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Ecological distribution and abundance of species of *Agaricus* grown in Northern Nigeria

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Abstract

This research highlights on the occurrence, distribution and abundance of Nigerian wild *Agaricus* species in Zaria, Nigeria. Thirty (30) different *Agaricus* species were collected from the wild from seven different sites in the Zaria area during the rainy seasons of 2011-2013. These were identified and characterized for species diversity. All the sites supported the growth of *Agaricus* mushrooms. There were significant differences in abundance of species of *Agaricus* across the years (2011-2013) due to favorable ecological factors such as rainfall, relative humidity and temperature. However, Site I (Area A; Botanical garden and Dam site) had the highest distribution of species of *Agaricus* in 2011-2013 and the least number were recorded in Kongo Campus and Kufena site.

Keywords: *Agaricus* spp.; Identification; Phylogenetic; Polymerase; Species diversity; Tropical region.

Introduction

Mushrooms belong in the kingdom Fungi (Chen *et al.*, 2015) and they form the largest group of Agaricomycetes which are also known as Homobasidiomycetes. Traditionally mushrooms have been considered as the fruit bodies of members of the order Agaricales which derived their names from the type genus *Agaricus* and type species *Agaricus campestris*, the field mushroom. However, according to modern molecular classification, not all members of the order Agaricales produce mushroom fruit bodies or basidiocarps and many other gilled fungi collectively known as mushrooms are also part of the class Agaricomycetes (Fasidi, *et al.*, 2008). Mushrooms are widely used for various purposes such as dyeing of wool and other natural fibers, medicine, Food, dietary supplements among others. For example, several species of mushrooms such as *Agaricus micromegatuus*, *Agaricus augustus* and *Agaricus macrosporus* are collected for consumption while *Agaricus subrufescens* is used for medicinal purposes (Kendrick, 2000; Rana, and Giri, 2006). The poisonous species that grow along with the edible *Agaricus* species such as *Amanita phylloides* are used as sources of mycotoxins and produce enzymes such as disulfiram which inhibits aldehyde dehydrogenase (ALDH) (Chang, 1999). Many species in the Agaricaceae are widely recognized for their medicinal and nutritional properties (Bahl, 1988).

Nutritional profile of mushrooms include total carbohydrate contents that range from 26 to 82% and is largely made of carbon, starches, pentoses, hexoses, disaccharides, amino sugars, sugar alcohols and sugar acids. This is in addition to their high fiber content; low lipid levels that are made up of polyunsaturated fatty acids and absence of cholesterol. Due to this economic significance, mushrooms are a huge source of revenue at local and national levels; hence they are being cultivated, usually from the spores. Identification of wild species is required in order to recognize and separate edible species from toxic ones. Conventionally, mushroom identification is by use of macro- and micro-morphological features (Adewusi *et al.*, 1993; Barros *et al.*, 2007). However, this method is not accurate and reliable due to phenotypic plasticity and intraspecific variability among the mushrooms, which could arise from mutations, or substrate and growth effects. Thomas and Isabella (2012) noted that, standard methods of identification of *Agaricus* species is lacking; while the use of nomenclatural keys developed by Kendrick, (2000) and Chang, (1999) are limited by varying environmental conditions that affect mushroom growth in different geographical locations. Because the

inaccurate identification of mushrooms has a serious implication on the species diversity of *Agaricus* in the tropical and subtropical regions, the current classification of Agaricales needs to be reviewed (Avian *et al.,* 2012). Furthermore, little is known about the taxonomy of wild species of mushrooms in Nigeria in spite of reported species diversity and habitat diversification. Molecular techniques have shown to be more reliable the identities of wild collections and are helpful in mushroom taxonomy (Chen *et al.,* 2015). In African countries including Nigeria, there is paucity of reports in molecular systematics of fungi. Where available, such studies have focused on cultivated species. Partial rDNA sequences, including the Internal Transcribed Spacer 1 (ITS-1); including the5.8S rDNA-Internal Transcribed Spacer 2, which is a primary fungal barcode can be used for molecular identification as well as to determine the phylogenetic relationships between selected species of the basidiomycetes (Tang *et al.,* 2005). The use of molecular markers for rapid identification and phylogenetic inference of fungi will assist in the taxonomic placement of wild species of mushrooms. Therefore, this study was conducted to determine the molecular identification and characterization of wild species of *Agaricus* growing in Zaria area, tropical region of Nigeria using DNA sequence comparisons.

