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Ethno-Botanical Study of Water Yam (*Dioscorea alata* L.) Tubers in Storage in the South-Eastern Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Water yam tubers are staple food consumed in South-Eastern Nigeria. This investigation focused on indigenous knowledge and usage of water yam tubers in South-Eastern Nigeria. A well-structured questionnaire 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. Descriptive statistics were adopted and relationships among some variables were checked with percentage error bars in MS EXCEL version 2007. Six hundred questionnaires successfully retrieved were responded to. The results were analyzed by gender, age groups and locations. The study revealed that 62% of the respondents were aware of water yam cultivation, 41% grew water yam tubers as food because of its nutritional importance while 94% believed that water yam had medicinal value. The findings from the study will be used as basis for further research on emerging indigenous practices and sustainability impact.

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Keywords: Ethno-botanical study; Nigeria; South East; storage; water yam.

1. INTRODUCTION

Yam (*Dioscorea* spp) belongs to the genus *Dioscorea* (Family *Dioscoreaceae*) and is the second most important tropical root crop in West Africa after cassava [1] and form an important food source in other tropical countries including East Africa, the Caribbean, South America, India and South East Asia [2,3].

Okigbo [3] estimated that the world production of yams is around 20 million tonnes per year. The greatest part of the world yam production (over 90%) is derived from West Africa [2,3,4]. and Nigeria alone produces three-quarters of the world total output of yam [5,3]. Yams are the fifth most harvested crops in Nigeria, following after cassava, maize, guinea corn and beans/cowpeas. More so, after cassava, yams are the most commonly harvested tuber crops in the country [6]. Yams do not only serve as the main source of earnings and food consumption, but also as a major employer of labour in Nigeria.

Despite the importance of yams to people, the attention to its production is still questionable [7]. Studies by Zaknayiba and Tanko [8] reveal that lack of access to inputs, finance, poor producer prices, inadequate storage facilities, incidence of pests and diseases have negatively affected yam production. Similarly, [9] examined some determinants of yam production in particular regions (North Central zone, North West zone, South East zone and South West Zone) in Nigeria. They found that the factors of production such as labour, finance and material inputs like fertilizer have influenced yam production in the region.

Among the wide species reported, only about ten species are estimated to have been domesticated across Africa, Asia and Latin America for food and income generation [10]. Of the ten cultivated species of yam, the six most important in Nigeria are: *Dioscorea rotundata* Poir (white yam), *Dioscorea alata* L. (water yam), *Dioscorea cayenensis* Lam. (yellow yam), *Dioscorea dumetorum* (Kunth) Pax. (cluster or bitter yam), *Dioscorea bulbifera* L. (aerial yam) and *Dioscorea esculenta* (Loir) Bark (Chinese yam) [11,12].

Water yam (*Dioscorea alata* L.) is the most economically important yam species which serve as a staple food for millions of people in tropical and subtropical (South China, India, Sri Lanka, Brazil, South Africa) countries [2,13]. *Dioscorea alata* is a crop with potential for increased consumer demand due to its low sugar content necessary for diabetic patients [14]. According to Scott et al. [15] water yam (*Dioscorea alata* L.) is the most widely distributed species of yam, though the total quantity produced is less than that of white yam. Water yam (*Dioscorea alata* L.) is grown widely in tropical and subtropical regions of the world. They are plants yielding tubers and contain starch between 70% and 80% of dry matter [16,17].

The tuber is the only economically important part of the crop and according to Sangoyomi [18] it is consumed roasted, fried, boiled, pounded or as flour which can be reconstituted with hot water. Yam tubers are of a very high value, as in food, where it is a major source of carbohydrate, minerals of calcium, phosphorus, iron and vitamin B and C [2,19]. It provides other nutritional benefits such as proteins, lipids, vitamins and minerals [20].

Across different ethnic communities and geographic regions, diverse species of *Dioscorea* have been adapted within different habitation as a food source due to the high nutritional benefits and therapeutic values toward treatment and cure of certain health problems [21,22]. While yam is one of the most important staple root and tuber crops worldwide, it is still classified as an orphan crop because it is highly underutilized and receives little investment or research attention toward crop improvement. Yam plays a significant role in food security, medicine and economy in the developing countries. Its importance places it as the fourth most essential and utilized root and tuber crop globally after potatoes (*Solanum* spp.), cassava (*Manihot esculenta*) and sweet potatoes (*Ipomoea* spp.) and the second in West Africa after cassava [23]. This is evident in annual global production, especially in West Africa.

In addition, the significance of yam in the cultural, social and religious environment of West Africa cannot be overemphasized [24]. Its symbolism as king of crops is manifested in its use in ceremonies such as those for fertility and marriages, as well as an annual festival held to celebrate its harvest. Importantly, the cultural and linguistic diversity that cuts across West Africa has no influence on the beliefs, social values and

religious practices attached to the yam crop. In spite of the importance of yams as major staple food and its socio-cultural value in the lives of the people of the West and Central Africa sub-region, research and documentation on this important staple food crop is very limited [18]. This present investigation focused on the indigenous knowledge of water yam in storage in the South-Eastern Nigeria.

2. MATERIALS AND METHODS

2.1 Ethno-Botanical Study of Water Yam

The method of Akpaja et al. [25] was used in the study area which involved the use of a well-structured questionnaire to obtain vital information from the respondents.

2.2 Study Area

The study was conducted in the South-Eastern Nigeria (Fig. 1). Geographically, South-Eastern Nigeria extends from latitudes 4^0 40^l to 7^0 20^l North and 6^0 00^l to 8^0 20^l East longitude. The study area occupies about 50,000 km^2 of Nigeria's total area of 923, 768km^2. A 2006 Census population estimate by the National Population Commission (NPC) reported that the South-Eastern Nigeria has a population of 30 million people [26]. The crops commonly grown in this region include but not limited to yam, cassava, cocoyam, and various vegetables and fruits. 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 1400mm in the north to 2500mm in the south with soil pH in some parts ranging from 3.5 to 6.4 [27].

2.3 Sampling Frame

The respondents to the questionnaires were the people from each of the five South Eastern States of Nigeria. The reason for selecting the area was because they were yam-producing and Igbo-speaking area. Besides, they share similar cultural and traditional beliefs.

2.4 Questionnaire Administration

A well-structured questionnaire was designed to aid in obtaining crucial information from the population of the study area. One hundred and twenty (120) questionnaires were distributed to the study population of different age groups in each of the five South Eastern States, making a total of six hundred (600) questionnaires used in the study. The questionnaires were constructed to get vital information as follows:

a. Demographic characteristics of the respondents.
b. Factors responsible for water yam cultivation.
c. Predisposing factors that deterred the production and storage of water yam.

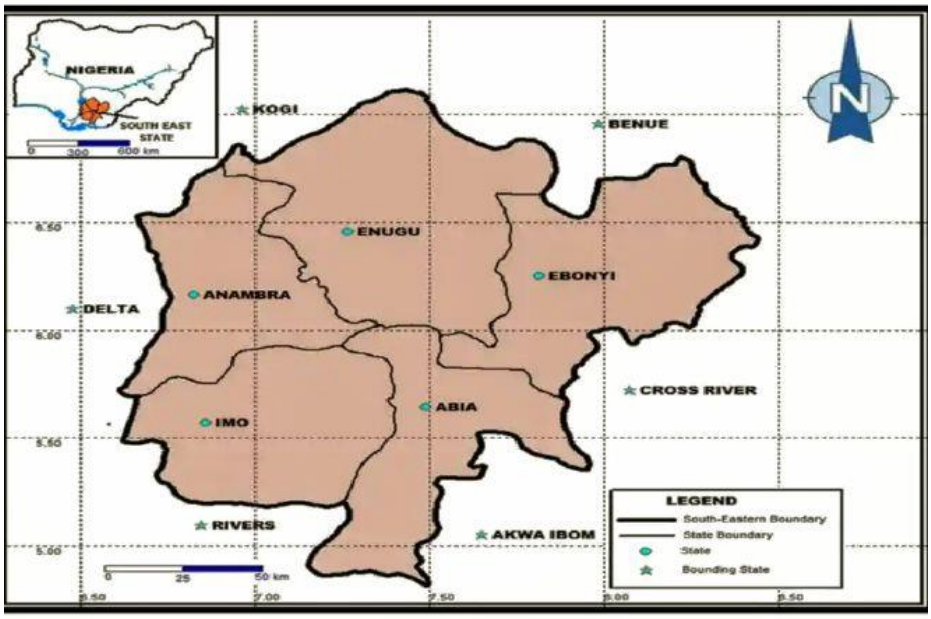

Fig. 1. Map of South East Nigeria Onoja et al., [38]

2.5 Data Analysis

Data were analyzed using MS EXCEL version 2007 and a descriptive statistics were used. The relationships between some variables were obtained.

