ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 21 No. 5 June 2021 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2021; 21(5): 18019-18034 https://doi.org/10.18697/ajfand.100.20290

KNOWLEDGE, PERCEPTION AND UTILIZATION OF BIOFORTIFIED CASSAVA AND ORANGE-FLESHED SWEET POTATO (OFSP) IN SELECTED RURAL AREAS IN NIGERIA

Uzokwe CA[1]*, Iheme GO[1], Oteh OU[2], Ewude MC[1] and Q Uruakpa[1]

Chinwe Adaugo Uzokwe

*Corresponding author email: uzokwe.chinwe@mouau.edu.ng

[1]Department of Human Nutrition and Dietetics, Michael Okpara University of Agriculture Umudike (MOUAU), Abia State, Nigeria

[2]Department of Marketing, MOUAU, Abia State, Nigeria

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 21 No. 5 June 2021 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

ABSTRACT

Vitamin A deficiency is a major public health problem in Nigeria. Staple crops are targeted by biofortification efforts because they possess low micronutrient density and are consumed in large quantities by a large proportion of poor households. This study was designed to assess the knowledge, perception and utilization of biofortified cassava and orange-fleshed sweet potato in selected Local government Areas in Abia and Imo States. The study was descriptive and cross-sectional in design. A total of 710 respondents were selected using a multi-stage sampling technique. A structured interviewer-administered questionnaire was used to elicit the required information. Statistical analysis was performed using descriptive statistics (frequency, percentage, mean and standard deviation) and inferential (correlation) analysis. Socio-demographic data revealed a preponderance of females, married, well-educated and working-class respondents. Monthly income above ₦29,000 (US$ 70.54) and household size of 4-6 members were reported in 53.5% and 48.6% of the respondents. Study results further revealed that some (34.9%) of the respondents had good knowledge, while 46.1% and 19.0% had an average and poor knowledge of biofortified staples, respectively. Orange fleshed sweet potatoes and biofortified cassava were purchased at least once monthly by 73.7% of the respondents, however 16.5% and 27.5% of the respondents consumed these biofortified staples on a daily and weekly basis. Low positive perception towards the consumption (27.5%), benefits (39.6%) and barriers (16.9%) of utilizing studied biofortified staples was reported. A positive correlation was observed between respondents' knowledge of biofortified staples and their benefits perception ($p = 0.003$), purchase ($p = 0.001$) and consumption ($p = 0.001$) frequency. Therefore, while a good number of the respondents were fairly knowledgeable about the studied biofortified staples, it significantly influenced the perception and utilization of these staples, despite being reportedly low. Therefore, increased sensitization, price subsidy and availability of these biofortified staples will help improve their acceptance and utilization among rural households.

Key words: Knowledge, perception, utilization, orange-fleshed sweet potato, biofortified cassava, Nigeria

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 21 No. 5 June 2021 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

INTRODUCTION

Micronutrient malnutrition such as the lack of vitamin A is one of the major public health problems in Africa. The World Health Organization reports that Vitamin A deficiency (VAD) affects 190 million pre-school aged children and 19 million pregnant women in Africa and South-East Asia [1].

The Copenhagen consensus in 2008 and the Lancet series on maternal and child malnutrition published in 2013 identified biofortification as one of the key interventions to reduce micronutrient deficiencies in low- and middle-income countries [2]. Staple crops are targeted for biofortification because they often have low micronutrient density and are consumed in large quantities by a large proportion of resource-poor populations [3].

Nigeria is one of the leading producers of cassava in the world with an annual production of 35-40 million metric tons [4]. Over 40 varieties of cassava (*Manihot esculenta*) are grown in Nigeria, cassava is the most important and versatile dietary staple in the country when compared to over 209 food crops consumed in Nigeria [4]. New varieties of cassava that are rich provitamin A carotenoids (pVACs), primarily β-carotene, have been developed [5]. These biofortified cassava varieties have yellow flesh mainly due to their rich beta-carotenoid content, and pVACs are more bioavailable than in other crops [6-8]. Furthermore, apart from the colour changes, evidence has shown that taste and other sensory properties varies due to the lower dry matter concentration associated with higher pro-vitamin A concentration [9].

