



(RESEARCH ARTICLE)



Ethno-Botanical Studies of Post-harvest Rot of White Yam (*Dioscorea rotundata* Poir.) in the Five South-eastern States of Nigeria

Chioma Lilian Anuagasi* and Raphael Nnaji for Okigbo

Department of Botany, Faculty of Biosciences, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.

GSC Advanced Research and Reviews, 2024, 20(01), 439–455

Publication history: Received on 07 June 2024; revised on 25 July 2024; accepted on 28 July 2024

Article DOI: <https://doi.org/10.30574/gscarr.2024.20.1.0269>

Abstract

White yam (*Dioscorea rotundata* Poir.) is the most important species of yam in West Africa cultivated for the consumption of its starchy tuber. Indigenous knowledge and usage of white yam in some parts of South-Eastern, Nigeria was investigated. This research work aimed at conducting ethno-botanical studies of post harvest rot of white yam in the five South-Eastern states of Nigeria. A well-structured, pre-tested questionnaire on cultivation, post harvest handling of yam, and conservation was designed and administered to obtain crucial information from the respondents within the study area. Five South-Eastern states of Nigeria namely; Abia, Anambra, Ebonyi, Enugu and Imo states were randomly surveyed. Ethno-botanical studies revealed that five hundred and eighty two households about 97% of the respondents were interviewed out of the six hundred questionnaires administered which were successfully retrieved and fully responded to. It was observed that more men (63.67%) were involved in yam farming than women (33.33%) who engage in yam farming. Overall, respondents within the study area who were aware of the indigenous knowledge of yam were significantly ($P < 0.05$) higher than those who were unaware. This ethno-botanical study revealed the traditional concepts and practices relating to yam cultivation and its conservation. Findings from this survey will be utilized as a basis for further investigations on emerging indigenous practices and sustainability impact.

Keywords: Ethno-Botanical; Survey; Rot; Conservation; South-Eastern States of Nigeria

1. Introduction

White yam (*Dioscorea rotundata* Poir.) according to [1, 2] is the most important specie of yam in West Africa. It is a monocotyledonous, perennial herb cultivated for the consumption of its starchy tuber [3]. Okigbo *et al.* [2] reported that the yam tuber is the only economical part of the crop, consumed roasted, fried, boiled, pounded or used as flour for baking and steaming for swallowing with soup. Opara and Nwokocha [4] reported that yams contribute significantly to food security and its availability in the market for a considerable part of the year helps prevent food shortages because it stores relatively longer than other food crops.

The term “Ethno-botany” is a multidisciplinary science that deals with the study of how the people of an exacting culture and region make use of plants. Gurib-Fakim [5] stated that “Ethno-botany” is an interdisciplinary field of research with specific focus on the empirical knowledge of indigenous people with respect to natural plant substances that influence health and wellbeing and their associated risk. Different *Dioscorea* species plays a remarkable position in the traditional medicines for the treatment of various diseases [6]. There are numerous reports available on ethno-medicinal uses of different *Dioscorea* species worldwide [7]-[9].

* Corresponding author: Anuagasi, C. L

[10]-[11] reported that yam is considered a man's crop and has ritual and socio-cultural significance. [12]-[13] reported that yam also plays a major role in the socio-cultural significance of the people mostly the South-Eastern Nigeria and also in the middle belt of Nigeria among the Tiv tribe [14]. Obidiegwu and Akpabio [15] reported that yam is a highly revered cultural crop and key festivities like marriage, chieftaincy ceremonies, conflict resolution, peace accords and sacrifices to the gods are tied to it. [16] reported that our dietary footprints and food habits are to a large extent, ethnically, regionally and culturally interconnected. This survey aims at conducting ethno-botanical studies of post harvest rot of white yam (*Dioscorea rotundata* Poir.) in the five South-Eastern states of Nigeria.

2. Materials and Methods

2.1. Study Area

Geographically, South-Eastern Nigeria extends from latitudes $4^{\circ} 40'$ to $7^{\circ} 20'$ North and $6^{\circ} 00'$ to $8^{\circ} 20'$ East longitude. The map of Nigeria showing the boundary area of the South-Eastern States of Nigeria is shown below (Figure 1). According to reports, 98% of the indigenous ethnic groups in South-East are Igbos by tribe while 2% of the population is the Igala people who lived in the North-Western part. The natural vegetation in many parts of South-Eastern states is mainly grassland and woodland as well as tropical rainforest. Also, the annual rainfall is between 1,400mm in the north to 2,500mm in the south with soil pH in some parts ranging from 3.5 to 6.4 [17].



Figure 1 The Five South-Eastern States of Nigeria [18]

2.2. Ethno-Botanical Survey of White Yam (*Dioscorea rotundata* Poir.)

The method of [19], [15], [20], [21] was adopted in this present study. This involved the use of a well-structured, pre-tested questionnaire to obtain vital information from the respondents in the field. The fieldwork process used interviews, public meetings, local informants, review of secondary and grey literatures and keen observations [15]. The survey on Ethno-botanical study was conducted between September, 2022 to December, 2022 and September, 2023 to December, 2023 in five states of South-Eastern, Nigeria. The states comprises of Anambra, Abia, Enugu, Ebonyi and Imo. A well-structured, pre-tested questionnaire on yam – its functions, importance, cultural value, cultivation as well as post harvest handling was designed and administered randomly to respondents within the study area.

