 2e.** Percentage response by age group on the interest in mushroom cultivation at 5% error bars; **Figure 2f.** Percentage ratio by age group on mushroom consumption by poor people alone at 5% error bars; **Figure 2g.** Percentage ratio by age group on the use of mushroom for religious rites at 5% error bars

Figure 3 shows the percentage response by location, Ohanso had the highest response with above 40% while Obunku had the lowest response with below 10%. There is a significant difference among the locations.

Reasons for mushroom consumption were checked among the locations. All the reasons for mushroom consumption were recorded in Akwete having nutritional importance as the highest, but there is significant difference among the reasons. Obohia recorded palatable taste, nutritional importance and substitute for meat as reasons for mushroom consumption. There is significant difference between substitute for meat and the other two reasons recorded in Obohia. Obunku recorded all the reasons for mushroom consumption having 100% response on palatable taste and nutritional importance, though there is a significant difference among the reasons. Equally Ohanso recorded all the reasons for mushroom consumption having palatable taste as the highest, but there is a significant difference among the reasons (Figure 3a). In palatable taste as a reason, all the locations recorded high with above 70% response, but there is significant difference between Akwete and the rest of location. Nutritional importance recorded high in all location with no significant importance. Substitute for meat had below 30% response in all location, though there is significant difference between Obohia and the rest of location. Soup thickener as a reason was not recorded in Obohia, Obunku had the highest response with above 70% and there is a significant difference among the location. Medicinal purpose was also not recorded in Obohia and all other location recorded below 20% response (Figure 3a).

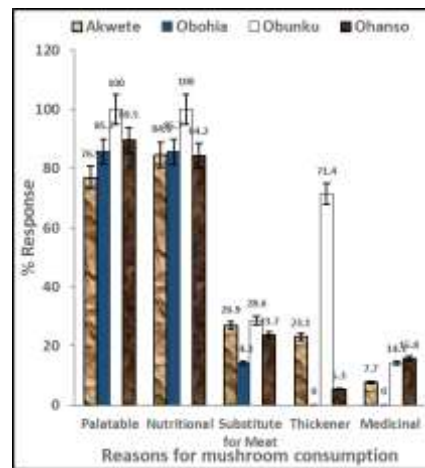
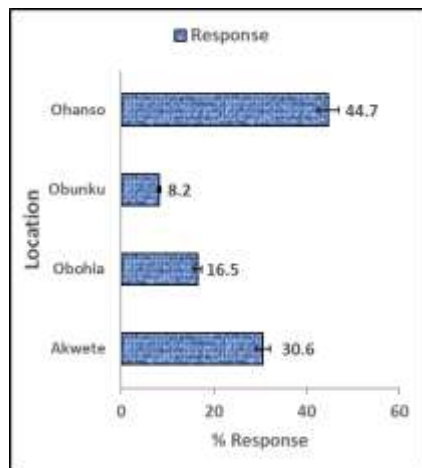


Figure 3. Percentage total response by location studied at 5% error bars; **Figure 3a.** Percentage consumption of mushroom for any reason by location studied at 5% error bars

Different methods of mushroom preservation were observed among the locations. Akwete recorded all the five methods of mushroom preservation having sun drying with over 90% response as the highest, there is a significant difference between sun drying and various other methods (Figure 3b). Obohia recorded sun drying and drying over flame as the only methods of mushroom preservation with significant difference between them. Obunku recorded sun drying with over 80% response, refrigeration and salt solution as the method of mushroom preservation with significant difference among them. Ohanso also recorded sun drying high, refrigeration and drying over flame as the methods used in mushroom preservation, there is a significant difference between sun drying and the other two reasons recorded in Ohanso (Figure 3b). All the locations recorded sun drying with no significant difference among them. Obohia had no knowledge of using refrigerator to preserve mushroom but there is significant difference between Obunku and the rest of the location. Drying over flame, oven drying and salt solution were below 20% response across the location (Figure 3b).