Sweet potato (*Ipomea batatas*) is a dicotyledonous plant from the family Convolvulaceae that grows in tropical and subtropical areas. It occupies an important place in the agricultural production of sub-Saharan Africa countries, covering about 3.2 million hectares with an estimated production at 13.4 million tons of tubers [10]. The introduction of orange-fleshed sweet potato (OFSP) is one food-based approach that has great potential to decrease vitamin A deficiency in Nigeria [11]. Although most varieties of sweet potato commonly grown in sub-Saharan Africa are white-fleshed and lacking in vitamin A, OFSP offers high levels of this important micronutrient and is both drought-resistant and easily cultivated [12].

Despite the significance of introducing biofortification in staples, accepting biofortified crops that are conventionally bred may require a change in the perception of farmers and consumers given the difference in colour, texture and taste relative to the traditional staple crops. Consumer acceptance depends on the sensory characteristics, beliefs and practices of a community [13].

Evidence on several aspects of biofortified staples in Nigeria ranging from agronomic characteristics [14], acceptability/sensory attributes [15] and cost implications [16,17] are well documented in previous studies. However, the paucity of data on the knowledge, perception and utilization of these biofortified staples in Nigeria particularly South East Nigeria deserves attention.

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 21 No. 5 June 2021 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Therefore, this study seeks to understand how much consumers know, how they perceive and utilize biofortified cassava and OFSP in relation to traditional white varieties.

MATERIALS AND METHODS

Study design

The study design was descriptive and cross-sectional.

Sample size determination

The sample size was obtained from calculating with the formula:

$$n = \frac{Z \times P\,(100 - P)}{X^2}$$

Where n = sample size
Z = confidence interval taken at 95% degree of probability which is approximately 2.
X = width of confidence interval at 5%.
P = prevalence of vitamin A deficiency in Sub-Saharan Africa is 48.0 per cent [18].

$$n = \frac{1.96^2 \times 48.0\,(100 - 48.0)}{5^2}$$

Minimum sample size = 384 respondents

A total of 710 respondents were selected in Ikwuano and Ohaji Egbema Local Government Areas (LGAs) of Abia and Imo State, respectively. The population size of Ikwuano and Ohaji Egbema LGAs was 137,993 and 800,904, constituting about 3.4% and 16.3% of the total population in Abia State and Imo State, respectively.

Sampling techniques

A multi-stage sampling procedure was adopted. Two Local Government Areas- Ikwuano and Ohaji Egbema LGAs in Abia and Imo State, respectively were purposively selected. Three wards were drawn from each of the selected LGAs using a simple random sampling by balloting technique. About 118 respondents were further selected per ward using the simple random technique.

Inclusion/exclusion criteria: Adults who reside in the selected communities and consume the two staple crops (cassava and sweet potato) were included in the study. Persons who did not meet these criteria were considered ineligible to participate in this study.

Informed consent

Approval was sought from the traditional rulers, religious leaders, market leaders and all relevant local stakeholders. Written informed consent of the respondents was obtained. The respondents were assured of the confidentiality and non-maleficence

nature of the research. Only those who willfully consented to take part in the study were recruited.

Data collection

Six research assistants were recruited and trained on the use and administration of the survey instrument. Data were collected using an interviewer-administered semi-structured questionnaire. This was used to elicit the following information from the respondents.

a) Awareness and knowledge of key nutrients added, benefits and preventable health problems associated with the consumption of OFSP and biofortified cassava
b) Perception towards OFSP and biofortified cassava consumption, as well as the benefits and barriers of utilizing these products.
c) Utilization of biofortified stables expressed in households' purchase and consumption frequency.

Data analysis

Knowledge of OFSP and biofortified cassava: Five (5) knowledge questions were asked and each of the correctly answered knowledge questions was awarded 20 marks. A total of 5 knowledge questions culminated in a perfect score of 100%. A composite score was calculated for each respondent and the scores divided into three as follows: 0-39% denoted poor knowledge; 40-69% -fair/average knowledge; and 70-100% -good knowledge.

Perception of OFSP and biofortified cassava

Perception questions were rated on a 5-point Likert scale. Responses for positive perception questions were scored: Strongly Agree -5, Agree -4, Others -0 while negative perception questions were assigned scores of 5 and 4 for "Strongly Disagree" and "Disagree" options, respectively. The percentage equivalents of values obtained were computed and categorized as negative perception - (0-49%) and positive perception -(50-100%).