3. RESULTS AND DISCUSSION

A total of 600 respondents comprising 32% from Anambra, 27% from Ebonyi, 21% from Enugu, 11% from Abia and 9% from Imo State responded to the structured questionnaire administered (Fig. 2). Of these, 78% were males and 22% were females (Fig. 3). The results revealed that water yam (Plate 1) production in the study area was dominated by male (78%). This is probably because yam production is energy demanding thus female farmers prefer to go into the production of other crops. This result is in line with the findings of Suleiman [28] and Ekunwe and Osewa [29] who noted that 85% of yam farmers in Kaiama Local Government, Kwara State were males. The socio-cultural background of the study area is diverse with four ethnic groups encountered among which the, Igbo, Hausa, Igala and Yoruba were the most prominent (Fig. 4). The diverse ethnic composition provides an in-depth understanding of the ethno-botany of the crop plant especially among neighboring ethnic groups. Various tribes emphasize different knowledge about the crop and this would assist in flora documentation and classification. The results revealed that 49% of the respondents were within the ages of 31 to 40 years (Fig. 5). This age group is usually believed to be the active age group. These findings are closely supported by that of Oluwatosin [30] who reported a mean age of 35yrs for yam farmers in Ondo State and Osun State respectively. On the educational level of the respondents, 288% had no formal education, 12% had primary education, 51% had secondary education and 9% had tertiary education (Fig. 6). This shows that yam farmers had a significant level of expertise in yam production. This study supports the findings of Oluwatosin [30] who suggested a secondary school qualification for farmers in Osun State. The 47% of the respondents were farmers in the study area, 21% were public servants, and 19% were traders while 13% engaged in other occupations (Fig. 7). Out of the 600 respondents interviewed, 62% of the respondents were aware of water yam cultivation in their area and also involved in its cultivation while 38% were not aware of water yam cultivation in their area (Fig. 8). This study supports the findings that Nigeria alone produces three-quarters of the world total output of yam [5,3]. Yams are the fifth most harvested crops in Nigeria, following after cassava, maize, guinea corn and beans/cowpeas. More so, after cassava, yams are the most commonly harvested tuber crops in the country [6]. Out of the 600 respondents interviewed, 41% of the respondents grew their water yam tubers as food for consumption, 37% grew the tubers as source of income, 3% as source of employment while 19% grew tubers for land security (Fig. 9). The data confirmed previous report that yam tubers are mainly cultivated as source of food. Water yam (*Dioscorea alata* L.) is the most economically important yam species which serve as a staple food for millions of people in tropical and subtropical countries [31]. Studies conducted in Eastern Nigeria showed that yams constituted an average of 32% of the farmer's gross income derived from arable crops [32]. From the data obtained, 6% of the respondents showed no interest in acquiring the knowledge of water yam cultivation while 94% indicated interest in water yam cultivation (Fig. 10). The results revealed that 43% of the respondents were within the ages of 41 to 50 years, 30% were between 51-60 years while 20% were between 31-40 years (Fig. 11). The age range of 35-45 years is usually believed to be the active age group. This finding is closely supported by that of Oluwatosin [30], who reported a mean age of 35 years for yam farmers in Ondo State and Osun State respectively. Out of the 600 respondents interviewed, 62% grew white yam, 26% grew water yam, 2% grew yellow yam while 10% grew aerial yam respectively (Fig. 12). This study supports the previous findings that *Dioscorea alata* is considered to be the most widely distributed species, but the highest levels of yam production worldwide can be attributed to *Dioscorea rotundata* [33].

On the method for water yam cultivation in the study area, 12% used mound making, 50% used ridge making, 33% used hole making while only 5% used bagging method (Fig. 13). The report confirmed that majority of the farmers use ridge making method for water yam cultivation. The results revealed that 53% of the respondents were yam farmers in the chain of water yam production, 13% were distributors and whole sellers, 32% were yam sellers while 2% performed other role not listed in the water yam production chain (Fig. 14). The 64% of the respondents chose April-June as the most

suitable season for water yam cultivation, 22% chose January-March, 10% chose October-December while 4% chose July-September (Fig. 15). Majority of the respondents (98%) in the study area confirmed the incidence of pest attack on the water yam both in the field and storage while 2% indicated there was no presence of pest attack (Fig. 16). This study is in line with the finding of Opera [34] who reported that the attack by yam beetle and microorganisms such as nematodes and yam virus are the most devastating.