Surveys on the people that hunt for mushroom based on locations were recorded. Akwete recorded all the groups (young women, young men, children, old women) that hunt for mushroom having young women with the highest percentage response, but the groups differ significantly across them. Obohia had young women and children as the only groups that hunt for mushroom and they differ significantly. Obunku and Ohanso had all groups except old women as the people that hunt for mushrooms. They also differ significantly across the groups. All the locations recorded young women, but there is significant difference between locations (Akwete and Obohia) and (Obunku and ohanso). Also all the locations had children as the people that hunt for mushroom but they differ significantly among the locations. All the locations except Obohia recorded young men, though with below 30% responses. Only Akwete recorded old women with below 10% response (Figure 3c).

Knowledge of mushroom cultivation was surveyed among the location. All the locations had knowledge of mushroom cultivation with below 50% response, though there is a significant difference among the locations. When compared with the people that have no knowledge of mushroom cultivation, there is a significant difference between them in all location except Obunku (Figure 3d).

All the locations had interest in mushroom cultivation with above 70% response, though they differ significantly. There is a significant difference between the people that have interest in mushroom cultivation and the people with no interest in mushroom cultivation across the locations (Figure 3e).

Discussion

Phosphate solubilizing bacteria isolated from rhizosphere soil samples of maize and tomato plants. They were identified as *Bacillus megaterium* and *Pseudomonas aeruginosa*. Mass production was carried out at the optimized condition in submerged batch fermentation. These mass cultures can be used further as potential biofertilizer by packing in suitable carrier materials and added to rhizosphere soils directly or through application with the seeds (Prasad, 2014).

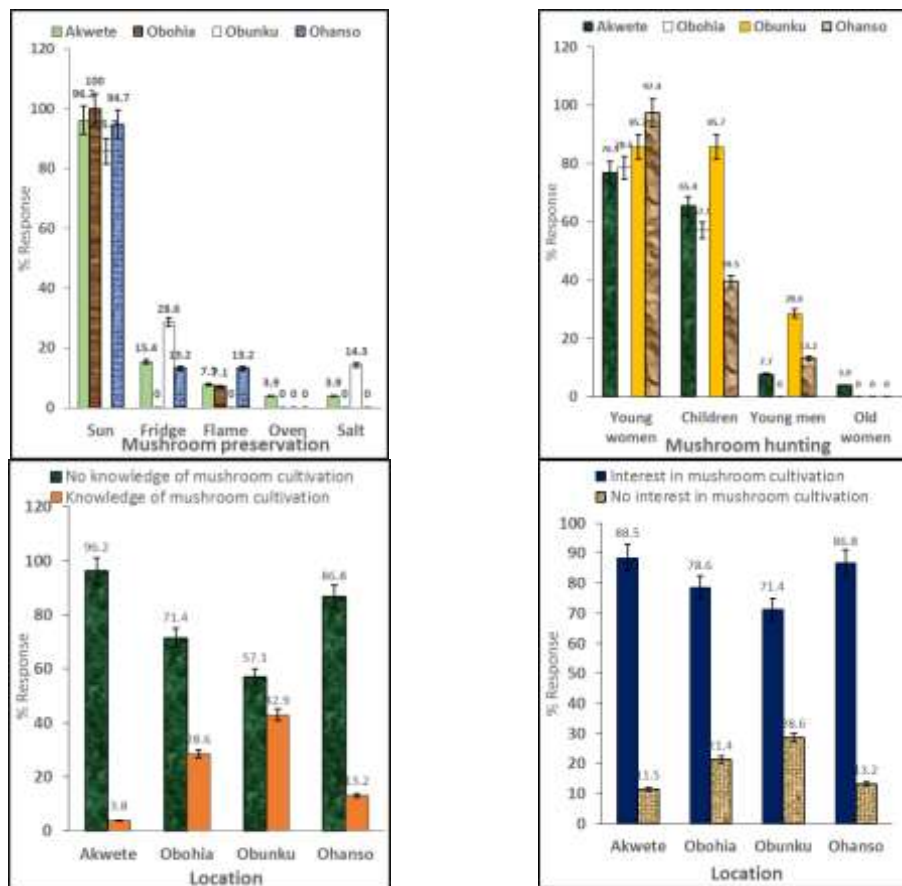


Figure 3b. Percentage of different methods of mushroom preservation by locations studied at 5% error bars; **Figure 3c.** Percentage opinion by locations on those involved in mushroom hunting at 5% error; **Figure 3d.** Percentage response by locations on the knowledge of mushroom cultivation at 5% error bars; **Figure 3e.** Percentage response by locations on the interest in mushroom cultivation at 5% error bars

PGPBs increased growth and yield parameters of dry bean. In addition, some of the PGPBs suppressed the diseases of bean caused by natural bacterial and/or fungal infections (Tozlu *et al.*, 2012). Molla *et al.* (2012) studied the *Trichoderma* composted kitchen wastes can serve as prospective biofertilizer for improvement in yield and quality of tomato cultivation.