Materials and Methods

Field studies were carried out from the Department of Biological Sciences of Ahmadu Bello University, Zaria, Nigeria on latitude 11°13''North, Longitude 7°12" East (Altitude 630 meters above sea level). Molecular evaluations were conducted at the Institute of Biomedical Research (IBR) Laboratory, KIU, Uganda. Meteorological data of Zaria was collected from the Meteorological unit of Institute of Agricultural Research, Ahmadu Bello University, Zaria, for the three year period of study for climatic parameters

Field Survey

Field surveys were conducted to collect wild *Agaricus* mushrooms from seven different locations in Zaria, Kaduna state, Nigeria. The method of collection of data was based on participatory method of field study. Field trips were undertaken during rainy season when the fruiting bodies are formed (mainly from May to October for three consecutive years: 2011, 2012 and 2013. Random Collection of wild mushrooms was carried out seven times in a month to all the locations and specimens were identified using the standard descriptions of Pegler and Spooner, (1997). Photographs of collected mushrooms were taken using digital camera for the purpose of identification and classification. During the collection, a hand trowel and pocket knife was used to dig up the mushrooms from the base in their substrate. Frequency species distribution, occurrence and abundance were studied in terms of presence or absence of basidioma using the methods of Rana, and Giri, (2006). The mushroom specimens collected were carefully kept in a cellophane bag and labeled accordingly. Plastic baskets were used to convey the mushrooms to the laboratory for further studies.

Preservation of collected mushrooms

Mushroom specimens were preserved in Formalin Acetic Acid (3:5:7) to 85cm^3 of distilled water inside clean specimen bottles as soon as they were brought from the field. The samples were oven dried at 45^{o}C and labeled accordingly and were preserved (Kendrick, 2000).

Data analysis: Frequency distribution, occurrence and abundance of Agaricus species in Zaria over a period of three (3) year (2011, 2012 and 2013)

Principal component analysis was used to analyze the correlation of wild *Agaricus* species in Zaria with climatic factors, and sampling locations over the three year period. Descriptive statistics using SPSS software was used to analyze the frequency distribution, occurrence and abundance of *Agaricus* species in Zaria over a period of three year (2011, 2012 and 2013). Cladistics analysis was used to perform a multiple alignment. The relationship between *Agaricus* species was represented using a cladogram based on phylogenetic analysis according to the methods of (Chen *et al.,* 2015).

Results and Discussion

Distribution, occurrence and abundance of Agaricus species from sampling Sites

Thirty (30) *Agaricus* mushroom species were collected during the survey. Overall occurrence of *Agaricus* species for the three years was significantly different (Table 2, 3 and 4). Field occurrence of *Agaricus s*pecies was studied through the months of May to October in 2011-2013. *Agaricus* species were found between the

months of May to October 2011, 2012 and 2013 (Appendix IV, V and VI). *Agaricus* mushrooms were found growing more in the months of July, August and September than in the months of May and October. There was significant difference in the monthly distribution of *A. excellen* and *A. fuscofibrillosus, A. macrosporus, A. pattersonae; A. pinyonensis; A. placomyces; A. ponderosa; A. silvicola; A. viporarius*, and *A. xanthodermus* in 2011 (Table 2) with August having the highest occurrence of species of *Agaricus* while May revealed the least (Table 3). However, for *A. ponderosa* and *A. silvicola*, their abundance in the months of September and August did not differ (Table 3).

The monthly distribution of *A. bisporus* and *A. fuscofibrillosus,* A.*micromegatus; A. ponderosa* and *A. xanthodermus* were significantly higher in 2012 compared to 2011 and 2013 (Table 4). The highest occurrence of *Agaricus* species in 2012 was in the month of August, followed by July and September respectively while the least were in the months of May and October. *A micromegatus* showed higher occurence in August and September while with May, June and October recording the least (Table 4). Similarly, .*A placomyces* showed highest occurrence in August but was least abundant in May, June and September. A. pan*derosa* also showed highest occurence in the month of September and was not significantly different from the month of August but was least abundant in May and October (Table 4). There was high abundance of *A .porphorocephalus* and *A. trisulphuratus* in the months of September and August respectively but was least in May, June and October. *A. xanthodermus* was highest in abundance in the month of August and least in abundance only in the months of May and June (Table 4).