Plate 1. Yam barn (*Dioscorea alata* L.)
Source: NRCRI, Umudike, Abia State

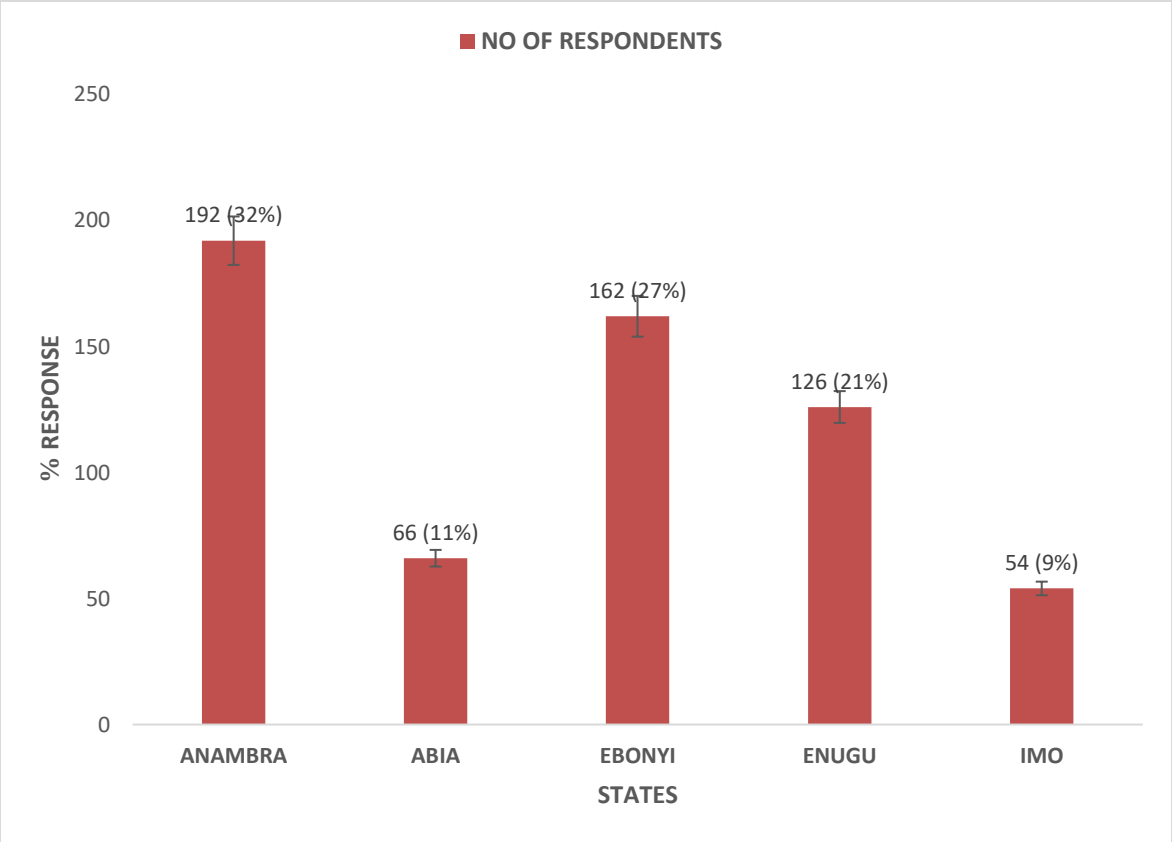

Fig. 2. Percentage response by respondents from the five South-Eastern States

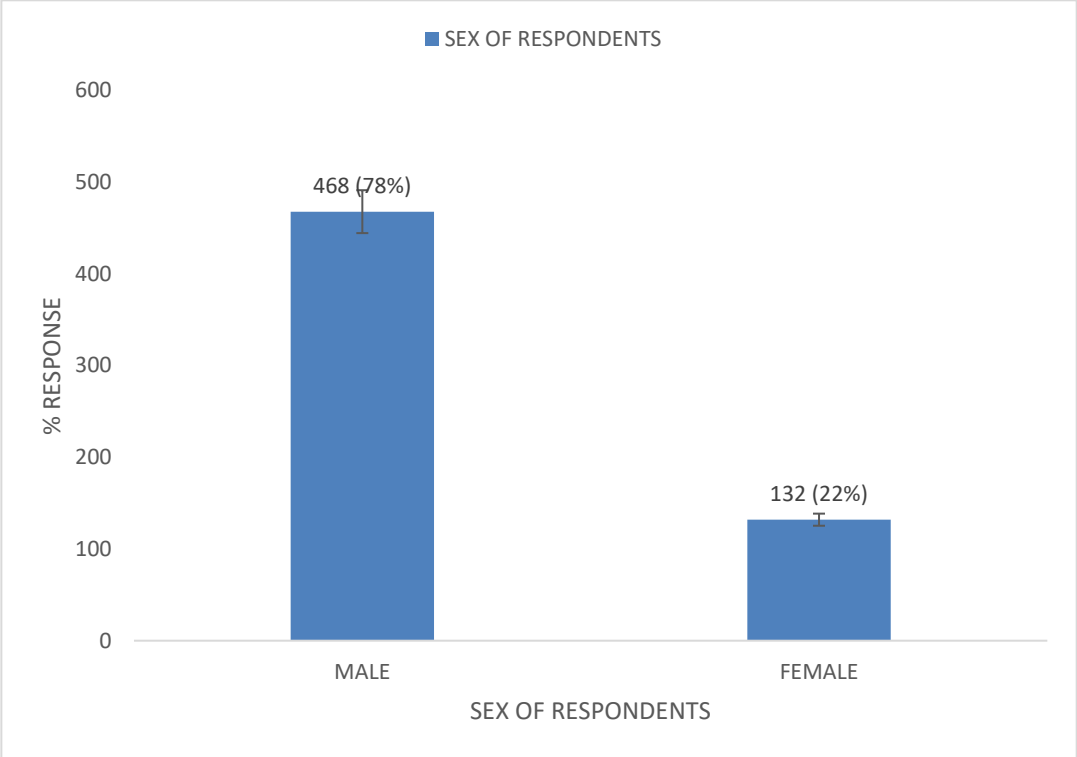

Fig. 3. Percentage response by gender

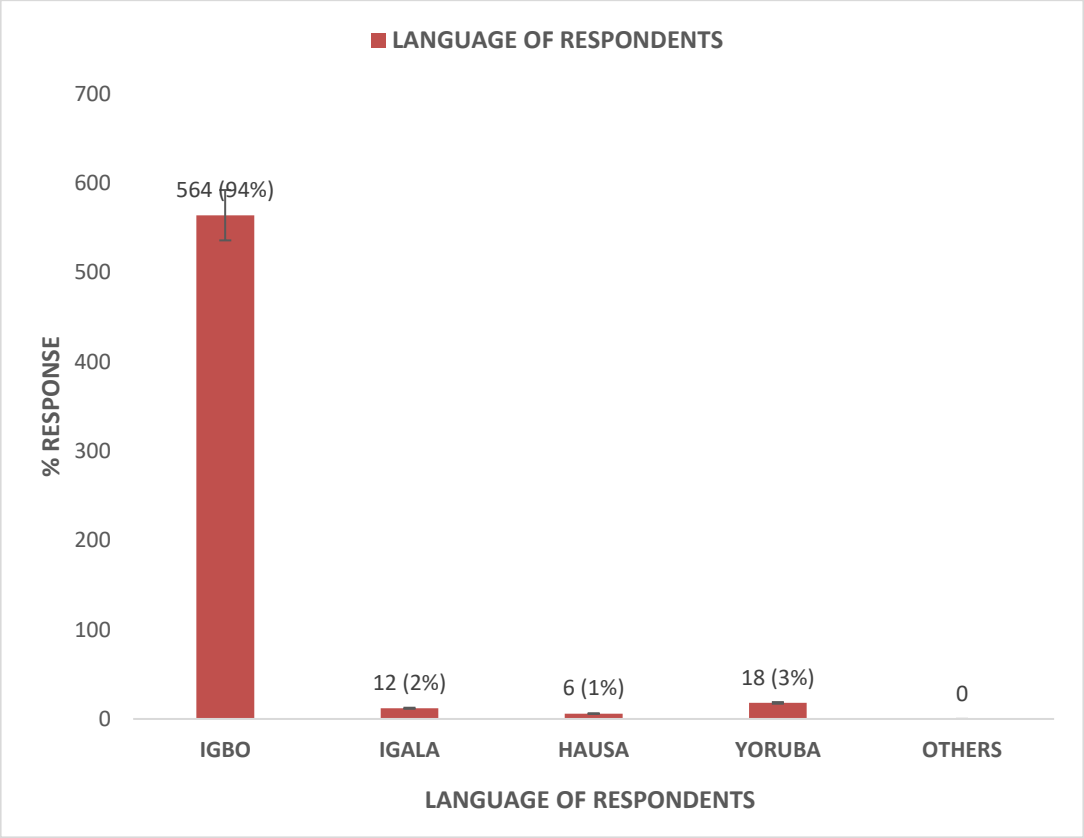

Fig. 4. Percentage response by respondents from various ethnic groups

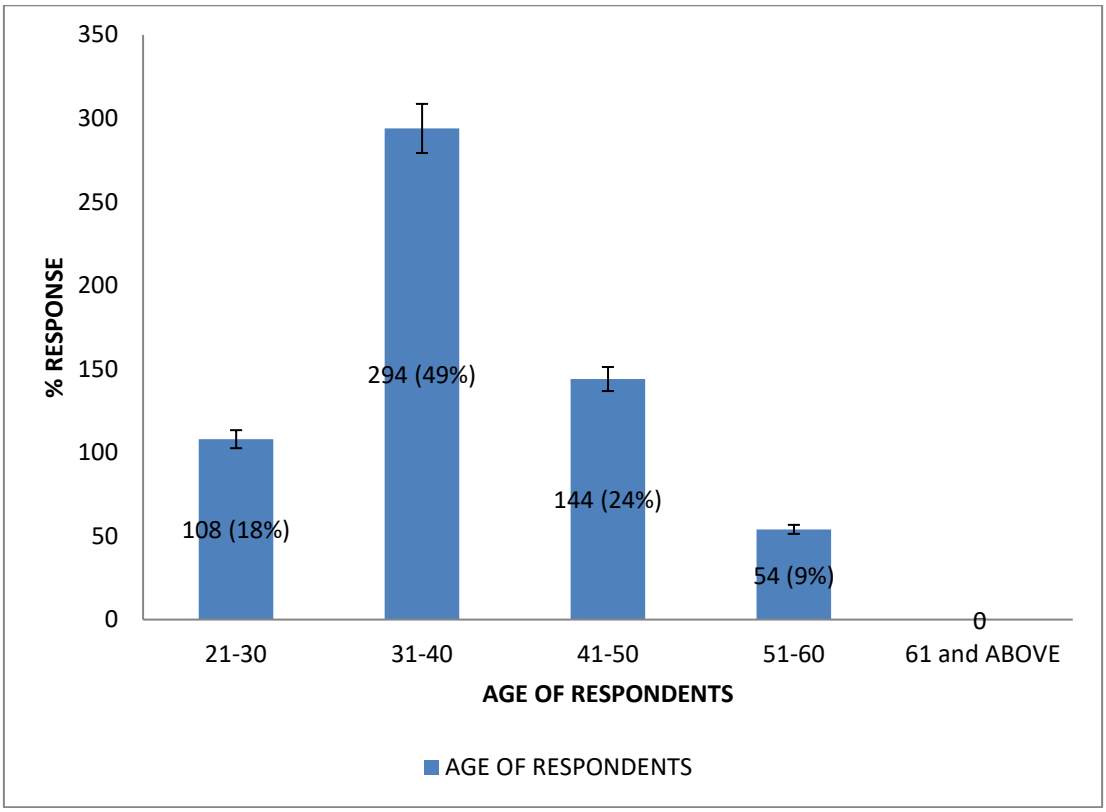

Fig. 5. Age of the respondents

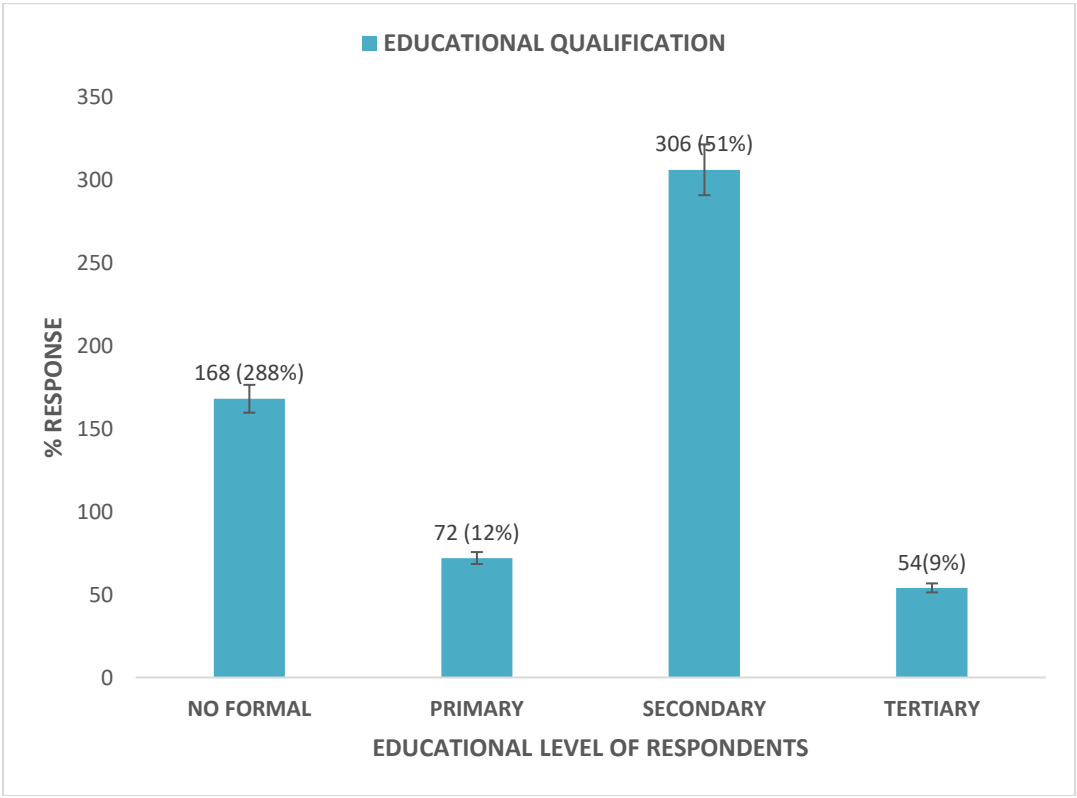

Fig. 6. Educational qualification of the respondents

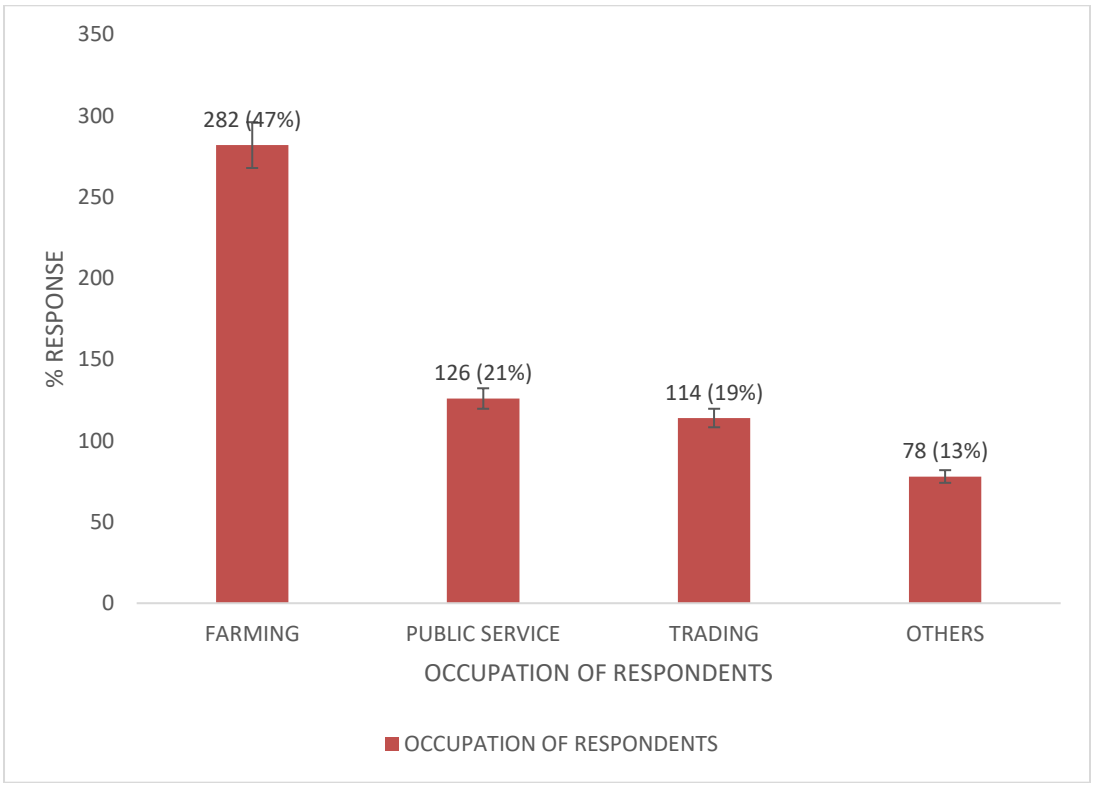

Fig. 7. Occupation of respondents

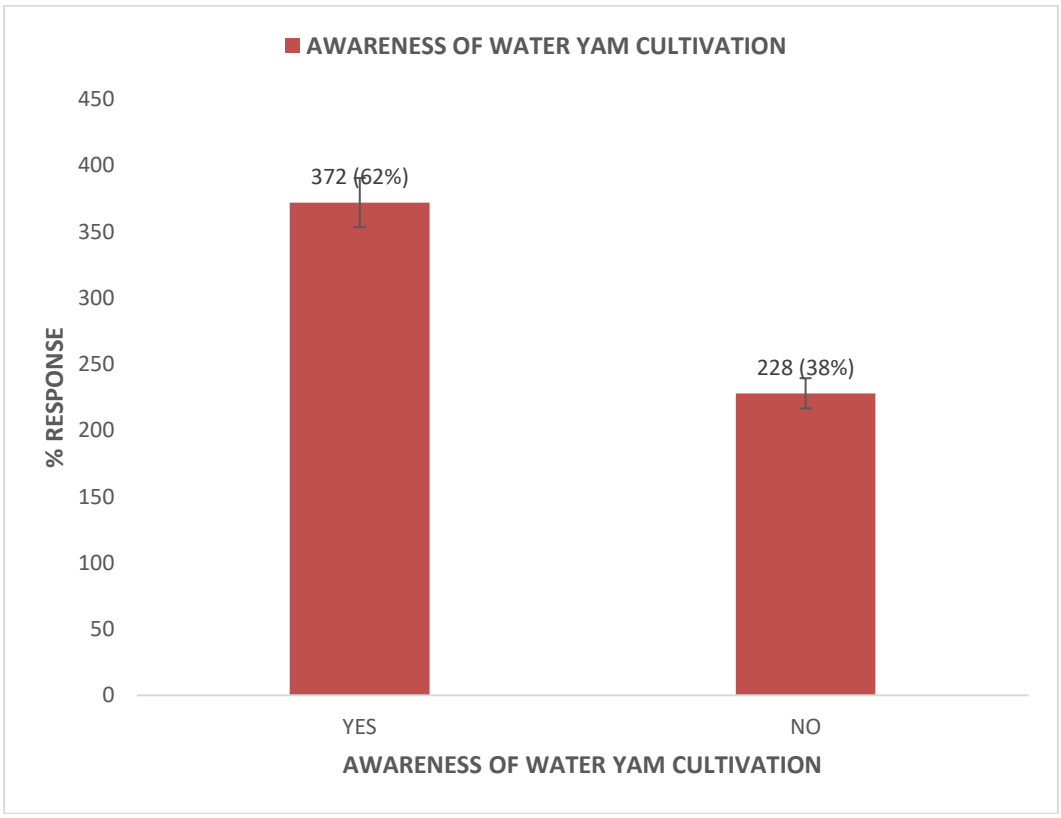

Fig. 8. Awareness of water yam cultivation by the respondents

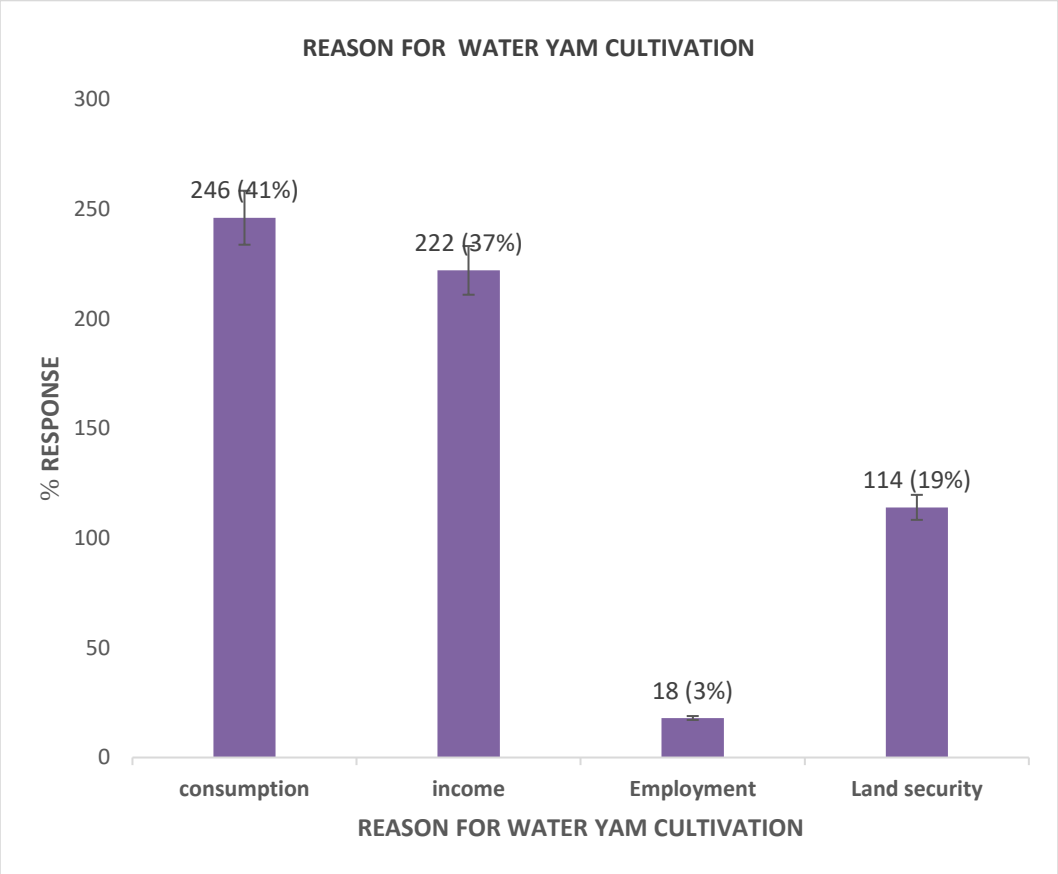

Fig. 9. Reason for water yam cultivation

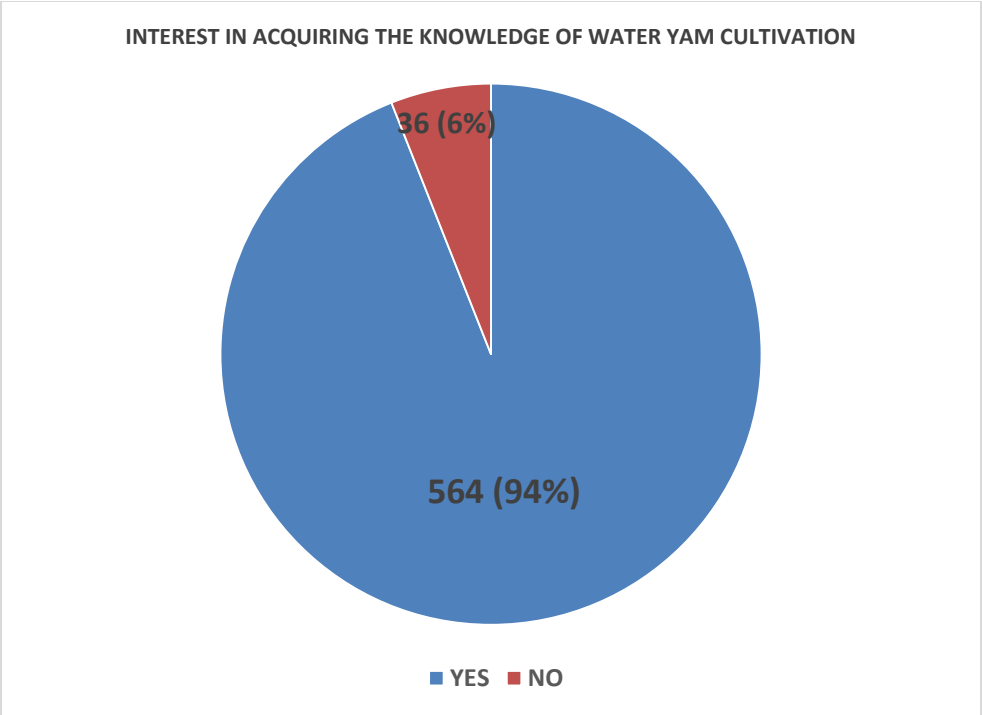

Fig. 10. Interest in acquiring the knowledge of water yam cultivation

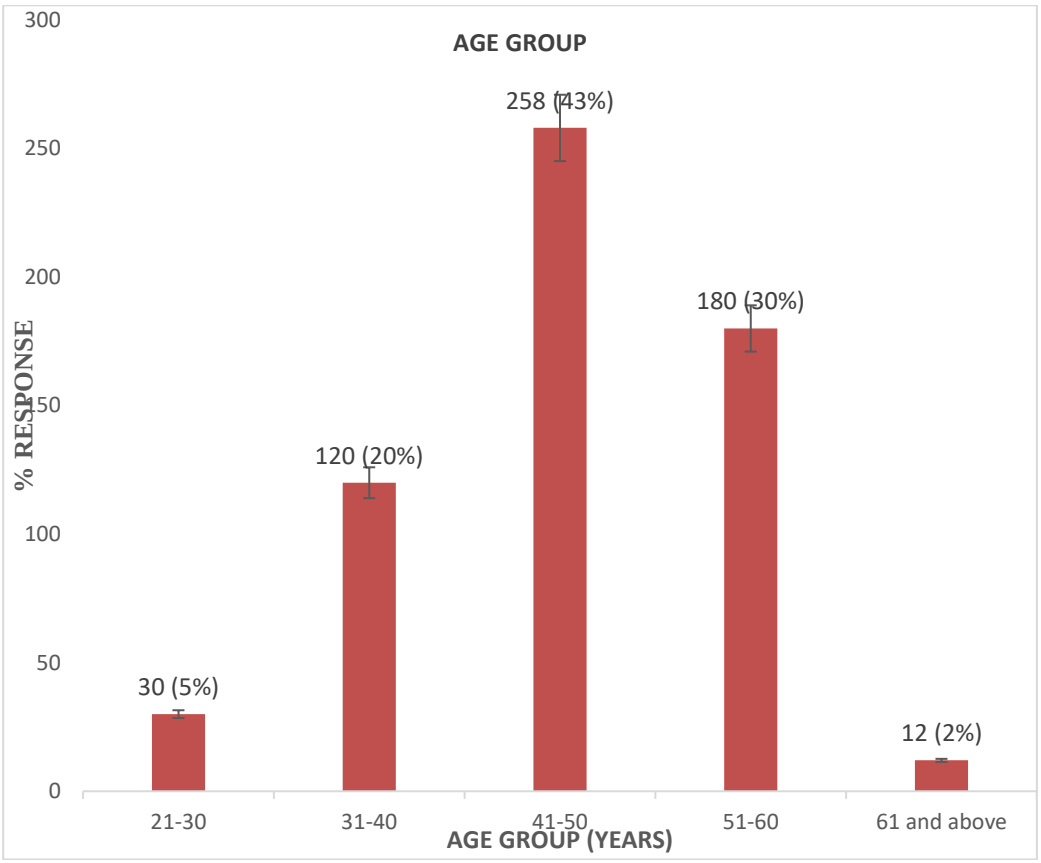

Fig. 11. Age group involved in water yam cultivation