The comparative effect of bacterial biofertilizers such as *Rhizobium*, Phosphobacteria and *Azospirillum* on growth and yield of green gram (*Phaseolus radiata* L.) and cowpea (*Vigna siensis* Edhl.) was studied. The bacteria were isolated from the soil samples and identified by staining and biochemical tests. The seeds were inoculated with bacterial biofertilizers with various treatments and showed in sterile polythene bag containing sterilized soil. After 65 days of plant growth, the morphological and bio-chemical parameters of cowpea were increased in combined inoculation of *Rhizobium*, Phosphobacteria and *Azospirillum* than green gram plants (Senthilkumar and Sivagurunathan, 2012).

The tissue culture and spore culture of *Cantharellus* species did not produce hyphal growth. The present research observed that *Cantharellus* species removed colour when it came in contact with water. *Cantharellus* species was also reported by the indigenes to be growing in bush that is over seven years old, especially where *Berlinia grandiflora* trees grow.

The residents of Ukwa-East in this study mentioned about 14 different species of mushrooms. This was in line with the findings of Ayodele *et al.*, (2011), who observed 10 different species of mushrooms used among the Igala people of Nigeria and also Okigbo and Nwatu (2015), who observed 11 different species of mushrooms used among Anambra people of Nigeria. However, most of the respondents (mostly elderly people) indicated that some of the mushrooms they used to consume are no longer found in their locality. They attributed their disappearance to human degradation of the ecosystem through deforestation, farming activities and annual fire outbreak in the environment and also the fact that they don't go for mushroom hunting. They indicated that urgent efforts should be made in order to preserve existing mushrooms from extinction. This observation was in consonant with the work of Elenwo and Okere (2007) and Okigbo and Nwatu (2015), who reported that loss of forest caused by deforestation and urbanization can lead to disappearance of mushrooms from our environment.

The ability to distinguish one mushroom from another is quite high, they claimed that it is an inheritance from their forefathers and they can distinguish between edible and poisonous mushrooms. The names of mushroom are associated with features such as mushroom colour, shape, size, texture, taste or substrate on which it is normally found.

Interesting results of this study were the integration of two edible mushrooms, *Cantharellus* sp. and *Termitomyces* sp. into the peoples' tradition. Oral tradition of people of Ukwa-East had that *Cantharellus* sp. is so valued within the locality to extent that they (mushroom) are used in preparing soups on special occasions such as marriage and burial ceremonies. *Cantharellus* sp. is also used to welcome a special visitor into their home. Moreover, different families preserve them to send for their children living abroad and freshly harvested mushroom can stay up to two weeks without spoiling. In fact it is the most valued mushroom in this locality. Also *Termitomyces* sp. is regarded as bringer of good omen in this locality. When seen in the bush, it means that the gods want to bless you and upon seeing, there are words to recite so that anybody passing through the route will not see it except you. The mushroom is very expensive and taste like chicken but very hard to come by. The rule is that when collected from the wild, the hunter should not consume alone. Some of the collected fruit bodies should be given to neighborhoods and upon receipt, a gift will be presented to the hunter in return, besides verbal offerings of blessings (Akpaja *et al.*, 2003).