Similarly in 2013 there was significant difference in the monthly distribution of *A. arvensis; A. bisporus; A. blandianus; A. diminitivus; A. excellen; A.fuscovulatus ; A. harmorroides; impudicus* and *A. liliacep; A.muranaceus; A. pattersonae; A. Kerrigan; A. pinyonensis; A. silvaticus; A.trisulphuratus; A. viporarius, and A. xanthodermus* (Table 4). The abundance of *Agaricus* species in 2013 was significantly lowest in the months of May, June and October and highest in August followed by July and September respectively (Table 4). The abundance of *A. arvensis* was significantly higher in the months of August and September but *Agaricus* species were not observed in the months of May, June and October except *Agaricus lilacep* that was observed in May through the years (Table 4). *A. diminitivus; A. excellen; A.fuscovulatus; A. haemorroides; A. lilacep; A. Kerrigan* and *A.silvaticus* showed highest occurrence in the month of August while *A.muranaceus* and *A. xanthodermus* were abundant in September (Table 4). The appearance and growth of the species of *Agaricus* across different months could have been influenced by the environmental (climatic) factors, which are considered to be optimum during the period. This also gave the highest abundance of species of *Agaricus* in the month of August in 2011. *Agaricus* species appears in abundance in 2012 and 2013 than in 2011. This report agreed with the findings of Bas (1991) and Largeteau *et al*. (2011) who reported that high humidity and moderate moisture are essential for the germination of mycelia and formation of basidioma of macro fungi. However, the months of May and October recorded the least abundance of species of *Agaricus* across the years, 2011-2013 and across the locations especially on areas B and C, probably because there was consistency in the decreased mean relative humidity and rainfall and an increased temperature, hence it could be considered as dry months for the growth of the fleshy mushrooms. In addition, Arora, (1986) observed that the bare nature of habitat characterized by scanty trees and less decomposed materials may not support the germination of basidiospores of species of *Agaricus*. The study sites (Table 1) were mainly fields with more of grasses and more exotic trees. There were no water bodies except in location A1, where Ahmadu Bello University Dam is situated.

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Table 1: Locations of wild *Agaricus* species collected in Zaria, Nigeria

Site name	Location	Coordinates
A1	Area A	$11^0$08'56.58"N; $7^0$39'35.62"E
	Botanical Garden	$11^0$08'44.60"N; $7^0$39'19.34"E
	Dam site	$11^0$08'16.14"N; $7^0$39'19.34"E
A2	Area G	$11^0$10'15.90"N; $7^0$37'26.58"E
	Area E	$11^0$09'39.76"N; $7^0$37'35.83"E
A3	Area C	$11^0$10'28.74"N; $7^0$37'30.28"E
	Institute of Agricultural Research	$11^0$09'55.08"N; $7^0$38'02.57"E
A4	Area BZ	$11^0$09'02.05"N; $7^0$38'20.33"E
	Area F	$11^0$09'13.51"N; $7^0$38'20.33"E
	A.B.U. Printing Press	$11^0$09'03.62"N; $7^0$38'51.15"E
	ICSA Ramat	$11^0$09'09.02"N; $7^0$39'10.84"E
A5	A.B.U. Academic Area	$11^0$09'01.59"N; $7^0$39'14.12"E
B	A.B.U Kongo campus	$11^0$04'59.82"N; $7^0$43'27.69"E
C	Kufena	$11^0$04'24.98"N; $7^0$40'11.70"E

Table 2: Mean values of the monthly occurrence of species of *Agaricus* in Zaria, 2011

MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MAY	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.00[c]	0.00[a]	0.00[a]	0.00[a]	0.00[a]	1.00[a]
JUNE	1.00[a]	0.00[a]	0.00[a]	1.00[a]	1.00[a]	0.00[a]	1.00[a]	1.00[a]	0.00[a]	0.00[c]	0.00[a]	0.00[a]	1.00[a]	1.00[a]	1.00[a]
JULY	2.00[a]	1.00[a]	1.00[a]	2.00[a]	3.00[a]	0.00[a]	1.00[a]	3.00[a]	2.00[a]	2.00[b]	2.00[a]	2.00[a]	3.00[a]	1.00[a]	2.00[a]
AUGUST	4.00[a]	3.00[a]	3.00[a]	4.00[a]	3.00[a]	2.00[a]	4.00[a]	3.00[a]	4.00[a]	4.00[a]	4.00[a]	4.00[a]	4.00[a]	4.00[a]	3.00[a]
SEPTEMBER	3.00[a]	4.00[a]	2.00[a]	1.00[a]	3.00[a]	0.00[a]	1.00[a]	2.00[a]	1.00[a]	1.00[c]	1.00[a]	1.00[a]	1.00[a]	4.00[a]	2.00[a]
OCTOBER	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.00[c]	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.00[a]
MEAN	2.00	1.17	1.00	1.17	1.33	0.25	1.00	1.25	1.00	1.00	0.91	1.08	1.33	1.33	1.25
SE±	1.54	1.19	0.89	1.08	1.33	0.61	1.45	0.96	0.91	0.35	1.60	1.11	1.29	1.22	1.00
CV	89.60	132.64	115.95	112.42	135.77	347.85	174.44	99.74	117.75	45.83	226.93	136.44	125.83	130.00	104.38

Keys: 1 - *A. alphitochrous*, 2- *A. arvensis*, 3- *A. augustus*, 4 - *A. bisperus*, 5- *A. biterguis*, 6- *A. blandianus*, 7- *A. canpentris*, 8- *A. diminutivus*, 9- *A. excellens*, 10 - *A. fuscofibrillosus*, 11 - *A. fuscovelatus*, 12- *A. haemorrhoiderius*, 13 - *A. impudicus*, 14- *A. iodolens*, 15- *A. lilaceps*, column mean with same letter within are not significant different. SE± = standard error

Table 2 cont'd: Mean values of the monthly occurrence of species of *Agaricus* in Zaria 2011

MONTH	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
MAY	0.00^{b}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{c}	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{a}	0.00^{c}	0.00^{a}	0.00^{b}	0.00^{b}
JUNE	1.00^{ab}	2.00^{a}	0.00^{a}	1.00^{a}	1.00^{b}	1.00^{a}	0.00^{c}	1.00^{b}	1.00^{b}	2.00^{a}	1.00^{a}	1.00^{c}	0.00^{a}	0.00^{b}	0.00^{b}
JULY	2.00^{ab}	1.00^{a}	0.00^{a}	4.00^{a}	1.00^{b}	1.00^{a}	2.00^{b}	1.00^{b}	1.00^{b}	2.00^{a}	2.00^{a}	2.00^{bc}	3.00^{a}	2.00^{ab}	1.00^{b}
AUGUST	4.00^{a}	4.00^{a}	3.00^{a}	4.00^{a}	4.00^{a}	3.00^{a}	3.00^{a}	2.00^{b}	3.00^{a}	4.00^{a}	3.00^{a}	3.00^{ab}	2.00^{a}	2.00^{a}	2.00^{ab}
SEPTEMBER	1.00^{ab}	3.00^{a}	3.00^{a}	2.00^{a}	0.00^{b}	1.00^{a}	1.00^{bc}	3.00^{a}	3.00^{a}	4.00^{a}	2.00^{a}	4.00^{a}	1.00^{a}	1.00^{b}	3.00^{a}
OCTOBER	0.00^{b}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{c}	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{a}	0.00^{c}	0.00^{a}	0.00^{b}	1.00^{b}
MEANS	1.25	1.25	0.91	1.58	0.83	0.91	0.91	0.91	1.08	1.67	1.25	1.58	0.91	0.67	1.00
SE±	0.71	0.96	1.24	2.03	0.57	1.24	0.67	1.08	0.58	1.34	1.00	0.41	0.97	0.65	0.65
CV	73.33	31.49	161.40	166.29	88.68	176.07	115.21	94.87	129.71	104.36	103.71	38.28	137.84	112.68	63.38