Statistical analysis

All statistical analyses were done using Statistical Package for Social Sciences (SPSS) for windows version 25 (IBM SPSS Inc., Texas, USA). Descriptive statistics (mean, frequency and percentage) were computed for the categorized and continuous variables. Correlation analysis was used to determine the significant ($p < 0.05$) influence of respondents' knowledge on their perception and utilization of biofortified staples.

RESULTS AND DISCUSSION

Socio-demographic characteristics of respondents

Results (Table 1) revealed that a good number of the respondents were females (64.6%), married (63.5%), mid-aged adults (36-55yrs-39.4%), educated (tertiary education-40.0%) and occupationally engaged (90.3%). Furthermore, more than half (53.5%) of respondents earned incomes above ₦29,000 ($76). The respondents'

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 21 No. 5 June 2021 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

households comprised mainly 4-6 (48.6%) and 7-9 (28.3%) members, while the rest either comprise less than 4 (15.2%) or above 9 (7.9) household members.

Awareness of OFSP and biofortified cassava

Study findings (Fig 1) revealed that most (65.2% and 84.9%) of the respondents were aware of OFSP and biofortified cassava, respectively. The key source of awareness on biofortified staples was traced to information received by a research institute or university staff.

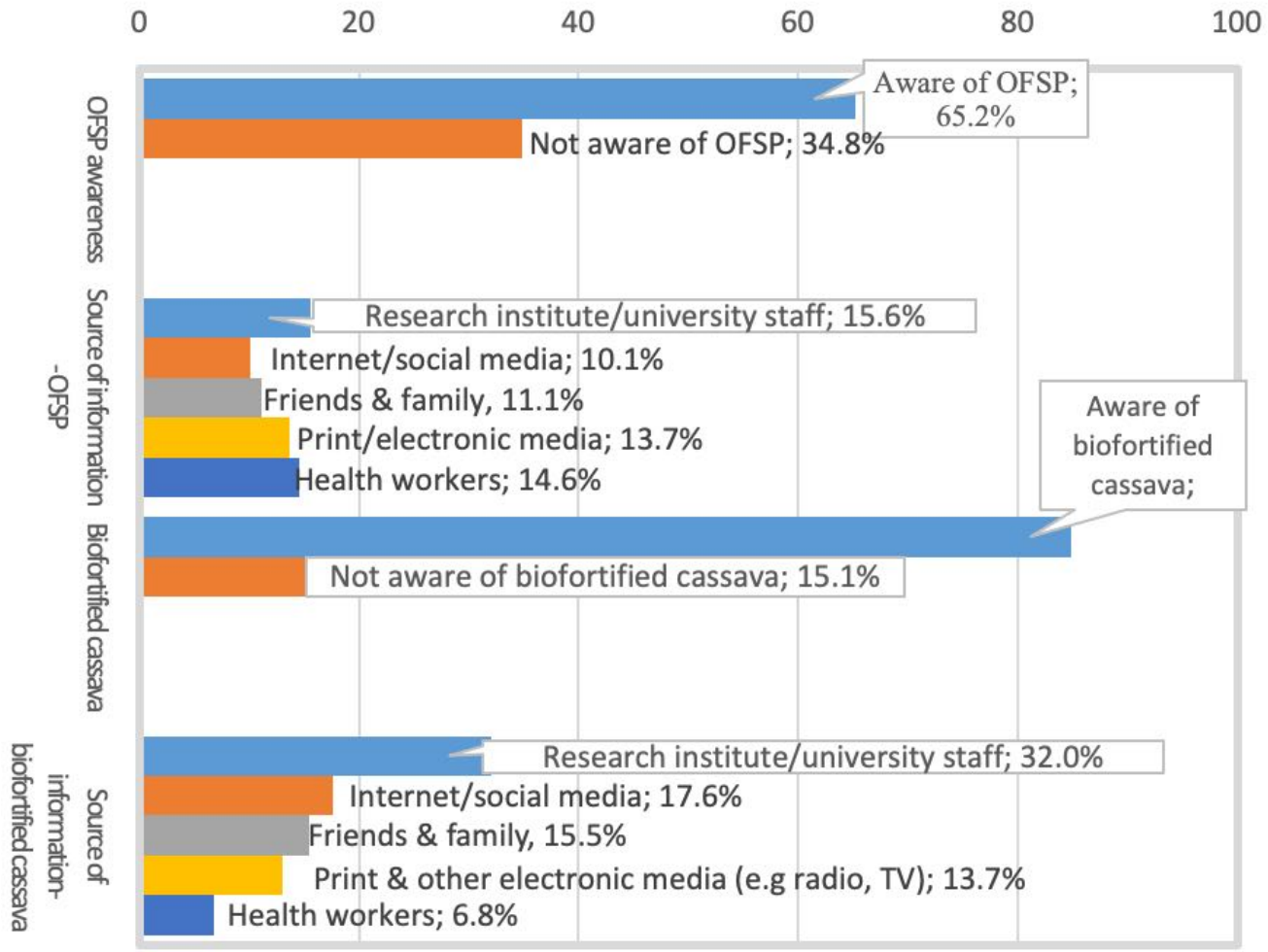

Figure 1: Awareness and source of information of OFSP and biofortified cassava

The high awareness level of respondents to biofortified staples in this study contradicts reports in Kenya where low awareness prevalence (28%) of food fortification was reported [19]. Similar to study reports, a study in north central Nigeria reported a high awareness level (100%) of orange fleshed sweet potato [20]. The fact that the majority of the respondents were aware of the term "orange-fleshed sweet potato" and "biofortified/yellow cassava" is an indication that biofortified staples are gaining recognition.

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 21 No. 5 June 2021 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Knowledge of OFSP and biofortified cassava

Results on respondents' knowledge of biofortified staples (Table 2) showed that less than half (45.5%) and most (64.4%) of the respondents could identify the nutrients used in biofortification of OFSP and yellow cassava, respectively. The benefits of consuming OFSP and yellow cassava was reported by most (64.6%) of the respondents. Some (43.7%) of respondents were knowledgeable of the health problems preventable by intake of OSFP and biofortified cassava. Sixty per cent (60%) of them correctly identified Vitamin A rich foods. Results on the categorized knowledge score revealed that 46.1% and 34.9% of the respondents had an average and good knowledge of OFSP and biofortified cassava. The low percentage (34.9%) of respondents with good knowledge does not compare well with findings from Okello *et al*. [21] and Sakala *et al.