The questionnaire was made up of three sections: The first section was made up of basic information about the respondents, while the second to the third sections focused more on the cultivation and post harvest handling practices, and conservation of yam to ascertain the major practices that may likely predispose yams in the study area to rot and fungal attack in storage. The study adopted a multistage sampling procedure, i.e. in the first stage; stakeholders were targeted, purposely chosen and interviewed from farms and yam loading and offloading points in the study areas. The second stage involved more about the review of grey literatures and comparisons with the results from the fieldwork [21].

The interviews were segmented into two demographic categories (60 years and above and below 60 years) to understand generational differences and associated perceptions related to the topic of study [15]. A public meeting was organized at the point of yam loading and offloading. Obidiegwu and Akpabio [15] reported that these informal yam stations signify a wider representation of yam farmers and distribution of stakeholders from all demographic categories. These stakeholders were interviewed to discern their level of perception of yam farming and livelihood practices. A single interview lasted on average between 45 minutes to one hour. Four local informants were used to facilitate community entry, interactions with interviewees, clarification of issues and interpretations of local dialects.

Field notes were recorded and later categorized and thematized. The questionnaires were sorted accordingly and data collected were used for analysis. The plant materials collected during the field study were pressed, preserved and dried following the standard method of preparation of herbarium techniques [22]. These herbarium specimens were deposited with the taxonomist and curator, Mr. Finian Iroka of Botany Department, Nnamdi Azikiwe University Awka, Anambra State, Nigeria with their respective assigned voucher numbers, after proper identification and authentication.

2.3. Sampling Frame

The respondents to the questionnaire were the Igbo-speaking ethnic group of South-Eastern States of Nigeria. The choice of selecting these areas was because they were predominantly found in Igbo land and also to compare the previous study by [15], [21] who concentrated their study in one out of the five South-Eastern states, namely; Akwa-Ibom, Anambra and Cross River states. In addition, the South-Eastern states have similar cultural and traditional beliefs as well as reverence for yam. All the people speak the same language, Igbo with slight variations in their pronunciations and intonations.

2.4. Sample Size/Sampling Procedure: Administration of questionnaire

A well-structured, pre-tested questionnaire was designed to assist in obtaining crucial information from the respondents in the study area. One hundred and twenty (120) questionnaires were randomly distributed to each of the five South-Eastern States making a ground total of six hundred (600) sampled questionnaires used in this survey.

The questionnaire was constructed to get vital information from respondents as follows;

- Personal data/details such as age, sex, educational qualification, occupation, etc.
- Indigenous knowledge of yam cultivation.
- Labour practices and gender roles in yam cultivation.
- Methods of yam cultivation adopted in their locality.
- Yam storage methods.
- Socio-cultural perspectives on yam distribution practices.
- Uses of yam in worship, marriages, funerals and festivals.
- Disease awareness on yam.
- Causes of post-harvest rot of yam.
- Methods of post harvest disease control of yam.

3. Results

The highest number of questionnaires, one hundred and nineteen (119) was retrieved from Anambra state followed by Enugu state with one hundred and eighteen (118) retrieved questionnaires. In Abia state, one hundred and sixteen (116) questionnaires were retrieved while one hundred and fifteen (115) questionnaires were retrieved from Ebonyi state. The least number of questionnaires, one hundred and fourteen (114) questionnaires was retrieved from Imo state, making a total of 97% questionnaires retrieved in this study (Table 1).

A total of two hundred (200) female respondents and three hundred and eighty two (382) male respondents were interviewed in this survey (Table 2). All the respondents within the study areas in this survey understood and spoke Igbo language fluently with slight differences in the pronunciations and intonations. The highest age bracket of respondents who have indigenous knowledge of yam was obtained from Anambra state, within the age range of 41-50 years old having a total of 56.30% respondents while the least occurred in Ebonyi state, within the age range of 51-60 years old having a total of 3.48% (Table 3). Respondents who have indigenous knowledge of yam in their communities had varying educational qualifications ranging from First School Leaving Certificate (FSLC), West African Senior Secondary Certificate Examination (WASSCE) or the General Certificate Examination (GCE), higher institution of learning or no educational qualification. In Ebonyi state, 73 respondents (63.48%) had no formal type of education. In Abia state, fifty five respondents (47.41%) had the First School Leaving Certificate (FSLC). The least number of educational qualification was obtained in Abia state with only three respondents (2.59%) having higher institution educational qualification (Table 4).