Edible mushrooms have been found to be essential source of food for people of Ukwa-East Local Government Area of Abia State. The questionnaire retrieved were above 60%, this showed that the results were fair enough to use for the analyses. The study showed that 60% of the respondents were females, this might be due to the fact that majority of the questionnaire were filled at market places and farmlands where female dominate mostly. All respondents interviewed consume edible mushrooms for many reasons such as substitute for meat, palatable taste, medicinal value, soup thickening and nutritional purposes. The study showed that more than 85% of the respondents consume edible mushrooms because of its palatability and nutritional importance, 23% respondents take them as substitute for meat, while 10% of the respondents consume mushrooms because of its medicinal purpose. This observation agreed with the work of Okigbo and Nwatu (2015) who reported that about 85% of Anambra people of Nigeria eat mushrooms as food whereas 2% utilize them for medicinal reasons. Additionally, Akpaja *et al.* (2003) reported that about 95% of Igbo people of Nigeria eat mushrooms because of taste, 86% use them as substitute for meat and fish while 36.36% use some of them for medicinal purposes. According to Farid *et al.* (2013), mushrooms have been collected and consumed by a good number of people which they attributed to their nutritional values. In substitute for meat as a reason, male response was higher than female response, this might be due to the fact that females in nature cannot replace meat for anything. It was obvious that females use mushroom as soup thickener more than males because they are cooks and have the kitchen. In the

other hand, males consume mushroom for medicinal purpose more than female and only few people have the knowledge of the uses of mushrooms in local traditional medical practices. This indicated that the knowledge of the people about the nutritional and health benefits of edible and medicinal mushrooms are limited.

Majority of the respondents use sun drying as a method for preserving freshly harvested mushrooms. This may be attributed to availability of sunshine. This makes it (sun drying) the cheapest method of mushroom preservation. About 13% of the respondents use refrigeration, 9% make use of flaming, 1% oven dry while 2% of the respondents use salt solution to preserve harvested mushrooms.

Based on the results, young women and children are mainly those responsible for collecting mushroom from the wild. In recent days, farming are mainly done by young women and children, young men hardly farm these days because they all believe in business and white collar jobs and those that go to farm will not start hunting for mushroom in the bush rather they go to cultivate or inspect their farmlands, this might be the reason why young women and children hunt for mushroom since they go to farm every day. Meanwhile old women hardly visit farm because of old age. Similarly, Kinge *et al.* (2011) observed that rural women and children of Cameroon, Central Africa are responsible for collecting mushrooms from wild during rainy season. According to some of the women interviewed, mushrooms gathered from the forest are sold to assist in their family income. On the other hand, children revealed that they harvest and sale mushrooms to earn a living instead of depending on their parents to provide all the necessary things they want in life. This observation was in line with the findings of Okigbo and Nwatu (2015); Akpaja *et al.* (2003) and Ayodele *et al.* (2011) who suggested that children use the money they made from sale of edible mushrooms to pay their school fees.

This study revealed that majority of respondents believed that mushrooms grow in the wild and can hardly be cultivated by human beings. Both gender have little knowledge on mushroom cultivation though males have more knowledge when compared with females. This is due to the fact that most people that attained to the questionnaires reside in the village and are not educated, couple with no electricity in these areas to watch television and know what is happening in the world. This was in line with the work of Ayodele *et al.* (2011) they reported that Igala people belief and stood on the point that mushrooms grow by the miracles of God and no one can cultivate or grow them. However, Farid *et al.* (2013) and Okigbo *et al.* (2015) showed that edible mushrooms are cultivable and can also be collected from the wild. This

therefore calls for concerted efforts to enlighten the people about mushrooms cultivation and their benefits.

Some of the respondents expressed their interest in learning how to cultivate edible mushrooms. This is because it will serve as another source of food, job creation and income to the family. Though about 23% of males had no interest in learning how to cultivate mushrooms, according to them (respondents) they could not combine with their former means of earning a living, which include trading and working for government. Also they believed is a job for the female counterpart.

In percentage response by age group, ≤ 29 years were seen to be below 10% response, this is due to the fact that young people of that age hardly reside in the village, most of them might be students in the university or they are serving their father's land or they are in the cities doing or learning businesses. Equally ≥ 80 years were also below 10% response, this might be because old people hardly go to far places because of health challenges and like I said earlier that these questionnaires were majorly filled at market places and farmlands. Majority of the questionnaire were filled by groups between 30-79 years old, because these are the most active group of people that can be seen at market places and farmlands.