* [22], which reported that 72.0% and 87.1% of their respondents had good knowledge of OFSP and yellow cassava. The preponderance of average and good knowledge of biofortified staples in this study highlights that effective rural sensitization of consumers on biofortified staples is ongoing in remote Nigerian areas as shown in the involvement of a good number (15.6-32.0%) of extension workers from research institutes/universities in knowledge dissemination (Fig 1). However, efforts should be intensified so that outcomes can be compared with other studies [21-22].

Perception towards OFSP and biofortified cassava consumption

Results (Table 3) showed that more than a quarter (27.5%) of the respondents had positive perception towards the consumption of the biofortified staples. This reflected in the opinion of some of the respondents that the biofortified staples are good for human consumption (49.6%), intake is not limited to women and children (27.1%), apparently healthier than the common types (38.0%), can be relied upon in times of food shortage (36.8%), restricted in amounts to consume due to perceived excess sweetness (34.9%) or do not cause GIT disturbances (28.8%).

Perception of the benefits of OFSP and biofortified cassava utilization

In comparison to their non-biofortified counterparts as shown in Table 4, OFSP and biofortified cassava was dubbed to have a superior taste (39.4%), higher yield (35.1%) and nutritional benefits (41.4%), better disease/insect resistance (41.7%) and mature earlier (44.1%). Overall, results showed that 39.6% of the respondents had a positive perception of the benefits of OFSP and yellow cassava consumption.

Perception towards barriers of OFSP and biofortified cassava utilization

Study (Table 5) reports showed that few (16.9%) of the respondents have positive perception towards the barriers militating against the consumption of OFSP and biofortified cassava. This was evident in the disagreement of few of the respondents to the assertions that biofortified staples are costly (31.1%), distasteful (31.1%), scarce/ unavailable (20.9%) and deteriorate easier (32.3%) than the traditional varieties.

The low prevalence of positive perception of respondents towards the consumption (27.5%), benefits (39.6%) and barriers (16.9%) of OFSP and biofortified cassava utilization contradicts findings from another study [16], which revealed that a majority of farmers had a positive perception of consumption and benefits of biofortified crops (75.0-93.3%). This could be attributed to the slight differences in the characteristics of

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 21 No. 5 June 2021 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

both populations, as it is expected that farmers may have better understanding and healthy perception of biofortified staples than consumers as they are the first point of contact of any innovative development in agriculture.