Majority of the respondents interviewed were farmers with some of them engaged with paid employment or self employed and the other respondents were students. In Abia state, one hundred and eleven (111) respondents representing 95.69% interviewed stated that they were farmers, while five (5) respondents representing 4.31% had paid employment (Table 5). In Anambra state, one hundred and one (101) respondents representing 84.87% were farmers while eighteen (18) respondents representing 15.13% were students. None of the respondents were engaged in paid employment or self employment. In Ebonyi state, six (6) representing 5.22% of the respondents were engaged in paid employment, five (5) respondents representing 4.35% were engaged in self employment, seven (7) respondents representing 6.09% of the respondents were students and ninety seven (97) respondents representing 84.35% were farmers. In Enugu state, eight (8) respondents representing 6.78% were engaged in paid employment, five (5) respondents representing 4.24% were self employed, eleven (11) respondents representing 9.32% were students, ninety two (92) respondents representing 77.97% were farmers while two (2) respondents representing 1.69% were self employed and farmers as well. In Imo state, eighty three (83) respondents representing 72.81% were farmers, twenty (20) respondents representing 17.54% were students and eleven (11) respondents representing 9.65% had paid employment. No respondent was self employed (Table 5).

Respondents interviewed specified that the age range actively involved in yam cultivation in their community were able bodied young men who make up the large proportion of the labour market and forms a greater majority of the work force. The highest age range actively involved in yam cultivation was observed in Ebonyi state and it fell within the age range of 31-40 years old, having a total of 68.70% of the respondents. The least age range actively involved in yam production was observed in Anambra state which fell within the age range of sixty (60) years and above (≥ 60) representing 3.36% of the respondents and was followed by 3.48% of the respondents in Ebonyi state within the same age range (Table 6).

There were different levels of involvements in yam production by the respondents observed during this survey. The highest level of involvement observed in yam production was found in Ebonyi state amongst yam farmers ($P < 0.05$), representing 69.57% of the respondents. This is followed by 61.34% respondents interviewed in Anambra state. However, the least value of 26.27% of the respondents was observed in Enugu state amongst yam farmers (Table 7). Most respondents interviewed also had a combination of different levels of involvement in yam production in their communities. Some of them were yam farmers as well as yam collectors/distributors, yam farmers as well as yam sellers/retailers, yam collectors/distributors as well as yam seller/retailers while others were yam farmers, yam collectors/distributors, yam sellers/retailers and consumers (Table 7).

Respondents who were aware of the indigenous knowledge of the processes involved in the cultivation of yam were significantly ($P < 0.05$) higher in comparison to those who were unaware of the indigenous knowledge of the processes involved in the cultivation of yam (Table 8). In Anambra state and Ebonyi state, respondents who had awareness of the indigenous knowledge of yam production were statistically ($P < 0.05$) higher representing 100% of the respondents than those who lack awareness of the indigenous knowledge of yam cultivation. This is followed by Imo state representing

99.12% of the respondents with the least being Enugu state with 85.59% of the respondents (Table 8). Figure 2 shows a freshly harvested tuber of white yam (*Dioscorea rotundata* Poir.) from the farm.

Yam farmers interviewed gave several reasons for their intentions on seed yam production. Seed yams are very important and determine the overall production output of yam yearly. In other words, healthy, fertile, vigorous and sizeable seed yams produce a bountiful harvest. Majority of the respondents interviewed stated that their intent for seed yam production was for private use in combination with sales to make profits. Abia state representing 98.28% of the respondents had the highest value ($P < 0.05$) of farmer's intent for seed yam production as private use in combination with sales to make income. This is followed by Imo state representing 92.98% of the respondents. The least value was observed in Enugu state representing 72.88% of the respondents (Table 9). There was no significant ($P > 0.05$) difference between the respondents whose intention for seed yam production was for private use only to that of those whose intention for seed yam production was exclusively for sales to make profit. However, no respondents gave charity as their intention for seed yam production (Table 9).

All the farmers interviewed acknowledged that they depend on family labour comprising men, women and children for yam cultivation. Respondents mentioned that there could be a need for hire especially at the peak of farming season depending on the relative size of the farm. In Abia state, 81.90% of the respondents used hired labour in yam cultivation. This is followed by 71.30% of the respondents in Ebonyi state with the least being 48.31% of the respondents in Enugu state. In this survey, it was observed that the respondents relied heavily on hired labour which was statistically ($P < 0.05$) higher in comparison to the other labour practices enumerated for this survey (Table 10). In Anambra state, 31.09% of the respondents reported that they complement hired labour with family labour during the peak season of farming. Across all the five South-Eastern states, there was no significant ($P > 0.05$) difference between the respondents who used mechanized labour to those who utilized labour exchange groups. In Enugu state, 7.63% of the respondents said that they mostly depend on family labour with hired labour sources. In Imo state, 19.30% of the respondents noted that they employed hired labour with labour exchange groups as the major source of labour practices involved in yam cultivation (Table 10).

It was observed during this survey that men performed labour roles different from the ones performed by women. Specific labour roles which were considered tedious were assigned to men such as cutting/clearing, tilling/mound making as well as planting, mulching and staking. In Anambra state, 82.35% respondents stated that they employed men and young boys for cutting/clearing their farmlands which they claimed are faster and gets more done in less time. This value 82.35% was statistically higher ($P < 0.05$) than the other values obtained for other states (Table 11). Other less tedious tasks which require more skills in execution were assigned to women and young girls. A total of 94.83% of the respondents in Abia state preferred using women and young girls for weeding due to the perceptions of their ability for greater weeding efficiency. This value 94.83% obtained in Abia state is significantly ($P < 0.05$) higher than the values obtained in Ebonyi state (86.96%) and Enugu state (76.27%). This is followed by 89.92% and 87.72% of the respondents obtained in Anambra state and Imo state respectively (Table 11).