Reasons for mushroom consumption by age group studied, palatability and nutritional importance as a reason were high across the groups, this might be because they have this belief that their people consume them or that it is part of their culture. This was in line with findings of Thapakorn and Thanawan (2013) that observed that individuals consume mushroom because they contain high amount of proteins, minerals and vitamins. Consuming mushroom as substitute for meat was seen to be 100% at ≥ 80 years, this is due to the fact that this group of people have lost most of their teeth, therefore having difficulties in chewing meat. 70-79 years was also high because they believe meat is no better for their consumption. ≤ 29 years had no record of consuming mushroom as substitute for meat, this might be due to the fact youth enjoy eating meat and cannot substitute for anything. Age $\leq 29-39$ years and 70- ≥ 80 years do not used mushroom as thickener, this might be because most of them lack the knowledge that mushroom can be used as thickener and some use mushroom as thickener but do not know that what they are using is mushroom. Again older people hardly enter kitchen because of health challenges and so do not know that mushroom can be used as thickener, younger people on the other hand prefer using processed thickener that can be gotten from the market. Age $\leq 29-39$ years do not consume mushroom based on medicinal importance because they believe once they are sick, they will go to chemist shop and get drug to treat themselves. Age 70-79 years recorded highest instead of ≥ 80 years, this might

be due to health challenges of these older people that make them tend to forget easily.

Sun drying as a method of mushroom preservation was high across the age groups because of availability of sunshine. Age's ≥ 29 -69 years were observed to use refrigeration method and ≥ 29 years had the highest response, this may be due to the fact that youth do not like stress and also invention of modern technologies and availability of electricity. Drying over flame was seen across the groups except group 50-59 years because these are remote villages that mostly cook with firewood while oven drying was only seen in this group (50-59 years). Using salt solution to preserve mushroom was only seen between ages 40-59 years.

It was observed that all groups recorded young women and children as the main groups that involve in mushroom hunting because they are the set of people that go to farm every day. It was only group 40-49 years that recorded old women as one of the group that hunt for mushroom, this might be because the people in this group still have grandmothers that are strong and still follow them to farm. Those that recorded young men are in groups 30-49 years and 60-69 years, those that said so in these groups might be the male respondents among the groups who still farm and accidentally come across mushroom in the farm not that they will go to bush for mushroom hunting.

In knowledge of mushroom cultivation, ages ≥ 29 years and ≤ 80 years had no knowledge that mushroom can be cultivated. This might be because the older people cannot read again, hardly travel and also lack socialization, so they find it hard to know what is happening around them while the poor education system of these remote villages affects the children from knowing what is happening. The children also hardly travel because during holidays they tend to help their parents at farm, couple with no electricity in the village and most parents cannot afford generator.

All age groups have very high interest in mushroom cultivation because it will serve as another source of protein, vitamins, job creation and income to the family. In contrast, age's 70- ≤ 80 years showed high response to lack of interest in learning mushroom cultivation. According to them (respondents) they said is a taboo to cultivate mushroom, that mushroom is miracle from God and only him can send them (mushroom) (personal communication).

Mushroom consumption food by poor alone was only observed between 30-49 years though with below 20% responses, this might be because those that responded positively in these groups are the people that do not consume mushroom, so they believed is food for the poor.

The survey on the use of mushroom on religious rites showed no result, this might be due to the fact the time frame of filling the questionnaire was too

small that I was not able to come across any traditional practitioner or that they believe am a student and also a female so they cannot lick or open the secret to me.

Responses based on location were checked, Ohanso had the highest response while Akwete on the other hand was equally high. Checking on the reason for mushroom consumption at different locations, palatable taste and nutritional important were the basic reasons for mushroom consumption but the low responses on its substitute for meat, might be because bushes around provided many bush meat for consumption. Absence of record on mushroom use as soup thickener and medicinal purpose at Obohia could be because the respondents did not consume mushroom because of these reasons of study. All the locations made use of sun drying as a method of mushroom preservation because it is readily available and cheap. All the locations except Obohia made use of refrigeration to preserve mushroom though they have low responses, maybe there is no electricity in the area that those that made use of fridge do it with generator. Oven drying was only observed at Akwete, perhaps the respondents are retired civil servants that have oven.

All the locations recorded young women and children as the main people that hunt for mushroom in the bush because they were the people that usually go to farm every day. There were no record of young men at Obohia, maybe their young men do not farm they are purely business men. Old women were only recorded in Akwete, it might be that the people that recorded them have strong grandmothers who still follow them to farm.