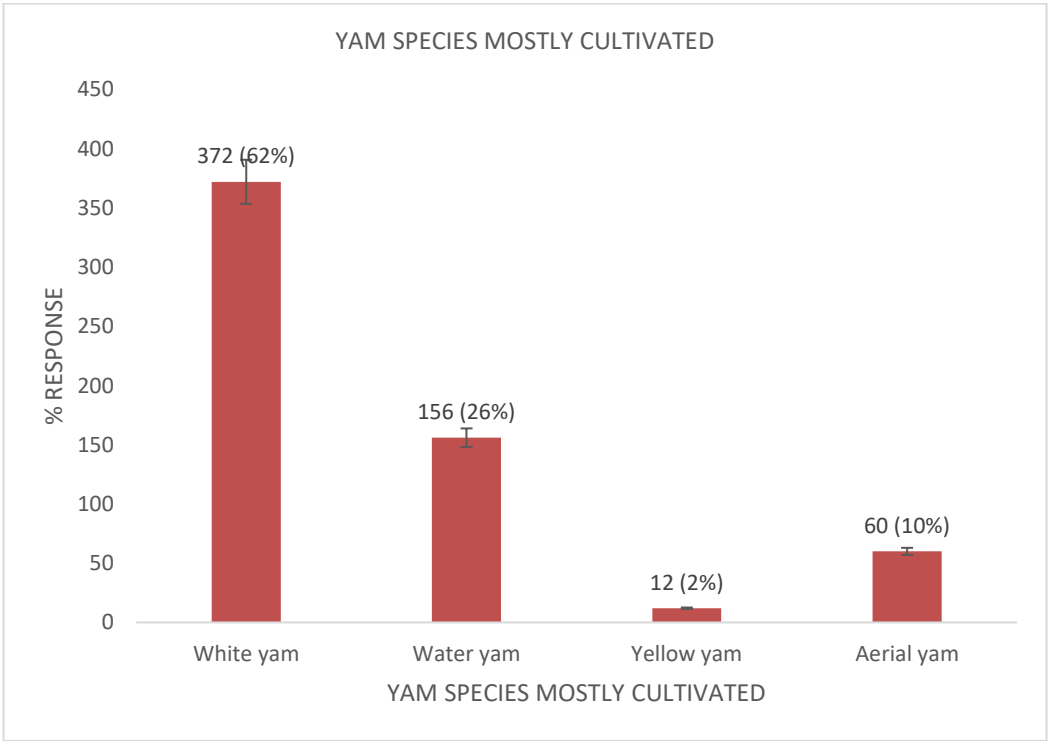

Fig. 12. Yam species mostly cultivated

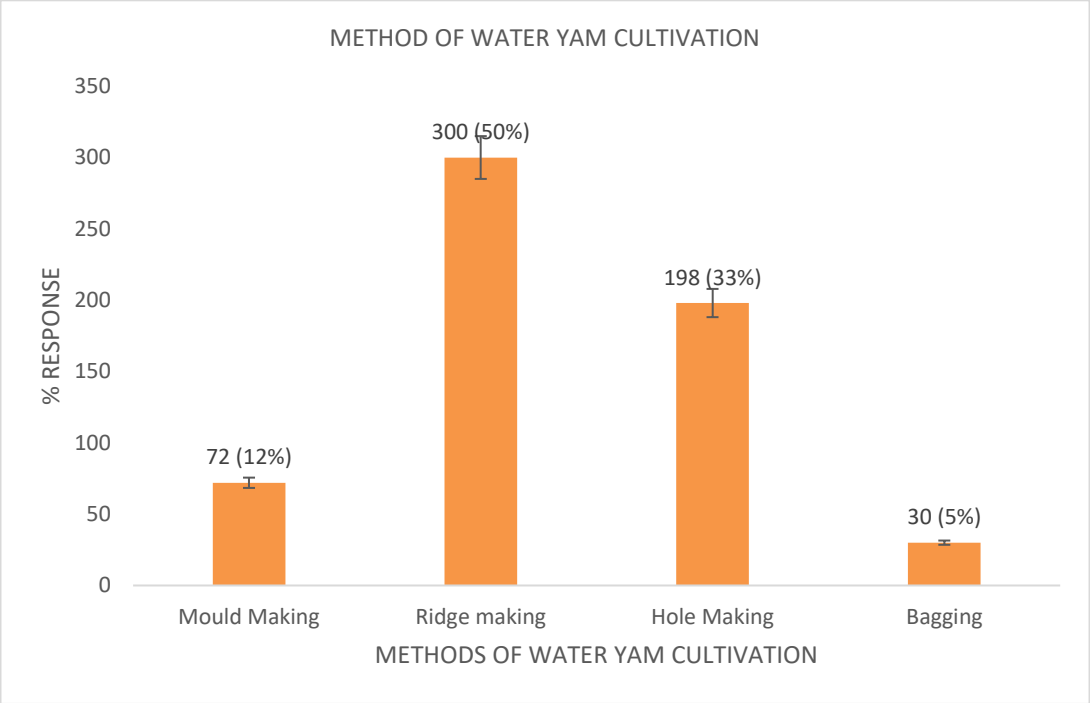

Fig. 13. Method of water yam cultivation

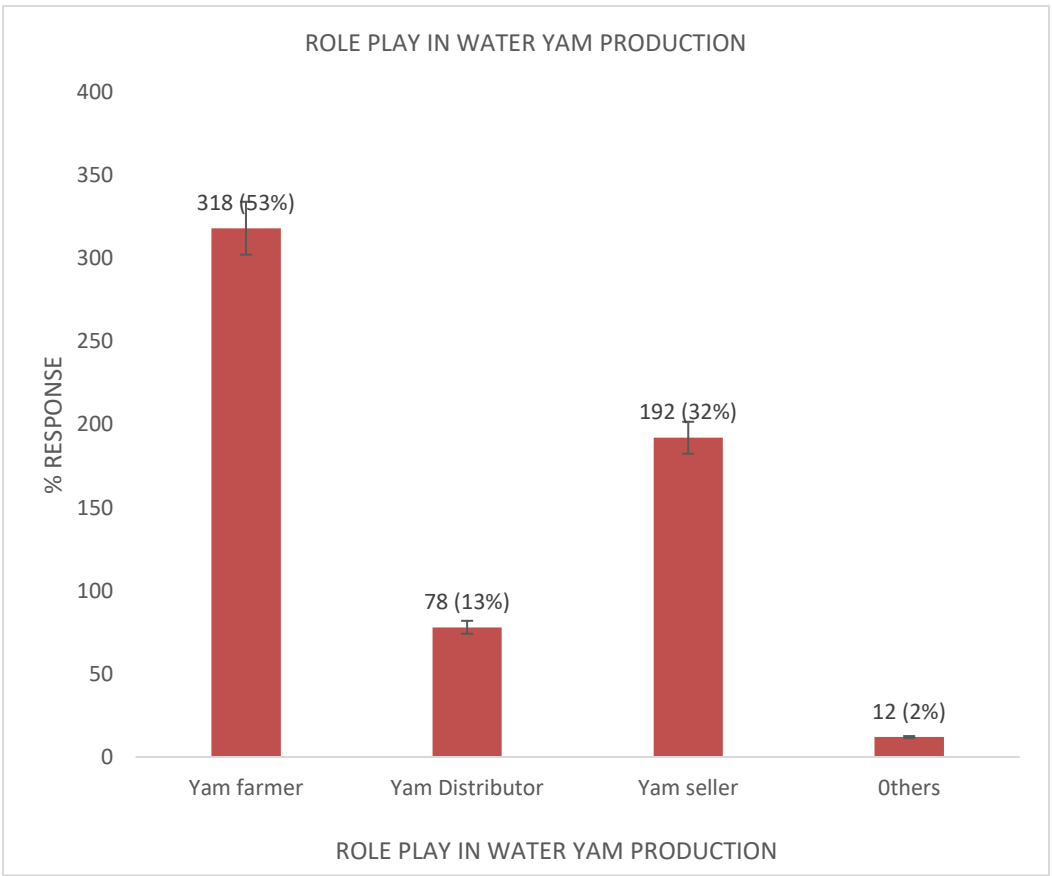

Fig. 14. Role play in yam production

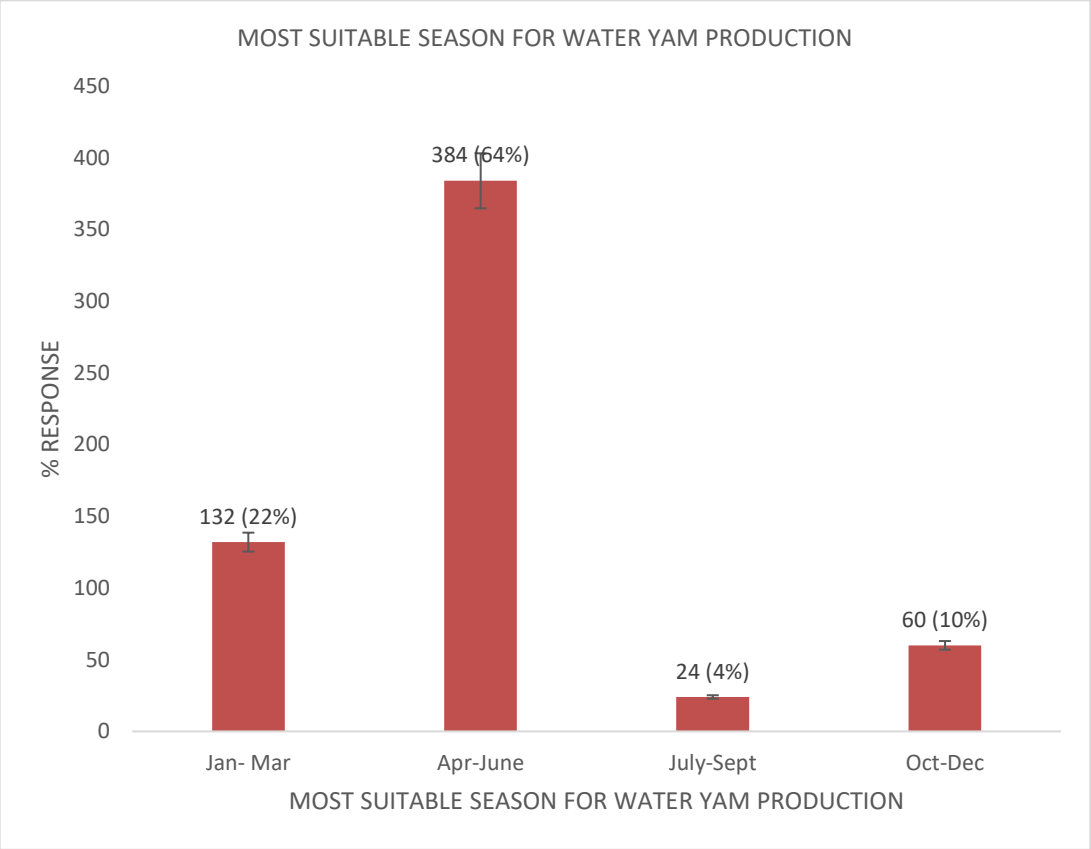

Fig. 15. Most suitable season for water yam production

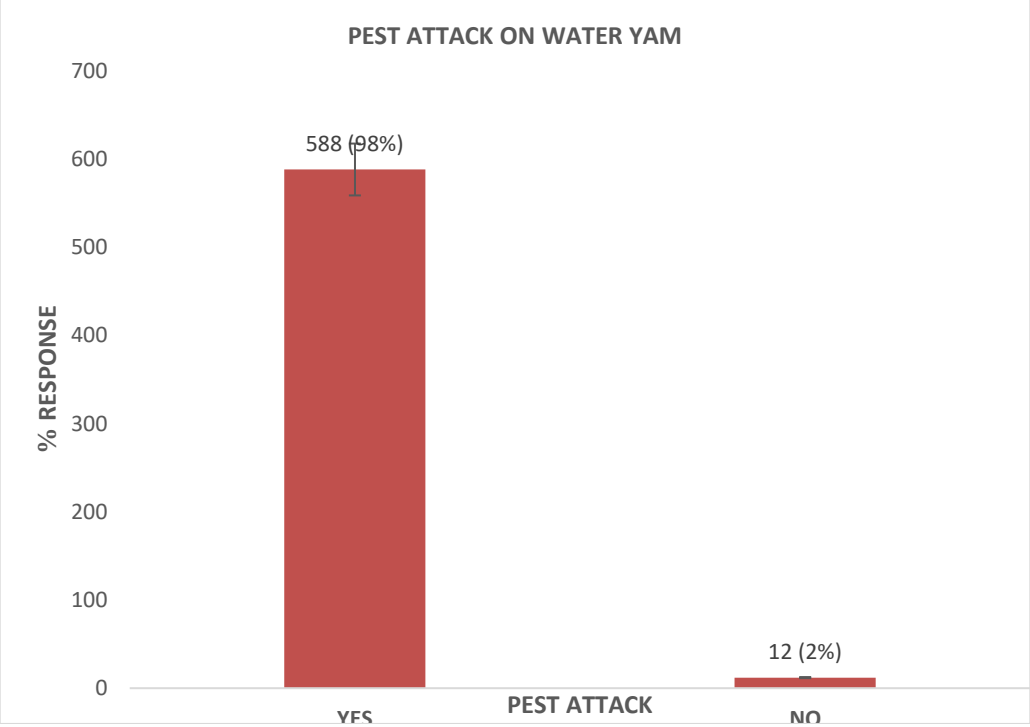

Fig. 16. Pest attack on water yam

The study showed that yam barn was the storage techniques that were popularly known to most of the respondents (70%). This is followed by straw and stick (17%) which ranked second in the storage method known in the study area (Fig. 17). This finding is similar to those of Suleiman [28]; Okoedo-Okojie and Onemolease, [35] whose studies revealed that yam barn ranked first, followed by heap on the floor. It is worthy to note, however, that only 2% of the respondents were aware of the raffia bag storage which is modern and improved method of yam storage. The data obtained confirmed that 63% of the respondents adopt cultural method of preservation of