The key aspect of yam production lies in the transfer from farms to preservation and distribution. After harvesting, yam tubers need to be conserved until they are either sold or eaten and seed yams are conserved for utilization in the next planting season. The respondents interviewed during this survey highlighted four main traditional storage methods out of the six enumerated for this survey with a combination of two or more methods in some cases. It was observed that the respondents did not utilize straws and sticks except for 7.63% of the respondents in Enugu state. It was also observed that the use of yam barns by the respondents was significantly ($P < 0.05$) higher when compared with the other methods of yam storage. The highest percentage of the respondents (56.82%) who used yam barns as method of storage was recorded in Ebonyi state. This was followed by Enugu state and Imo state with 50.00% and 42.11% respondents respectively. The least percentage (12.60%) was recorded in Anambra state (Table 12). The use of heaps as a method of yam storage was observed to be adopted the most by the respondents interviewed in Anambra state by 42.02%. This value was significantly ($P < 0.05$) higher than those recorded in Imo state (35.09%). The least value (9.48%) of the respondents who used heaps as a method of yam storage was recorded in Abia state. Only 5.08% of the respondents interviewed in Enugu state used mud as a method of yam storage (Table 12). In Enugu state and Imo state, 0.85% and 0.87% of the respondents reported the use of raffia bags and compact storage respectively for storage. On the other hand, most of the respondents interviewed, reported the use of a combination of two methods of yam storage. The most commonly used combination method of storage observed in this survey was the use of heaps and yam barns. The highest percentage (75.86%) of the respondents was recorded in Abia state. This was followed by 45.38% of the respondents recorded in Anambra state. The least (10.17%) of the respondents was observed in Enugu state (Table 12). Some of the yam storage methods observed during this survey was captured in photographs and presented below (Figure 3).

The storage period was evaluated in this survey and the highest storage period of 1-3 months was observed in Abia state where 79.31% of the respondents attested to storing their yams for a period of one to three months. The storage period of 4-6 months was observed to be the highest in Imo state with 43.86% of the respondents. Respondents who stored their yams for the duration of 7-9 months and more than 9 months were not significantly ($P>0.05$) higher than the other aforementioned storage periods (Table 13). The best quarter for the storage of the yam produce was investigated in this survey. Respondents gave varying views about the quarter of the year they store yams. In Abia state, 65.52% of the respondents interviewed reported that they preferred to store their yams between the quarters of January to March. In Anambra state, 79.83% of the respondents interviewed stated that they preferred to store their yams between the quarters of October to December. Those who stored their yam produce between the quarters of July to September were significantly ($P<0.05$) higher than those who stored their yam produce between the quarters of April to June (Table 14). Other respondents interviewed reported that they preferred to store their yam produce for two quarters with periods spanning from January to June, July to December and October to March. The highest quarters were October to March and Ebonyi state, recorded the highest value of 33.91%. This was closely followed by Imo state with 29.82% respondents and the least was Enugu state with 10.17% respondents. There was no significant ($P>0.05$) difference between respondents who stored their yam produce between the quarters of January to June to that of those who stored their yam produce between the quarters of July to December (Table 14).

The survey on the use of chemical pesticides during storage revealed that 100% of the respondents in Abia state, Anambra state, Ebonyi state and Imo state do not use fungicides during storage. Only a small proportion, 0.85% of the respondents agreed that they use fungicides during storage in Enugu state. Respondents who do not use fungicides for storage were significantly ($P<0.05$) higher than those who use fungicides for storage (Table 15). The awareness of natural methods of storage was surveyed. The highest percentage of respondents who were aware of other natural methods of storage was observed in Ebonyi state where 69.57% of the respondents affirmed their awareness of other natural methods of storage (Table 15). In Abia state, 100% of the respondents were not aware of other natural methods of storage. This was followed by Anambra state where 97.48% of the respondents were not aware of other natural methods of storage. Respondents who were not aware of other natural methods of storage was significantly ($P<0.05$) higher than those who were aware of other natural methods of storage (Table 15).

Factors predisposing yams to rot and fungal infestations in storage were surveyed. The major factors identified by the respondents in this study include; natural wounds, field pests, cuts from diggers and field diseases. In Abia state, 100% of the respondents reported that all the aforementioned factors predisposes yam to rot and fungal attack in storage. This was followed by Imo state where 95.61% of the respondents agreed to the same view and the least was Enugu state with 81.36% (Table 16). All the aforementioned factors combined that predisposes yams to rot and fungal infestation in storage were significantly ($P<0.05$) higher than the individual factors that predisposes yams to rot and fungal infestation in storage (Table 16). The type of diseases the respondents encountered in the storage was investigated. According to most of the respondents, dry rot was mostly encountered in storage. In Ebonyi state, 93.91% of the respondents reported that they encountered dry rot in the storage. This is followed by Imo state with 77.19% respondents and the least was observed in Anambra state where 48.74% of the respondents reported that they encountered dry rot in storage (Table 17). Soft rot is another storage disease observed in Anambra state with 26.05% of the respondents while the least was reported in Ebonyi state with 4.35% of the respondents reporting same. Some of the respondents reported that they encountered dry rot and soft rot in storage. Others reported that they encountered dry rot and wet rot. While some others reported that they encountered all three storage diseases. However, there was no significant ($P>0.05$) difference between the respondents who encountered two or more of the storage diseases to those who encountered the storage diseases singly (Table 17).