Furthermore, respondents' positive reactions to cost and scarcity/unavailability of these biofortified staples garnered the least percentage. Similarly, a study found out that more than 40% of households had a negative view and demonstrated an unwillingness to consume OFSP if they were to become scarce and expensive [23]. Therefore, relevant stakeholders should ensure that these biofortified staples are made available and affordable in local markets.

Utilization of biofortified cassava and orange-fleshed sweet potato

Results (Fig 2) showed that the majority (73.7%) of the households purchased OFSP and biofortified cassava usually 2-3x (26.9%) or 4-6x monthly (23.7%). The frequent (daily/ weekly) consumption of OFSP and biofortified cassava by most (62.9%) of the consumers is a reflection of the reported high purchase frequency of these products every month (≥1x monthy-73.7%).

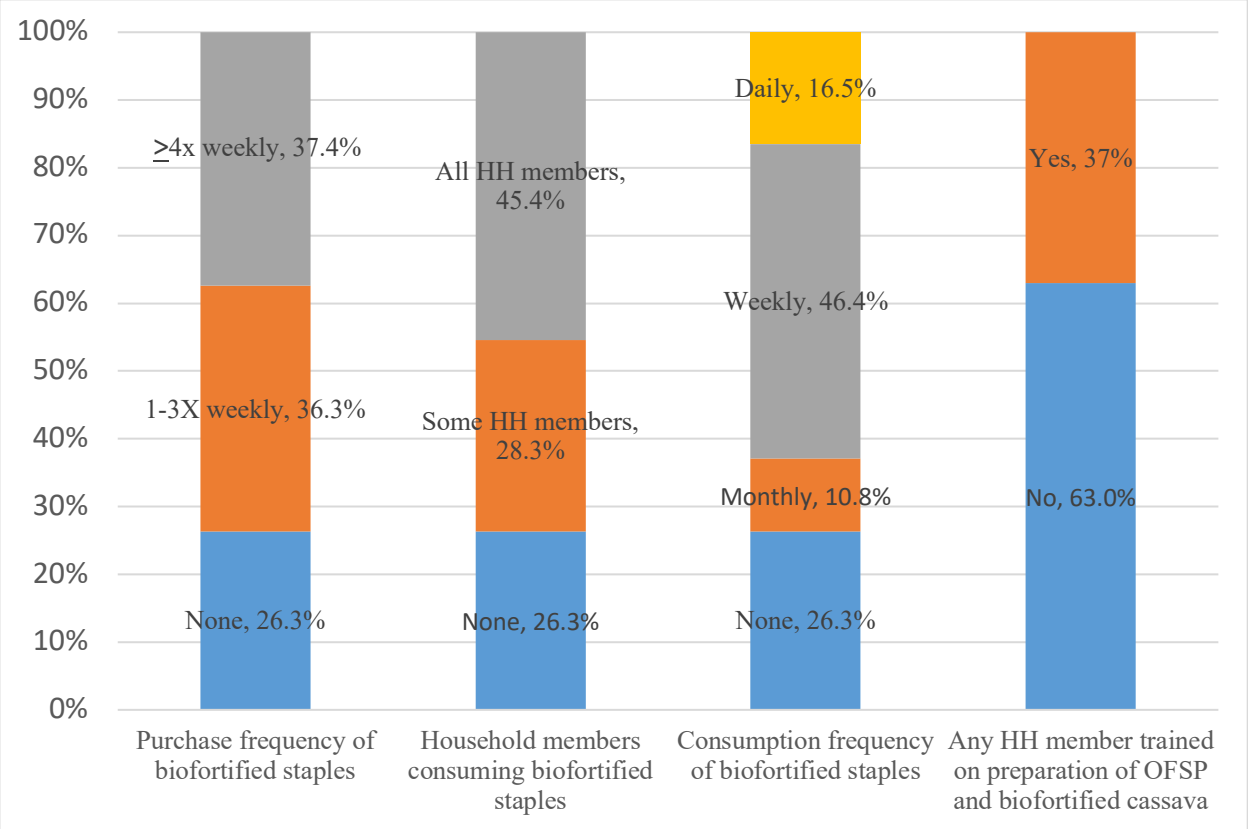

Figure 2: Utilization of biofortified cassava and orange-fleshed sweet potato (N=710)

Almost half (45.4%) of all the respondents reported that all their household members consumed these biofortified staples. Daily and weekly consumption frequency of these biofortified staples were observed in 16.5% and 27.5% of the households. A little