Knowledge of mushroom cultivation was low at Akwete and Ohanso, because majority of the people from these locations are business people and subsistent farmers. On the other hand, they are the people that had more interest in mushroom cultivation, maybe to use them to augment their income. On the basis of establishment of pure culture of *Cantharellus* sp., the results were zero. This might be because *Cantharellus* sp. is a mycorrhizal mushroom and it is very hard to cultivate this type of mushroom using artificial methods or because of time frame and lack of capital to do extensive work.

Conclusion

Mushrooms grow in Ukwa-East Local Government Area and the residents have indigenous knowledge of mushrooms and their uses. It is therefore pertinent to conclude that Ukwa-East farmlands hold a rich array of unexplored and untapped mushrooms which can be used in the production of nouveau nutraceuticals, myco- disinfectants and myco-coagulants.

Recommendation

Mycophagy should be encouraged to promote food security and reduce protein and mineral deficiencies prevalent in the diet of the people.

The cultural belief of Ukwa-East people on mushroom particularly those that have cultural attachment need to be further investigated. This will help a great deal in enlightenment campaign among the people about mushroom cultivation.

There should also be proper documentation of all ethno-study of mushroom since there is paucity of documented information on that in Nigeria.

Research on establishment of pure culture and cultivation of *Cantharellus* species (a mycorrhizal mushroom) should be given priority attention in institution of higher learning in the country.

References

- Adenipekun, C. O. (2008). Bioremediation of engine-oil polluted soil by *Pleurotustuberregium* Sing., a Nigerian white-rot fungus. *African Journal of Biochemistry*. 7:55-58.
- Akpaja, E. O., Isikhuemhen, O. S. and Okhuoya, J. A., (2003). Ethnomycology and usage of edible and mushrooms among the Igbo people of Nigeria. *International Journal of Medicinal Mushrooms*. 5:313-319.
- Akpaja, E. O., Okhuoya, J. A. and Ehwerheferere, B. A. (2005). Ethnomycology and Indigenous uses among the Bini Speaking people of Nigeria: a case study of Aihuobabekun Community near Benin City, Nigeria. *International Journal of Medicinal Mushrooms*. 7:373-374.
- Akpaja, E. O., Dania, A. T., Okhuoya, J. A. and Isikhuemhen, O. S. (2014). Heritage of edible mushrooms among the Okpameri people of Edo State, Nigeria. *Nigerian Journal of Mycology*. 6:66-84.
- Alabi, R. O. (1990). Mycology and Nigerian Culture: Past, Present and Future, *Proceeding of 1st Conference of African Mycology, Mauritius*. pp. 43-52.
- Anonymous (2016). Ukwa-East Local Government Area of Abia State. Retrieved from https://en.m.wikipedia.org/wiki/Ukwa_East.
- Asemota, U. K., Salisu, A., Okereke, O. E., Etim, V. A. and Onyenekwe, P. C. (2015). Ethnomycology: Edible and Medicinal Mushrooms of the Indigenous Gbagyi People of Nigeria. *International Journal of Current Biotechnology*. 3:1-7.
- Atlas, R. M. and Bartha, R. C. (1992). Hydrocarbon biodegradation and soil spill. *Bioremediation*. In *Advance Microbiology and Ecology*, NY, pp. 287-338.
- Ayman, S. D., Kabeil, S. S., William, A. B. and EL-Saadani, M. A. (2008). Production of mushroom (*Pleurotusostreatus*) in Egypt as a source of nutritional and medicinal food. *World Journal of Agricultural Sciences*. 4:630-634.