water yam, 16% used biological method (curing, fungicide treatment), 9% used chemical while 12% employed other methods (biocontrol agents, yeasts) for water yam preservation (Fig. 18). The study indicated that natural wounds (38%), field disease (35%) (yam anthracnose, yam leaf spot) and field pests (27%) (insect pests, nematode pests) were seen as the major predisposal factors causing water yam rot during storage (Fig. 19). On the period in which water yams are stored after harvest, the study revealed that 57% respondents stored their water yams between 4-6 months before they sell them, 40% stored their water yams between 7-9 months while 2% stored their tubers above 10 months before sending them to the market (Fig. 20). In this study, 94% of the respondents believed that water yam has medicinal value. They revealed that *Dioscorea alata* is used to treat post-partum abdominal pain in women. They further revealed its use in the treatment of the fungal skin infection, *Tinea nigra*, which attacks the uppermost layers of skin. Similar to the current findings, Dutta [21] has reported the application of *D. alata* paste in the treatment of skin diseases. The local tribal communities of Enugu in Nigeria used *D. alata* against fever and the tubers of *D. cayenensis* are used to treat diarrhea [36]. However, 6% of the respondents did not report any medicinal use of the plant in the study (Fig. 21). The 97% of the respondents believed that water yams have a socio-cultural value while 3% responded otherwise (Fig. 22). The socio-cultural value of water yam includes information on nature, mythical beliefs and medicine. Some respondents in the study area used it during marriage and fertility ceremonies. All the tribes studied can recognize dry/wet/harvest seasons. Other knowledge on non-food uses is tribe dependent (cultural practices, traditional knowledge and uses of water yam vary among different ethnic groups or tribes in the region). This documented indigenous knowledge can be transferred to other communities that cultivate the crop even though the knowledge recorded in this study