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 21 No. 5 June 2021 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

proportion (37.0%) of the respondents have participated in cooking demonstration on the preparation of OFSP and yellow cassava.
A majority (73.7%) of the respondents consumed biofortified staples and this corroborates a study which reported high consumption of OFSP (86.3%) in Chipata, Zambia [22]. One plausible explanation to the observed high utilization (in terms of purchase and consumption) of OFSP and biofortified cassava in this study could be the quality of knowledge received from experts, given that the common source of awareness of biofortified staples were extension staff of universities or research institute. Chowdhury *et al*. [24] affirmed that consumers who were not properly informed or knowledgeable about the benefits of OFSP in comparison to the normal varieties were not willing to sustain the purchase of orange-fleshed sweet potato.

Influence of knowledge on perception and utilization
Results revealed a positive correlation between respondents' knowledge and perception towards the benefits of biofortified staples ($r= 0.11$; $p <0.01$). Also, a significantly positive association exists between respondents' knowledge of biofortification and its purchase ($r= 0.29$; $p <0.01$) and consumption ($r= 0.23$; $p <0.01$) frequency. The observed significant ($p <0.05$) correlation between respondents' knowledge of studied biofortified staples and perception as well as utilization in this study agrees with reports from an evaluation study of OFSP promotion projects in Mozambique and Uganda which revealed that farmers' improved OFSP knowledge from training sessions received on the benefits OFSP was associated with their adoption of OFSP in the diets [25]. People with knowledge of the benefits of interventions are likely to adopt the practices that are promoted to prevent known consequences of not doing so [26], and thus knowledge of biofortified staple foods will influence their household purchase and utilization frequency.

CONCLUSION

Study findings revealed an average knowledge level of OFSP and biofortified cassava in selected rural communities of Abia and Imo states. The respondents had a negative perception towards the consumption, benefits and barriers of utilizing biofortified staples. Despite the monthly purchase of biofortified staples by many consumers, it still amounted to a low daily consumption frequency of OFSP and biofortified cassava. Consumers' knowledge of OFSP and biofortified cassava was found to significantly influence their perception and utilization of the products. Therefore, research institutes and relevant stakeholders should ensure that rural sensitization is promoted at a higher scale with accompanying cooking demonstration and price reduction to improve acceptability and utilization.

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 21 No. 5 June 2021 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Table 1: Socio-demographic characteristics of respondents

Variables	Frequency (N=710)	Percentage
Sex		
Male	251	35.4
Female	459	64.6
Age (in years)		
Less than 18 years	43	6.1
18-35 years	263	37.0
36-55 years	280	39.4
56 years and above	124	17.5
Marital status		
Married	451	63.5
Single	121	17.0
Separated	35	4.9
Widowed	103	14.5
Educational status		
No formal education	49	6.9
Primary education	106	14.9
Secondary education	271	38.2
Tertiary education	284	40.0

Table 2: Respondents' knowledge of OFSP and biofortified cassava

Knowledge questions	Correct responses	Freq.	%
Nutrient(s) used in the biofortification of OSFP	Provitamin A	322	45.5
Nutrient(s) used in biofortification of cassava	Provitamin A	457	64.4
Benefit(s) of eating OSFP and biofortified cassava tubers	Preventing blindness, boosting immunity	459	64.6
Health problem(s) that can be prevented by consuming biofortified cassava and OFSP tubers	Vitamin A deficiency	310	43.7
Foods that can prevent Vitamin A deficiency	OFSP, biofortified cassava	426	60.0
Knowledge scores	**Freq (%)**	**Mean ± S.D**	
Poor (<40)	135 (19.0)	8.74 ±9.96	
Average (40-69)	327 (46.1)	51.44 ± 9.91	
Good (71-100)	248 (34.9)	86.61 ± 9.43	
Total	710 (100.0)	55.61 ±29.28	

https://doi.org/10.18697/ajfand.100.20290

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 21 No. 5 June 2021 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Table 3: Perception of OFSP and biofortified cassava consumption