- Ayodele, S. M., Akpaja, E. O. and Anyiador, F. (2007). Evaluation of the yield of *Lentinussquarrosulus* (Mont) Singer on selected economic trees species. *Pakistan Journal of Biological Sciences*. 10:4288-4286.
- Ayodele, S. M., Akpaja, E. O. and Adamu, Y. (2011). Some edible medicinal mushrooms of Igala Land in Nigeria, their sociocultural and ethnomycological uses. *International Journal of Science Nature*. 2:473-476.
- Bilal, A. W., Bodha, R. H. and Wani, A. (2010). Nutritional and Medicinal Importance of Mushrooms. *Journal of Medicinal Plants Resources*. 4:2598-2604.
- Borchers, A. T., Keen, C. L. and Gershwin, M. E. (2004). Mushrooms, tumors and immunity: An update. *Experimental Biology and Medicine*. 229:393-406.
- Cheesbrough, M. (2004). *District laboratory practice in tropical countries*. 4th edition. Cambridge University Press, New York. pp. 167-194.
- Davis, R. A. and Aegerter, B. J. (2000). *Edible Mushroom Cultivation*. Jodhpur India: Scientific Publishers, pp. 2-5.
- Elenwo, E. N. and Okere, S. E. (2007). Waste re-cycling using edible mushroom cultivation. *Journal of Applied Science, Environment and Management*. 11:153-156.
- Farid, M. T., Hero, M. I. and Nareen, Q. F. A. (2013). Survey and Identification of Mushrooms in Erbil Governorate. *Research Journal of Environmental and Earth Sciences*. 5:262-266.
- Fasidi, I. O. and Ekuere, U. U. (1993). Studies on *Pleurotustuberregium* (Fries) Singer: cultivation, proximate composition and mineral content of sclerotia. *Food Chemistry*. 48:255-258.
- Food and Agricultural Organization (FAO) (2006). Corporate Document Repository. Wild Edible Fungi: A Global Overview of their Importance to People. Retrieved from www.fao.org/documents.
- Gbolagade, J. S., Ajayi, A., Oku, I. and Wankasi, D. (2006). Nutritive value of common wild edible mushrooms from southern Nigeria. *Global Journal of Biotechnology and Biochemistry*. 1:16-21.
- Harkonen, M., Niemela, T., Mbindo, K., Kotiranta, H. and Pearce, G. (2015). Zambian mushrooms and mycology. *Norrlinia*. 29:21-54.
- Hoiberg, D. H. (2010). "Abia". *Encyclopaedia Britannica*. I:A-ak Bayes (15th ed.). Chicago, IL: Encyclopaedia Britannica Inc. pp.32.
- Hussain, T. (2001). Growing mushroom: a new horizon in agriculture. *Mushroom Journal*. 21:23-26.
- Idu, M., Osemwegie, O., Timothy, O. and Onyibe, H. I. (2007). A survey of plants used in Nigerian Mushrooms: Underutilized Non-Wood Forest Resources traditional healthcare by Waja tribe Bauchi State, Nigeria. *Plant Archives*. 7:535-538.
- Isikhuemhen, O. S., Anoliefo, G. O. and Oghale, O. I. (2003). Bioremediation of crude oil polluted soil by white rot fungus, *Pleurotustuberregium* (Fr.) Sing. *Environmental Science and Pollution Research*. 10:108-112.
- Kinge, T. R., Tabi, A. M., Enow, E. A., Njouonkou, L. and Nji, T. M. (2011). Ethnomycological Studies of Edible and Medicinal Mushrooms in the Mount Cameroon Region (Cameroon, Africa). *International Journal of Medicinal Mushrooms*. 13:299-305.