Table 1 Frequency of Retrieved Questionnaires across States

States	Frequency	Percentage	Cumulative Frequency	Cumulative Percentage
Abia	116	19.93	116	19.93
Anambra	119	20.45	235	40.38
Ebonyi	115	19.76	350	60.14
Enugu	118	20.27	468	80.41
Imo	114	19.59	582	100.00

Table 2 Sex Distribution of Respondents in the Study Area

States	Sex	Frequency	Percentage (%)
Abia	Male	76	65.52
	Female	40	34.48
	Total	116	100.00
Anambra	Male	75	63.03
	Female	44	36.97
	Total	119	100.00
Ebonyi	Male	77	66.96
	Female	38	33.04
	Total	115	100.00
Enugu	Male	73	61.86
	Female	45	38.14
	Total	118	100.00
Imo	Male	81	71.05
	Female	33	28.95
	Total	114	100.00

Table 3 Age Range and Distribution of Respondents

States	Age Range of	Respondents	(%)		
	21-30	31-40	41-50	51-60	≥ 60
Abia	0.00	28.45	31.89	29.32	10.34
Anambra	15.13	4.20	56.30	18.49	5.88
Ebonyi	27.83	44.34	24.35	3.48	0.00
Enugu	25.42	34.75	14.41	13.56	11.86
Imo	28.95	19.30	29.82	12.28	9.65

Table 4 Educational Qualifications of Respondents

States	Educational Qualifications	Frequency	Percentage (%)
Abia	FSLC	55	47.41
	WASSCE/GCE	20	17.24
	Higher Institution	3	2.59
	None	38	32.76
Anambra	FSLC	52	43.70
	WASSCE/GCE	7	5.88
	Higher Institution	18	15.13

	None	42	35.29
Ebonyi	FSLC	10	8.70
	WASSCE/GCE	18	15.65
	Higher Institution	14	12.17
	None	73	63.48
Enugu	FSLC	16	13.56
	WASSCE/GCE	37	31.36
	Higher Institution	17	14.41
	None	48	40.68
Imo	FSLC	10	8.77
	WASSCE/GCE	45	39.47
	Higher Institution	14	12.28
	None	45	39.47

Table 5 Occupations of the Respondents

States	Occupation	Frequency	Percentage (%)
Abia	Paid Employment	5	4.31
	Self Employment	0	0.00
	Student	0	0.00
	Farmer	111	95.69
Anambra	Paid Employment	0	0.00
	Self Employment	0	0.00
	Student	18	15.13
	Farmer	101	84.87
Ebonyi	Paid Employment	6	5.22
	Self Employment	5	4.35
	Student	7	6.09
	Farmer	97	84.35
Enugu	Paid Employment	8	6.78
	Self Employment	5	4.24
	Student	11	9.32
	Farmer	92	77.97
	Self Employed + Farmer	2	1.69
Imo	Paid Employment	11	9.65
	Self Employment	0	0.00
	Student	20	17.54
	Farmer	83	72.81

Table 6 Age Range Actively Involved in Yam Cultivation

States	Age Range	Of the	Respondents	(%)	
	21-30	31-40	41-50	51-60	≥ 60
Abia	0.00	35.34	34.48	21.55	8.62
Anambra	10.92	10.92	57.14	17.65	3.36
Ebonyi	27.83	69.70	0.00	0.00	3.48
Enugu	17.80	30.51	21.19	17.18	12.71
Imo	29.20	9.73	38.94	12.39	9.73

Table 7 Level of Involvement in Yam Production by the Respondents

Levels of Involvement in Yam Production (%)									
States	Yam Farmer (a)	Yam Collector/ Distributor (b)	Yam Seller/ Retailer (c)	Yam Loader/ Off loader (d)	Yam Consumers (e)	(a)+(b)	(a)+(c)	(b)+(c)	(a)+(b)+(c)+(e)
Abia	52.59	6.03	18.10	13.79	3.45	0.00	6.03	0.00	0.00
Anambra	61.34	8.40	21.85	8.40	0.00	0.00	0.00	0.00	0.00
Ebonyi	69.57	7.83	6.96	15.65	0.00	0.00	0.00	0.00	0.00
Enugu	26.27	16.10	23.73	22.88	4.24	0.00	3.39	3.39	0.00
Imo	34.21	13.16	20.18	14.91	3.51	3.51	3.51	6.14	0.88

Table 8 Awareness of Indigenous Knowledge Involved in Yam Cultivation

States	Awareness of Indigenous Knowledge of Yam Production (%)	Lack of Awareness of Indigenous Knowledge of Yam Production (%)
Abia	95.69	4.31
Anambra	100.00	0.00
Ebonyi	100.00	0.00
Enugu	85.59	14.41
Imo	99.12	0.88