Variables	**Positive responses**	
	Frequency	**Percentage**
Orange fleshed sweet potato and biofortified cassava tubers are good for human consumption	352	49.6
Orange fleshed sweet potato and biofortified cassava are foods for women and children	192	27.1
Orange fleshed sweet potato and biofortified cassava are healthier than white-fleshed ones	270	38.0
Orange fleshed sweet potato and biofortified cassava are the most reliable food crops for our family during times of food shortage	261	36.8
You can't eat too much orange-fleshed sweet potato and biofortified cassava because you will get stomach problems	248	34.9
You can't consume too much orange-fleshed sweet potato and biofortified cassava because they are very sweet	204	28.8
Perception level	**Freq (%)**	**Mean ± S.D**
Negative (0-49)	518 (73.0)	21.26 ± 15.85
Positive (50-100)	192 (27.50)	62.71 ± 8.55
Total	710 (100.0)	32.47 ± 23.29

https://doi.org/10.18697/ajfand.100.20290

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 21 No. 5 June 2021 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Table 4: Perception of the benefits of OFSP and biofortified cassava utilization

Variables	**Positive response**	
	Frequency	**Percentage**
The taste of orange-fleshed sweet potato/yellow cassava is better than white-fleshed sweet potato and yellow cassava	280	39.4
Orange-fleshed sweet potato and yellow cassava has a higher yield compared with white cassava	250	35.1
Orange-fleshed sweet potato and yellow cassava have higher nutritional benefits compared with white sweet potatoes and cassava respectively.	294	41.4
Orange-fleshed sweet potato and yellow cassava are resistant to disease and insects than white-fleshed sweet potato and yellow cassava thereby reducing risk and damage	296	41.7
Orange-fleshed sweet potato and yellow cassava matures earlier than white-fleshed sweet potato and yellow cassava	313	44.1
Perception level	**Freq. (%)**	**Mean ± S.D**
Negative (0-49)	429 (60.4)	9.05 ± 15.16
Positive (50-100)	281 (39.6)	79.12 ± 13.12
Total	710 (100.0)	36.78 ± 37.18

https://doi.org/10.18697/ajfand.100.20290

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 21 No. 5 June 2021 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Table 5: Perception towards barriers of OFSP and biofortified cassava utilization

Variables	**Positive responses**	
	Frequency	**Percentage**
Orange-fleshed sweet potato and yellow cassava are costly	151	21.2
Consumption of orange-fleshed sweet potato and yellow cassava is against our tradition here	505	71.1
Orange-fleshed sweet potato and yellow cassava are not loved by children	425	59.9
Orange-fleshed sweet potato and yellow cassava do not taste as good as white-fleshed	221	31.1
Orange-fleshed sweet potato and yellow cassava are scarce and not readily available.	148	20.9
Orange-fleshed sweet potato and yellow cassava spoil easily	229	32.3
Perception level	**Freq. %)**	**Mean ± S.D**
Negative (0-49)	590 (83.1)	27.82 ± 17.32
Positive (50-100)	120 (16.9)	75.31 ± 15.38
Total	710 (100.0)	35.85 ± 24.62

https://doi.org/10.18697/ajfand.100.20290

REFERENCES

1. **World Health Organization (WHO).** Global prevalence of vitamin A deficiency in populations at risk 1995–2005. WHO global database on vitamin A deficiency. Geneva: WHO press 2009.

2. **Ruel MT and H Alderman** Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *Lancet* 2013; **382**: 536–551.

3. **Bouis HE, Hotz C and B McClafferty** Biofortification: a new tool to reduce micronutrient malnutrition. *Food Nutr. Bull.* 2011; **32**: 31–40.

4. **International Institute of Tropical Agriculture (IITA).** Nigeria Food Consumption and Nutrition Survey 2001-2003, Summary Report. 2003; **7**:70-78.

5. **Ilona P, Bouis H, Palenberg M, Moursi M and A Oparinde** Vitamin A cassava in Nigeria: crop development and delivery. *Afri. J. Food Agric. Nutr. Dev.* 2017; **17**: 12000–12025.

6. **Berni P, Chitchumroonchokchai C, Canniatti-Brazaca SG, De Moura FF and ML Failla** Impact of genotype and cooking style on the content, retention, and bioaccessibility of β-carotene in biofortified cassava (Manihot esculenta Crantz) conventionally bred in Brazil. *J. Agric. Food Chem.* 2014; **62**:6677–6686.

7. **La Frano MR, Woodhouse LR, Burnett DJ and BJ Burri** Bio-fortified cassava increases β-carotene and vitamin A concentrations in the TAG-rich plasma layer of American women. *Bri. J. Nutri*. **110**: 310–320.