Keys; 16 - *A. macosporus*, 17- *A. micromegatuus*, 18 - *A. muranaceus*, 19 - *A. pantherina*, 20- *A. pattersoniae*, 21- *A. kerrigan*, 22- *A. pinyonensis*, 23 - *A. placomyces*, 24 - *A. ponderosa*, 25 - *A. porphyrocephalus*, 26- *A. silvaticus*, 27 - *A. silvicola*, 28- *A. trisulphuratus*, 29- *A. viporarius*, 30- *A. xanthodermus.* Column mean with same letter within are not significantly different. SE± = standard error

Table 3: Mean values of the monthly occurrence of species of *Agaricus* in Zaria, 2012

MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MAY	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	1.00^{a}
JUNE	1.00^{a}	0.00^{a}	0.00^{a}	1.00^{b}	1.00^{a}	0.00^{a}	1.00^{a}	1.00^{a}	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{a}	1.00^{a}	1.00^{a}	1.00^{a}
JULY	3.00^{a}	1.00^{a}	1.00^{a}	2.00^{ab}	3.00^{a}	0.00^{a}	1.00^{a}	3.00^{a}	2.00^{a}	1.00^{b}	2.00^{a}	2.00^{a}	3.00^{a}	1.00^{a}	2.00^{a}
AUGUST	4.00^{a}	3.00^{a}	4.00^{a}	4.00^{a}	3.00^{a}	2.00^{a}	4.00^{a}	3.00^{a}	4.00^{a}	3.00^{a}	4.00^{a}	4.00^{a}	4.00^{a}	4.00^{a}	3.00^{a}
SEPTEMBER	1.00^{a}	4.00^{a}	3.00^{a}	1.00^{b}	3.00^{a}	0.00^{a}	1.00^{a}	2.00^{a}	1.00^{a}	1.00^{b}	1.00^{a}	1.00^{a}	1.00^{a}	4.00^{a}	2.00^{a}
OCTOBER	0.00^{a}	0.00^{a}	1.00^{a}	0.00^{b}	0.00^{a}	0.00^{a}	1.00^{a}	0.00^{a}	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
MEANS	1.33	1.17	1.42	1.17	1.33	0.25	1.08	1.25	1.00	0.83	1.08	1.08	1.33	1.33	1.25
SE±	0.98	0.98	1.32	0.55	1.33	0.61	0.74	0.86	0.68	0.41	0.74	1.11	1.29	1.22	0.98
CV	104.28	119.18	149.31	66.39	140.98	346.41	96.08	97.43	96.61	86.60	113.55	145.46	136.93	129.90	104.38

Keys: alp - *A. alphitochrous*, arv - *A. arvensis*, aug - *A. augustus*, bis - *A. bisperus*, bit - *A. bitorguis*, bla - *A. blandianus*, can - *A. canpentris*, dim – *A. diminutivus*, exc - *A. excellens*, fusf - *A. fuscofibrillosus*, fusv - *A. fuscovelatus*, hae - *A. haemorrhoiderius*, imp - *A. impudicus*, iod - *A. iodolens*, lil - *A. lilaceps*, Means with same letter within column are not significantly different. SE± = standard error

Table 3 cont'd: Mean values of the monthly occurrence of species of *Agaricus* in Zaria, 2012