Figure 2. Freshly Harvested Tubers of White Yam (*Dioscorea rotundata* Poir.) from the Farm

Table 9 Intent for Seed Yam Production by Yam Farmers

States	Intentions for Seed Yam Production (%)			
	Private use Only	Private use in combination with sales to make income	Exclusively for sales to make income	Charity
Abia	0.00	98.28	1.72	0.00
Anambra	1.68	86.55	11.76	0.00
Ebonyi	20.00	74.78	5.22	0.00
Enugu	13.56	72.88	13.56	0.00
Imo	0.88	92.98	6.14	0.00

Table 10 Labour Practices Involved in Yam Cultivation

States	Sources of Labour Practices (%)							
	Family Labour (a)	Hired Labour (b)	Mechanized Labour (c)	Labour Exchange Groups (d)	(a+b)	(a+c)	(b+c)	(a+b+c+d)
Abia	9.48	81.90	3.45	5.17	0.00	0.00	0.00	0.00
Anambra	31.09	63.87	3.36	1.68	0.00	0.00	0.00	0.00
Ebonyi	20.87	71.30	4.35	3.48	0.00	0.00	0.00	0.00
Enugu	25.42	48.31	5.93	4.24	7.63	0.85	3.39	4.24
Imo	7.02	68.42	1.75	3.51	0.00	0.00	19.30	0.00

Table 11 Gender Labour Roles in Yam Cultivation

States	Labour Practices	Males		Females	
		Frequency	Percentages (%)	Frequency	Percentages (%)
Abia	Cutting/Clearing	73	62.93	43	37.07
	Tilling/Mound making	82	70.69	34	29.31
	Planting, Mulching and Staking	70	60.34	46	39.66
	Weeding	6	5.17	110	94.83
	Harvesting	34	29.31	82	70.69
Anambra	Cutting/Clearing	98	82.35	21	17.65
	Tilling/Mound making	86	74.14	33	25.86
	Planting, Mulching and Staking	90	75.63	29	24.37
	Weeding	12	10.08	107	89.92
	Harvesting	34	28.57	85	71.43
Ebonyi	Cutting/Clearing	86	74.78	29	25.22
	Tilling/Mound making	72	62.61	43	37.39
	Planting, Mulching and Staking	60	52.17	55	47.83
	Weeding	15	13.04	100	86.96
	Harvesting	28	24.35	87	75.65
Enugu	Cutting/Clearing	88	74.58	30	25.42
	Tilling/Mound making	80	67.80	38	32.20
	Planting, Mulching and Staking	88	74.58	30	25.42
	Weeding	28	23.73	90	76.27
	Harvesting	38	32.20	80	67.80
Imo	Cutting/Clearing	74	64.91	40	35.09
	Tilling/Mound making	52	45.61	62	54.39
	Planting, Mulching and Staking	60	52.63	54	47.37
	Weeding	14	12.28	100	87.72
	Harvesting	30	26.32	84	73.68

Table 12 Yam Storage Methods Utilized by the Respondents

States	Yam Storage Methods/Techniques (%)						
	Straws and Sticks	Heaps	Yam Barns	Mud (Burying in the Mud)	Raffia Bags	Compact Storage	Heaps Barns +Yam
Abia	0.00	9.48	14.66	0.00	0.00	0.00	75.86
Anambra	0.00	42.02	12.60	0.00	0.00	0.00	45.38
Ebonyi	0.00	10.14	56.82	0.00	0.00	0.00	33.04
Enugu	7.63	26.27	50.00	5.08	0.85	0.00	10.17
Imo	0.00	35.09	42.11	0.00	0.00	0.87	21.93



(a)-(b) Heaps method; (c) Yam Barn; (d) Compact Storage using straws and sticks

Figure 3 Yam Storage Methods Observed During the Ethno-botanical Survey

Table 13 Duration of the Storage Period

States	Storage Periods (%)			
	1-3 months	4-6 months	7-9 months	More than 9 months
Abia	79.31	20.69	0.00	0.00
Anambra	57.98	37.82	1.69	2.52
Ebonyi	57.39	35.65	2.61	4.35
Enugu	50.00	36.44	4.24	9.32
Imo	53.51	43.86	1.75	0.88

Table 14 Quarters of the Storage Period

States	Quarters of the Storage Period (%)						
	January-March	April-June	July-September	October-December	January-June	July-December	October-March
Abia	65.52	0.00	0.00	9.48	0.86	0.00	24.14
Anambra	12.61	5.88	1.68	79.83	0.00	0.00	0.00
Ebonyi	44.35	0.00	3.48	18.26	0.00	0.00	33.91
Enugu	17.80	0.00	18.64	50.00	0.00	3.39	10.17
Imo	18.43	0.00	8.77	42.98	0.00	0.00	29.82

Table 15 Use of Fungicides during Storage and Awareness of other Natural Methods of Storage without Fungicides