8. **Zhu C, Cai Y, Gertz, ER, La Frano MR, Burnett DJ and BJ Burri** Red palm oil–supplemented and biofortified cassava gari increase the carotenoid and retinyl palmitate concentrations of triacylglycerol-rich plasma in women. *Nutri. Res.* 2015; **35**: 965–974.

9. **Chavez AL, Sanchez T, Jaramillo G, Bedoya JM and J Echeverry** Variation of quality traits in cassava roots evaluated in landraces and improved clones. *Euphytica* 2005; **143**: 125–133.

10. **FAOSTAT**. Sweet potato stocks in sub-Saharan African countries in. www. Faostat.fao.org. 2005.

11. **Low JW, Arimond M, Osman N, Cunguara B, Zano F and D Tschirley** "A food-based approach introducing orange-fleshed sweet potatoes increased vitamin A intake and serum retinol concentrations in young children in rural Mozambique" *J. Nutr*. 2007; **137**: 1320–1327.

12. **Mwanga RM, Odongo B and C Niringiye** 'Dimbuka-Bukulula' sweetpotato. *Hort. Sci.* 2009; **44**: 828–832.

13. **Nestel P, Bouis HE, Meenakshi JV and W Pfeiffer** Biofortification of staple food crops. *J. Nutri.* 2006; **136**: 1064–1067

14. **Adetoro, NA, Ogunbayo, SA and MO Akinwale** Agronomic performance of pro vitamin A cassava varieties in three locations in Nigeria. *Afr. J. Plant Sci*. 2018; **12 (10)**: 249-255.

15. **Bechoff A, Chijioke U, Westby A and KI Tomlins**. 'Yellow is good for you': Consumer perception and acceptability of fortified and biofortified cassava products. *PLoS One* 2018; **13** (9)

16. **Olatade KO, Olugbire OO, Adepoju AA, Aremu FJ and PB Oyedele** How Does Farmers' Characteristics Affect Their Willingness to Adopt Agricultural Innovation? The Case of Biofortified Cassava in Oyo State, Nigeria. *Int. J. Sci. Tech*. 2016; 59-75.

17. **Olayinka JY, Olatunji YA, Olalade LA, Oluwatosin OL and IF Ayanda** Farmers' willingness to cultivate pro-vitamin A cassava variety in Kwara State, Nigeria. *J. Agric Extens.* 2020; **24**: 72-84.

18. **WHO**. Global database on child growth and malnutrition. Geneva, World Health Organization 2003. www.who.int/nutgrowthdb *Accessed 12th July 2020.*

19. **Amaya AL, Kyallo F, Judith K, Okoth PK, Anselimo M, Daniel S and J Mwai** Food Fortification: The Level of Awareness among Kenyan Consumers. *Hindawi J. Nutri. Metab.* 2020; 1-7.

20. **Salau ES, Luka EG, Amfani CE and TD Elijah** Awareness Level, Perception and Utilization of Orange Fleshed Sweet Potatoes among Households in Nasarawa Southern Agricultural Zone, Nigeria. *J Sustain. Dev. Afr.* 2018; **20**: 201-208

21. **Okello JJ, Shikuku K, Sindi K and J Low** Farmers' perceptions of orange-fleshed sweet potato: Do common beliefs about sweet potato production and consumption really matter? *Afri. J. Food Agric. Nutri. Dev.* 2015; **15**: 10153-10170.

22. **Sakala P, Kunneke E and M Faber** Household Consumption of Orange-Fleshed Sweet Potato and its Associated Factors in Chipata District, Eastern Province Zambia. Food Nutr. Bull. 2018; **39**: 127-126.

23. **Campilan D, Attaluri S, Mallubhotla S and AV Surya** Sweet potato consumption in Orissa, India and implications for nutrition and livelihood improvement. 15th Symposium of ISTRC, Lima, Peru November 2009.

24. **Chowdhury S, Meenakshi J, Tomlins K and C Owori** Are consumers willing to pay more for biofortified foods? Evidence from a field experiment in Uganda. HarvestPlus Working Paper. Washington, DC: International Food Policy Research Institute 2009.

25. **Behrman J** The Harvest Plus Reaching End Users (REU) Orange Fleshed Sweet Potato (OFSP) Project: Report of Qualitative findings from Uganda: Washington, DC: International Food Policy Research Institute 2011.

26. **Glanz K, Rimer B and F Lewis** Health behavior and health education. San Francisco, CA: John Wiley & Sons, Inc. 2002.