- Lodge, J. L., Chapela, I., Samuels, G., Uecker, F. A., De sjardin, D., Horak, E., Miller, O. K., Hennebert, G. L. Jnr., Decock, C. A., Ammirati, J., Burdsall, H. H. Jnr., Oberwinkler, F., Pegler, D. N., Spooner, B., Peterson, R. H., Rogers, J. D., Ryvardeen, L., Watling, R., Turnbull, E. and Whalley, A. J. S. (1995). Survey of the Patterns of Diversity in non-Lichenized Fungi. *Mitteilungen der Eidgenossischen Forschungsanstalt für Wald, Schnee Und Landschaft*. 70:157-173.
- Musieba, F., Okoth, S., and Mibey, R. K. (2011). First Record of Occurrence of *Pleurotus citrinopileatus* Singer on new hosts in Kenya. *Agricultural and Biological Journal of North America*. 2:1304-1309.
- Myers, N., Mittermeier, G. C., Da Fonseca, B. A. G. and Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature*. 403:853-858.
- Narh Mensah, D. L. and Obodia, M. (2014). Morphological characteristics of mycelia growth of two strains of the indigenous medicinal mushroom, *Lentinussquarrosulus* Mont. (Singer) on solid media. *African Journal of Agricultural Research*. 9:1753-1760.
- Nwordu, M. E., Isu, R. N. and Ogbadu, G. H. (2013). Catalogue and Identification of Some Wild Edible Macro-Fungi in Nigeria. *Online International Journal of Food Science*. 2:1-15.
- Odebode, S. O. (2005). Contributions of Selected Non-Timber Forest Products to Household Food Security in Nigeria. *Journal of Food, Agriculture and Environment*. 3:138-141.
- Oei, P. (2003). *Mushroom Cultivation: Appropriate Technology for Mushroom Growers*. Netherlands, Backhuys Publishers Leiden.
- Oghenekaro, A. O., Akpaja, E. O. and Samuel, J. O. (2010). Effect of Illumination and Sclerotia on the Growth and Development of *Pleurotustuberregium* (Fries) Singer. *Continental Journal of Food Science and Technology*. 4:46-52.
- Okhuoya, J. A. and Iskhuehmen, O. S. (1999). *Mushroom Cultivation: The Nigerian Experience*. The 3rd International Conference on Mushroom Biology and Mushroom Production. Retrieved from <http://wsmbmp.mushworld.com>.
- Okhuoya, J. A. and Akpaja, E. O. (2005). Mycomedicine and Ethnomycology: The Nigerian Experience. *International Journal of Medicinal Mushrooms*. 7:439-440.
- Okhuoya, J. A. and Osagualekhor, D. O. (2005). Sociocultural and ethnomycological uses of mushroom among Esan people of Nigeria. *International Journal of Medicinal Mushrooms*. 7:442-443.
- Okhuoya, J. A., Akpaja, E. O., Osemwegie, O. O., Oghenekaro, A. O. and Ihayere, C. A. (2010). Nigeria Mushrooms: Underutilized Non-Wood Forest Resources. *Journal of Applied Science and Environmental Management*. 14:43-54.
- Okigbo, R. N., Nwatu, C. M. and Ramesh, P. (2012) A Case Study on Fungal Leaf Spot Diseases of Orange Plants. *Elixir Journal of Applied Botany*. 42:6182-6186.
- Okigbo, R. N. and Nwatu, C. M. (2015) Ethnostudy and Usage of Edible and Medicinal Mushrooms in Some Parts of Anambra State, Nigeria. *Natural Resources*. 6:79-89.
- Okigbo, R. N., Okigbo, J. E. and Eze, N. O. (2015). Cultivation of mushroom (*Pleurotustuberregium*) using oil palm fruit fiber (*Elaeisguinenensis*) and topsoil as substrates. *Nigerian Journal of Mycology*. 7:75-84.

- Osemwegie, O. O., Eriyaremu, E. G. and Abdulmalik, J. (2006). A survey of macrofungi in Edo/Delta region of Nigeria, their morphology and uses. *Global Journal of Pure and Applied Science*. 12:149-157.
- Osemwegie, O. O. and Okhuoya, J. A. (2009). Diversity of Macrofungi in Oil Palm Agroforest of Edo State Nigeria. *Journal of Biological Science*. 9:584-593.
- Osemwegie, O. O., Okhuoya, J. A., Oghenekaro, A. O. and Evueh, G. A. (2010). Macrofungi Community in Rubber Plantation and a Forest of Edo State, Nigeria. *Journal of Applied Science*. 10:391-398.
- Oso, B. A. (1975). Mushrooms and the Yoruba people of Nigeria. *Mycologia*. 69:271-279.
- Shelley, E. and Geoffrey, K. (2004). *Pocket Nature: Fungi*. 80 Strand London WC2R 0RL.
- Thapakorn, K. and Thanawan, P. (2013). Lead accumulation in the straw mushroom, *Volvariellavolvacea*, from lead contaminated rice straw and stubble. *Bulletin of Environmental Contamination and Toxicology*. 91:231-234.
- Wasser, S. (2002). Medicinal Mushrooms as a Source of Anti- Tumor and Immuno -modulating Polysaccharides. *Applied Microbiology and Biotechnology*. 60:258-274.
- World Bank (1992). *World Development Report*. New York, Oxford University Press, Inc.

(Received: 15 September 2018, accepted: 30 October 2018)