States	Use of Fungicides for Storage		Awareness of Natural Methods of Storage	
	Yes (%)	No (%)	Yes (%)	No (%)
Abia	0.00	100.00	0.00	100.00
Anambra	0.00	100.00	2.52	97.48
Ebonyi	0.00	100.00	69.57	30.43
Enugu	0.85	99.15	12.71	87.29
Imo	0.00	100.00	18.42	81.58

Table 16 Factors Predisposing Yams to Rot and Fungal Infestation in Storage

States	Factors Predisposing Yams to Rot (%)				
	Through Natural Wounds	Field Pests	Cuts from Diggers	Field Diseases	All of the Above
Abia	0.00	0.00	0.00	0.00	100.00
Anambra	1.68	1.68	9.24	1.68	85.72
Ebonyi	0.00	3.48	6.96	2.60	86.96
Enugu	3.39	11.01	3.39	0.85	81.36
Imo	0.88	0.88	2.63	0.00	95.61

Table 17 Storage Diseases Encountered during the Survey

States	Storage Diseases (%)					
	Dry Rot	Wet Rot	Soft Rot	All of the above	Dry Rot +Soft Rot	Dry Rot +Wet Rot
Abia	68.97	10.34	17.24	0.00	3.45	0.00
Anambra	48.74	24.37	26.05	0.84	0.00	0.00
Ebonyi	93.91	1.74	4.35	0.00	0.00	0.00
Enugu	70.34	5.93	16.10	6.78	0.85	0.00
Imo	77.19	11.41	9.65	0.00	0.00	1.75

4. Discussion

Respondents across the five South-Eastern states of Nigerian were knowledgeable about the indigenous use of yam in their community. A total of five hundred and eighty two (582) households were randomly surveyed and interviewed. Thus, making a total of 97% questionnaires retrieved in this study (Table 1). This is similar to the observation of [19]. More males, three hundred and eighty two (382) about 63.67% were involved in yam farming against two hundred (200) females about 33.33% (Table 2). This agrees with the study of [15], [21] who reported that more men were involved in yam farming because yam is a “male” crop [11] which requires high tensile strength for the farming operations.

All the age ranges of the respondents sampled had indigenous knowledge of yam in their community. However, respondents who were middle-aged seemed to have more knowledge than the other age ranges (Table 3). Educational qualification of the respondents showed that majority of the yam farmers had little to basic educational qualifications. This observation did not correlate with the study of Mazza *et al.* [23] who reported that four variables namely age, farm size, educational level and income from other farm produce were significant factors affecting farmer’s income generation.

A great majority of the respondents interviewed were yam farmers by occupation (Table 5). Others were yam farmers but had paid employment, students or self employed. Respondents interviewed specified that the age range actively involved in yam cultivation in their community were able-bodied young men of average age. This is in tandem with [24] in “Things Fall Apart” who stated that yam farming is not for the “Ofeke” or lazy man and [23] who reported that active farming was by middle-aged men. Different levels of involvement in yam production were observed. Most respondents interviewed were yam farmers, others were yam sellers/retailers, yam collectors/distributors, yam loaders/off loaders as well as consumers. A combination of more than one level of involvement in yam cultivation was also observed. This is in tandem with [21] who took cognizance of other levels of involvement in yam production as economic actors in the yam production and intermediary chains.

It was confirmed that respondents who were aware of the indigenous knowledge of the processes involved in the cultivation of yam were significantly higher in comparison to those who were unaware. This is in tandem with [15], [21] who elaborated the level of awareness of the respondents they interviewed. It was observed that yam farmers engage in seed yam production with various intents. From this survey, most of the respondents affirmed that their intents for seed yam production were for private use in combination with sales to make profit (Table 9). This observation is in sharp contrast with that of [21] who reported that 53% of their respondents produced yam for private use only, 46% produced for private use and sale while only 1% produced for sale in Cross River state. This may be due to the remote nature of the study area. However, in this study it was observed that more respondents produced seed yam exclusively for sales to make income than for private use only. No respondent gave charity as their intent for seed yam production. This was attributed to the current economic crunch in the country by the respondents.

Labour practices involved in yam cultivation were evaluated. A good number of the respondents acknowledged that they depend on family labour comprising of men, women and children for yam cultivation. Majority of the respondents affirmed that they outsource labour (hired labour) by hiring especially at the peak of the farming season due to their large farm sizes for commercial agricultural purposes (Table 10). A small number of the farmers with large expanse of land draw on mechanical sources (mechanical labour). Labour exchange group is social and involves mutual labour support and assistance from families, groups and cooperatives on a “turn by turn” basis. Others required a combination of labour sources such as family labour in combination with hired labour, family labour supplemented by mechanized labour, hired labour in combination with mechanical sources while other respondents require all four labour sources due to their farm size to cope with the pressure of peak season farming. This observation is in contrast with the study by [21] who reported that most of their respondents (100%) depended on family labour, 38% on labour exchange groups, 31% on hired labour and 1% on mechanized labour.