MONTH	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
MAY	0.00^{a}	0.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{a}	0.00^{c}	0.00^{a}	0.00^{b}
JUNE	1.00^{a}	1.00^{b}	0.00^{a}	0.00^{a}	1.00^{a}	1.00^{a}	1.00^{a}	0.00^{b}	1.00^{bc}	0.00^{b}	1.00^{a}	1.00^{a}	0.00^{c}	0.00^{a}	0.00^{b}
JULY	2.00^{a}	1.00^{bc}	0.00^{a}	0.00^{a}	1.00^{a}	1.00^{a}	2.00^{a}	2.00^{ab}	1.00^{bc}	2.00^{ab}	2.00^{a}	2.00^{a}	3.00^{a}	2.00^{a}	1.00^{b}
AUGUST	4.00^{a}	2.00^{a}	3.00^{a}	4.00^{a}	3.00^{a}	4.00^{a}	4.00^{a}	3.00^{a}	3.00^{ab}	2.00^{ab}	3.00^{a}	3.00^{a}	2.00^{b}	2.00^{a}	2.00^{a}
SEPTEMBER	1.00^{a}	2.00^{a}	3.00^{a}	2.00^{a}	1.00^{a}	0.00^{a}	1.00^{a}	1.00^{ab}	3.00^{a}	4.00^{a}	2.00^{a}	4.00^{a}	1.00^{c}	1.00^{a}	1.00^{b}
OCTOBER	0.00^{a}	0.00^{c}	1.00^{a}	1.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{c}	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{a}	0.00^{c}	0.00^{a}	1.00^{b}
MEANS	1.25	0.91	1.00	1.08	1.08	1.00	1.17	0.91	1.25	1.08	1.25	1.42	0.91	0.67	0.08
SE±	0.66	0.20	0.88	0.86	1.11	0.32	0.98	0.61	0.58	0.74	0.92	1.29	0.20	0.61	0.58
CV	75.19	31.49	123.83	132.86	171.91	53.67	119.18	94.48	76.31	96.08	103.79	129.20	31.49	128.45	66.39

Keys; mac - *A. macosporus*, mic - *A. micromegatus*, mur - *A. muranaceus*, pan - *A. pantherina*, pat - *A. pattersoniae*, ker - *A. kerrigan*, pin - *A. pinyonensis*, pla - *A. placomyces*, pon - *A. ponderosa*, por - *A. porphyrocephalus*, sil - *A. silvaticus*, sil - *A. silvicola*, tri - *A. trisulphuratus*, vip - *A. viporarius*, xan - *A. xanthodermus.* Means with same letter within column are not significant different. SE± = standard error

Table 4: Mean values of the monthly occurrence of species of *Agaricus* in Zaria, 2013

MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MAY	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{c}	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{b}	0.00^{c}	0.00^{a}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{a}	1.00^{b}
JUNE	1.00^{a}	0.00^{b}	0.00^{a}	1.00^{bc}	1.00^{a}	0.00^{b}	0.00^{a}	1.00^{b}	0.00^{c}	0.00^{a}	0.00^{b}	1.00^{ab}	2.00ab	1.00a	1.00^{ab}
JULY	2.00^{a}	1.00^{ab}	1.00^{a}	2.00^{a}	3.00^{a}	3.00^{a}	0.00^{a}	1.00^{b}	2.00^{b}	2.00^{a}	2.00^{ab}	2.00^{ab}	3.00^{a}	3.00^{a}	2.00^{ab}
AUGUST	4.00^{a}	4.00^{a}	2.00^{a}	2.00^{b}	3.00^{a}	2.00^{ab}	2.00^{a}	4.00^{a}	4.00^{a}	4.00^{a}	4.00^{a}	4.00^{a}	3.00^{ab}	4.00^{a}	3.00^{a}
SEPTEMBER	3.00^{a}	4.00^{a}	2.00^{a}	2.00^{b}	3.00^{a}	0.00^{b}	0.00^{a}	1.00^{b}	1.00^{c}	1.00^{a}	1.00^{b}	1.00^{ab}	1.00^{ab}	3.00^{a}	2.00^{ab}
OCTOBER	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{c}	0.00^{a}	0.00^{b}	0.00^{a}	1.00^{b}	0.00^{c}	0.00^{a}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{a}	0.00^{b}
MEANS	1.50	1.33	0.83	0.91	1.33	0.75	0.25	1.08	1.00	1.00	1.08	1.25	1.33	1.58	1.25
SE±	1.26	0.84	0.98	0.38	0.98	0.49	0.61	0.38	0.32	1.57	0.74	0.66	0.63	1.13	0.58
CV	119.23	88.74	166.85	58.07	104.28	92.70	346.41	49.13	44.72	222.11	1.08	75.19	67.08	100.86	66.13