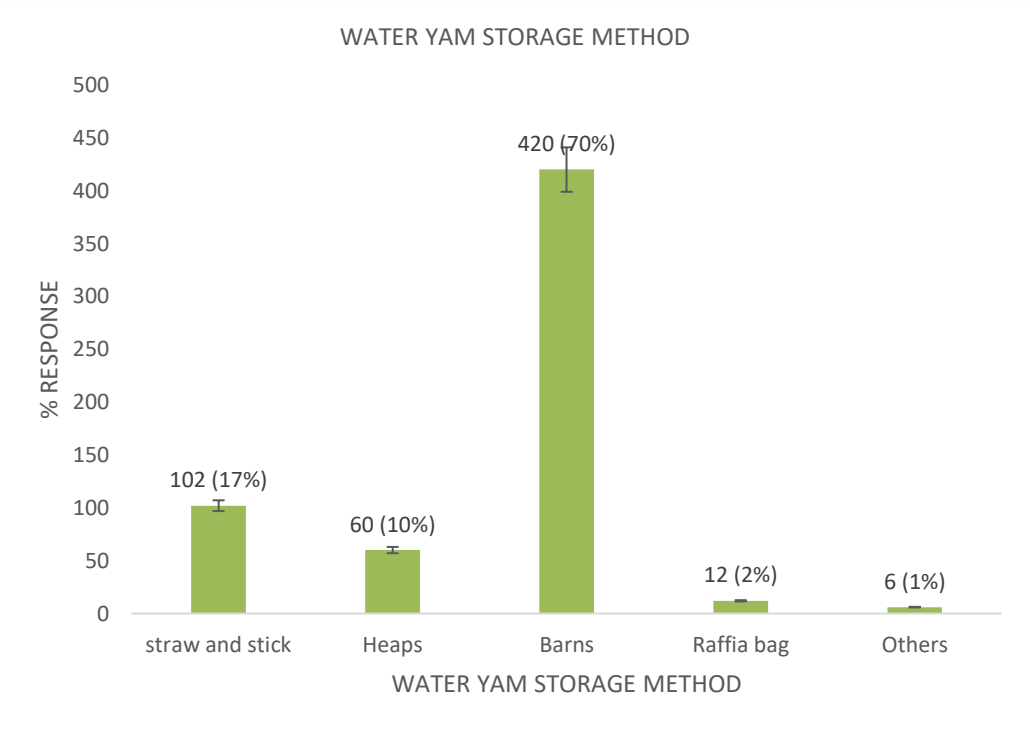

Fig. 17. Water yam storage method

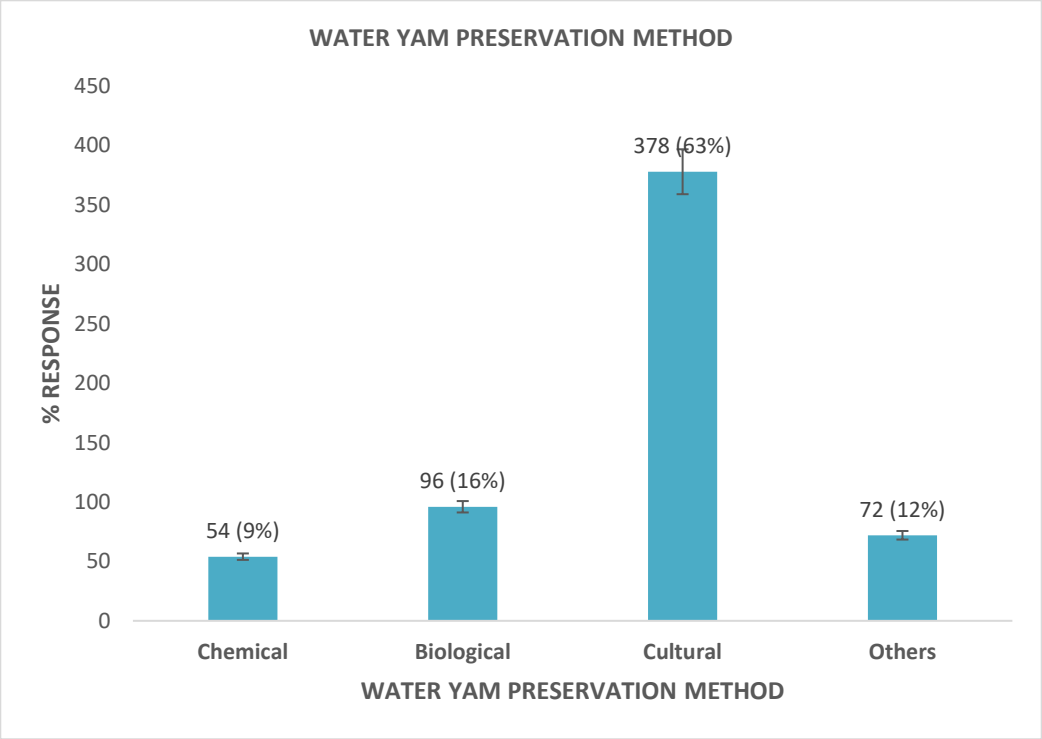

Fig. 18. Water yam preservation method

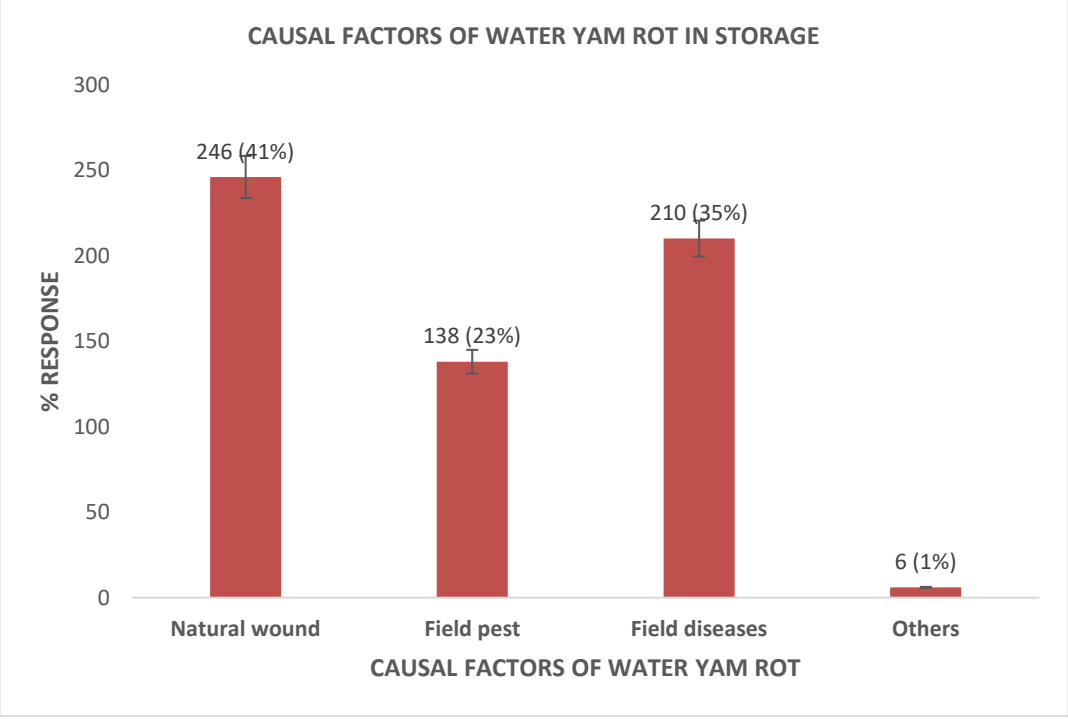

Fig. 19. Causal factors of water yam rot in storage

is tribe dependent. The 65.67% of the respondents ticked that water yam could be cooked/boiled, 18.83% stated that it could be roasted while 7.50% said that it could be fried as chips (Fig. 23). In line with these findings, Dutta [21] and Zinash [37] have reported the consumption of *Dioscorea* species by mixing them with mushrooms, meat and other vegetables. According to Sangoyomi [18] it is consumed roasted, fried, boiled, pounded or as

flour which can be reconstituted with hot water. However, this can vary depending on the variation in the eating habits of individuals, some of whom may prefer to consume yams alone, while others may eat them with additional foods. These crops can be consumed to fill the gaps of any meal types especially at breakfast time. This indicates the variation in ethno-medicinal knowledge between different parts of the world [35].