Gender labour roles in yam cultivation were evaluated and it was observed that men performed labour roles significantly ($P < 0.05$) different from the ones performed by women. There is usually more demand for specific labour tasks such as cutting/clearing, tilling/mound making, weeding, planting, mulching and staking which are usually assigned to men. It is noteworthy that while cutting/clearing, tilling/mound making demand more tensile strength, weeding requires more skills in execution. However, it was observed that weeding and harvesting which required more skills and technicality in execution were assigned to women in this survey. More males were assigned arduous tasks while females were assigned labour tasks requiring more skills and technicality in execution. This is in sync with [15], [21] who observed same labour roles amongst the male and female gender in their studies. They opined that the number

of fields in which men provided the bulk of the labour was highest during land clearing, mound making and planting. Thus, confirming that both men and women are heavily engaged in different yam cultivation and post-harvest tasks.

The key aspect of yam cultivation lies in the transfer from farms to preservation and distribution. Hence, storage is inevitable in yam cultivation. The straws and sticks technique for yam storage utilized these components as preservatives where certain leaves and sticks are used in storage to further protect harvested yams from diseases and pest attacks. Compact storage refers to the technique where yams are packed in an organized form in a vehicle, preventing spaces in between them as much as possible. Heaps technique involves gathering tubers of yam together after sorting them into various sizes. The heaps method is usually used by yam seller/retailers for ease of marketing. Yam barn is the most traditional method of yam storage where yams are tied with twine against segments of interlocked bamboo or raffia under a shaded area. The size of one's barn is a measure of his dominance and societal reverence amongst his kin [24]. Respondents who still use this method of storage were above 60 years of age. Traditional mud method of storage simply involves burying yam tubers in the mud. Raffia bags were mainly used by collectors as the major material of storage and distribution (Table 12).

The main storage technique observed amongst respondents was a combination of heaps and yam barn methods. This is a contrast to [21] who reported the use of four storage techniques namely; straws and sticks, mud, raffia bags and compact storage across livelihoods by the respondents. This current study did not take cognizance of storage techniques across livelihoods. It was also observed that most of the respondents above 60 years of age adopted raffia bags, mud, straws and sticks techniques which were the more traditional forms of storage. A 73 years old male respondent in Anambra state said that the use of yam barn asserts one's wealth and dominance in the society but also attracts envy from his kin. Obidiegwu and Akpabio [15] hold a different view, that yam barn is a symbol of one's wealth and that some social responsibility is enshrined in societal tradition. Such that even though collection of yam tubers from the barn is not physically demanding, this privilege is usually arrogated to men who are regarded as the chief custodians of the yam barn.

Respondents reported the duration of the storage to be 1-3 months, while other respondents stored yam for a period of 4-6 months. The values obtained for these storage periods were significantly ($P < 0.05$) higher than those who store yam for a period of 7-9 months and more than 9 months (Table 13). Similarly, the quarter of the storage period was evaluated to determine the best quarter for the storage of yam. Most respondents preferred to store yam between the quarters of October to December. This is in tandem with Ema *et al.* [21] who reported that the period spanning July and September was reserved for harvesting while the remaining months following were usually for storage. Others preferred the quarter of January to March to store yam tubers. Other respondents interviewed preferred to store their yam tubers for two quarters with periods spanning from January to June, July to December and October to March (Table 14).

It was confirmed in this study that yam farmers do not use chemical pesticides (fungicides) during storage. Only a small percentage (0.85%) in Enugu state affirmed that they use fungicides during storage. A 65 years old male respondent in Anambra state pointed out that the use of chemical in storage induces rot in the yam tubers. Most of the respondents interviewed were not aware of other natural methods of storage. About 69.57% of the respondents in Ebonyi state affirmed their awareness of other natural methods of storage (Table 15). They mentioned the use of ash from the fire place as a natural method of storage.

The major factors predisposing yam tubers to rot and fungal attack in storage in this survey includes; through natural wounds, field pests, cuts from diggers and field diseases (Table 16). This is in tandem with [2] who reported that rot starts in the field and continues in storage. Storage diseases encountered by the respondents include; dry rot, wet rot, soft rot and a combination of dry rot and soft rot or dry rot and wet rot and the occurrence of all three storage diseases in storage (Table 17). A 60 years old male respondent in Anambra state reported that dry rot was mostly encountered in storage because of the non-usage of chemicals. But in cases where chemicals are used, wet rot or soft rot is usually encountered. Similarly, a 43 years old male respondent in Ebonyi state reported the same.

There were limitations encountered during the survey of ethno-botanical study. The first is the sample size. It is important to state that one hundred and twenty (120) questionnaires are not enough to obtain all the vital information from each state of South-Eastern, Nigeria. Secondly, relevant stakeholders such as traditional rulers, religious priests, public officials and urban dwellers were not interviewed. This inability to interview these individuals means that the findings in this study do not represent every segment of what is applicable about yam in South-Eastern, Nigeria. Also, the study followed two farming circles in order to get adequate information from the respondents which prolonged the study. Furthermore, insecurity in the South-Eastern states of Nigeria restricted interviews in major yam cultivating zones of the region during this survey.

5. Conclusion

This survey revealed that the respondents had indigenous knowledge of yam, its cultivation, conservation and socio-cultural importance. This ethno-botanical study of white yam has bridged the knowledge gap of indigenous use of yam in the South-Eastern states of Nigeria. Findings from this survey will be utilized as a basis for further investigations on the emerging indigenous practices and sustainability impact.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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