Keys: alp - *A. alphitochrous*, arv - *A. arvensis*, aug - *A. augustus*, bis - *A. bisperus*, bit - *A. biterguis*, bla - *A. blandianus*, can - *A. canpentris*, dim - *A. diminutivus*, exc - *A. excellens*, fusf - *A. fuscofibrillosus*, fusv - *A. fuscovelatus*, hae - *A. haemorrhoiderius*, imp - *A. impudicus*, iod - *A. iodolens*, lil - *A. lilaceps*, Means with same letter within column are not significantly different . SE± = standard error

Table 4 cont'd: Mean values of the monthly occurrence of species of *Agaricus* in Zaria, 2013

MONTH	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
MAY	0.00^{a}	0.00^{a}	0.00^{b}	0.00^{a}	0.00^{c}	0.00^{b}	0.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{c}	0.00^{a}	0.00^{c}	0.00^{b}	0.00^{c}
JUNE	1.00^{a}	1.00^{a}	0.00^{b}	1.00^{a}	1.00^{bc}	1.00^{b}	1.00^{bc}	0.00^{a}	1.00^{a}	2.00^{a}	1.00^{bc}	1.00^{a}	0.00^{c}	0.00^{b}	0.00^{c}
JULY	2.00^{a}	1.00^{a}	1.00^{ab}	4.00^{a}	2.00^{b}	2.00^{ab}	4.00^{a}	4.00^{a}	1.00^{a}	2.00^{a}	2.00^{ab}	2.00^{a}	3.00^{a}	2.00^{a}	1.00^{ab}
AUGUST	2.00^{a}	4.00^{a}	3.00^{ab}	4.00^{a}	1.00^{bc}	3.00^{a}	2.00^{ab}	4.00^{a}	3.00^{a}	4.00^{a}	3.00^{a}	2.00^{a}	2.00^{b}	2.00^{a}	2.00^{ab}
SEPTEMBER	1.00^{a}	3.00^{a}	3.00^{a}	2.00^{a}	4.00^{a}	1.00^{b}	2.00^{ab}	3.00^{a}	3.00^{a}	3.00^{a}	2.00^{ab}	2.00^{a}	1.00^{c}	1.00^{b}	3.00^{a}
OCTOBER	0.00^{a}	1.00^{a}	0.00^{a}	0.00^{a}	0.00^{c}	0.00^{b}	0.00^{c}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{c}	0.00^{a}	0.00^{c}	0.00^{b}	1.00^{ab}
MEANS	0.91	1.33	1.08	1.42	1.08	1.08	1.33	1.42	1.00	1.50	1.25	0.91	0.91	0.67	0.91
SE±	1.17	1.52	0.66	1.46	0.27	0.42	0.41	1.88	0.68	0.98	0.42	0.82	0.20	0.26	0.58
CV	180.91	160.86	86.76	130.71	35.75	54.61	43.30	168.09	96.61	92.70	47.33	126.75	31.49	54.77	90.17

Keys; mac - *A. macosporus*, mic - *A. micromegatuus*, mur - *A. muranaceus*, pan - *A. pantherina*, pat - *A. pattersoniae*, ker - *A. kerrigan*, pin - *A. pinyonensis*, pla - *A. placomyces*, pon - *A. ponderosa*, por - *A. porphyrocephalus*, sil - *A. silvaticus*, sil - *A. silvicola*, tri - *A. trisulphuratus*, vip - *A. viporarius*, xan - *A. xanthodermus.* Means with same letter within column are not significantly different. SE± = standard error

Conclusions and Recommendations

The study showed that there was significant difference in occurrence and abundance of species of *Agaricus* across the years (2011-2013) which was due to favorable ecological (climatic) factors such as rainfall, relative humidity and temperature. However, Site A_1 (Area A; Botanical garden and Dam site) had the highest distribution of species of *Agaricus* in 2011-2013 across the months of June, July, August and September and the least number recorded was in Kongo Campus and Kufena site. *Agaricus trisulphuratus* was highest in 2011-2013. The study may serve as baseline information for further studies on the taxonomy of other genera of mushrooms in Nigeria. Study on the distribution of species of mushrooms in other parts of Nigeria should be carried out in other to identify species richness.

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