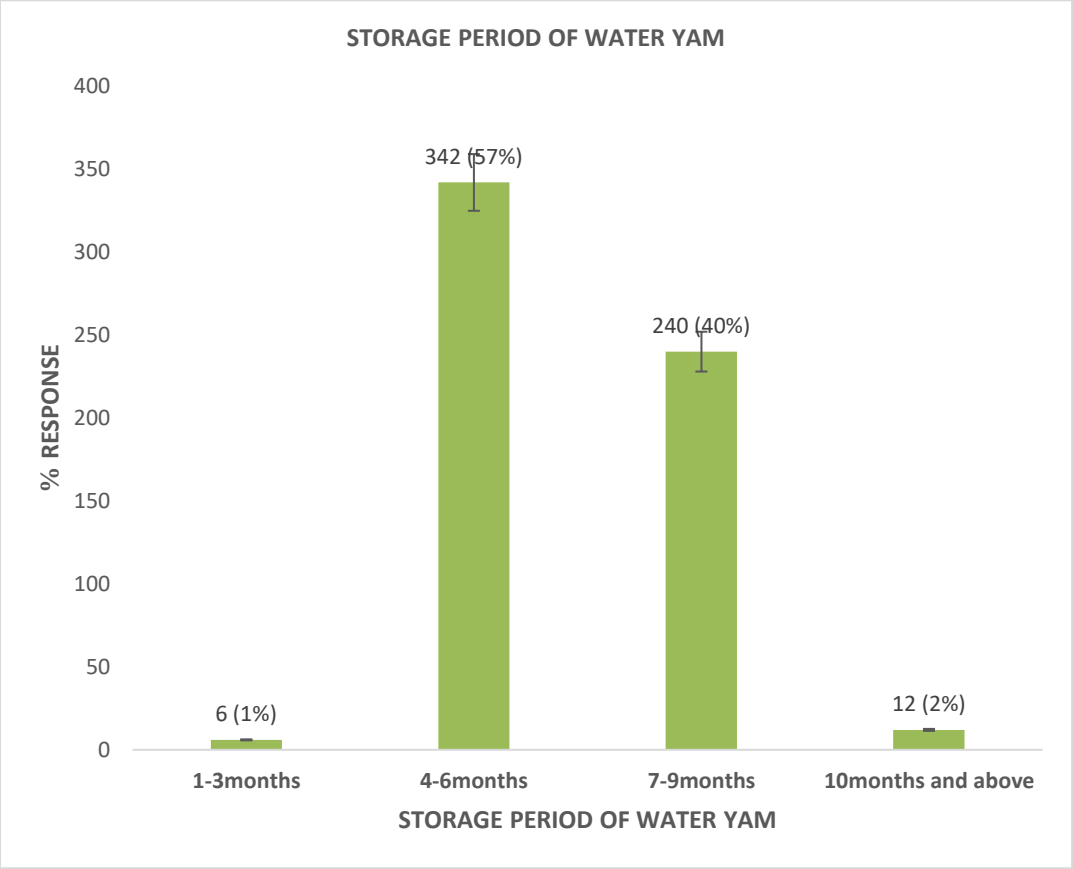

Fig. 20. Storage period of water yam

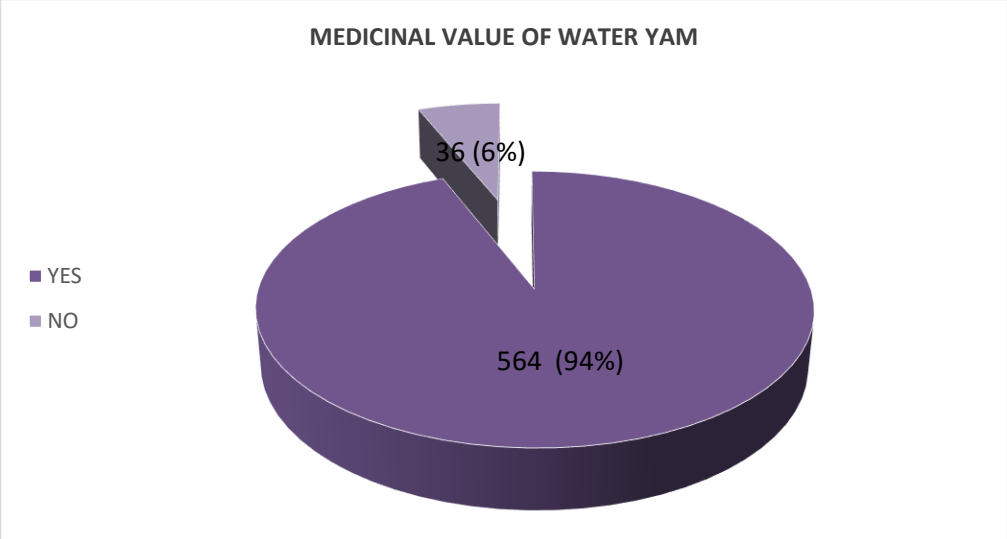

Fig. 21. Medicinal value of water yam

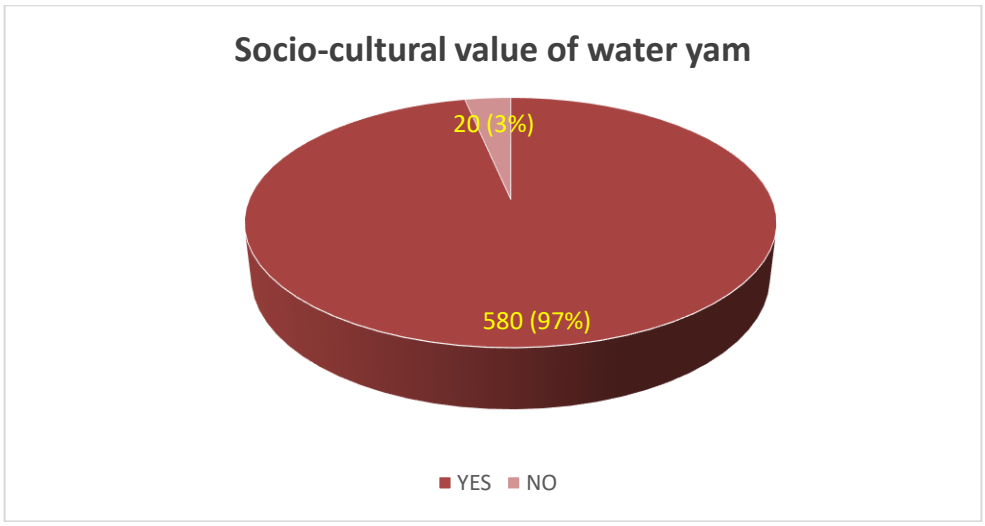

Fig. 22. Socio-cultural value of water yam

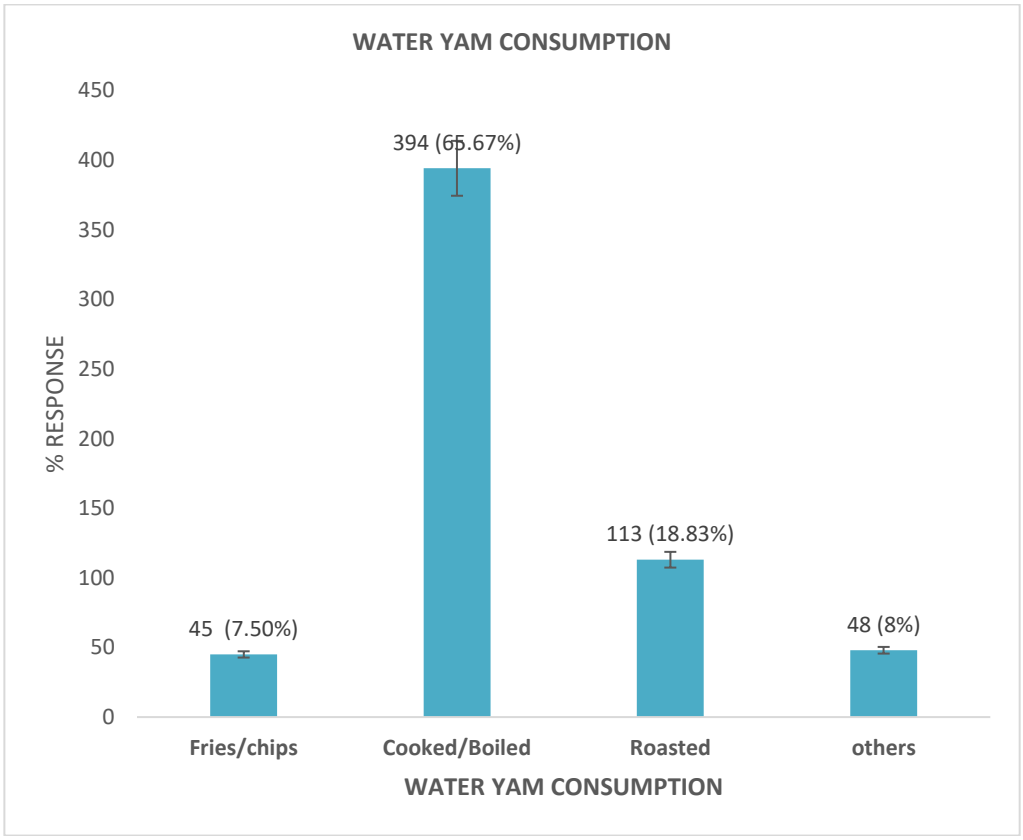

Fig. 23. Water yam consumption

4. CONCLUSION

In the light of the foregoing, water yam tubers are grown in the South-Eastern Nigeria and the people from the study area have indigenous knowledge of water yams and their uses. This documented indigenous knowledge can be transferred to other communities that cultivate the crop.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models

(ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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