

Full Length Research Paper

Sweetpotato breeding priority and preferred traits to increasing its utilisation in Niger and Nigeria

Issa Zakari Mahaman Mourtala^{1,2*}, Nwankwo Maxwell Innocent³, Dan-Jimo Baina² and Happiness Ogba Oselebe¹

¹Department of Crop Production and Landscape Management, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria.

²Department of Natural Resources Management, National Institute of Agronomic Research of Niger, Niamey, Niger.

³National Root Crop Research Institute, Umudike, Abia State, Nigeria.

Received 8 February, 2023; Accepted 31 March, 2023

Sweetpotato is an important food, feed and vegetable crop in Niger and Nigeria. The adoption of a new variety depends on farmers and consumers preferences. The objective of this study was to identify sweetpotato preferred traits by end-users in Niger and Nigeria. The study was conducted in two countries through participatory rural appraisal. The results revealed that sweetpotato is produced by men in Niger, while it is mostly produced by women in South-East Nigeria. In Niger, 100% of cultivated varieties were landraces, while 75.00% in Nigeria were landraces. Results showed that in Niger, farmers preferred high yielding, white flesh colour, and drought tolerant varieties, while in Nigeria they preferred high yielding, white flesh colour, and earliness cultivars. Traders and consumers in both countries preferred healthy, white flesh colour and big storage root size varieties. There is a need of effective breeding program in Niger, and both countries should turn toward developing cultivars with high yield, drought tolerant, and pest and disease resistant.

Key words: sweetpotato, preferred trait, farmer, consumer, Niger, Nigeria.

INTRODUCTION

Roots and tubers are part of diet for majority of the global population, with world average per capita consumption of 19.4 kg/year (2013-2015) and projecting to achieve 21.0 kg/year by 2025 (OCED and FAO, 2016). Among roots and tubers, sweetpotato [*Ipomoea batatas* (L.) Lam] is an important food, feed and vegetable crop in most tropical developing countries. Sweetpotato is an important root crop grown in more than 115 nations (FAOSTAT, 2019). Sweetpotato has wide production geography, from 40° north to 32° south latitude of the globe. It possesses special attributes such as adaptability in wider

topography, the ability to grow in subsidiary circumstance, good productivity in short durations, and balanced nutritional composition (Trancoso-Reyes et al., 2016). Sweetpotato global production of 2021 was 88,867,913 tons, with area of production of 7,410,026 ha (FAOSTAT, 2023). In West Africa, Nigeria was the first sweetpotato producer (3,943,046 tons), while Niger ranks fifth (224,017 tons) during 2021 (FAOSTAT, 2023). Sweetpotato is an important food, feed and vegetable crop in most tropical developing countries. It has high levels of carbohydrate profile, dietary fibre, vitamins, and

*Corresponding author. E-mail: issazakarym@yahoo.fr.

minerals (K, P, Ca, Mg, Fe, Mn, Cu). The roots have high nutritional value and sensory versatility in terms of taste, texture, and flesh colour (white, cream, yellow, orange, purple). B-carotene content is crucial because vitamin A deficiency is a serious health problem that results in blindness, weakness and death (Gurmu et al., 2014; Wang et al., 2016).

Due to its favourable profile, sweetpotatoes have been the focus research in recent years (Wang et al., 2016). The decision to adopt a new cultivar is complexly related to field and yield performance as well as consumer taste acceptability (Sugri et al., 2012). The most important criteria of smallholder farmers in Sub-Saharan Africa to adopt sweetpotato variety are yield, drought tolerant, maturity period, resistant to pathogens and pests, taste, nutritive value, multipurpose used, market demand and external appearance of leaves and roots (Low et al., 2017). Meanwhile, end-used preferred traits are never constant but change in the long run due to many factors, mainly changing food preferences, and new food forms, cultural dynamics industrial application, new information that impact utilisation among others (Afuape et al., 2021). The acceptance of new sweetpotato cultivar in Niger and Nigeria must fulfil both farmers and consumers preference. This preference varies from one state to another. Moreover, traders also play an intermediate and important role between sweetpotato production and utilisation. A variety that fails to satisfy agronomic trait for production will not accept by farmers, and the one that fails to fulfil consumers' preferences will also lose the market value.

Considering these perception and preference of farmers, traders and consumers in sweetpotato production, marketing and utilisation; the breeding program should involve the client at each step to meet their need for easy adoption of newly released variety. This can be addressed through participatory plant breeding (PPB) (Tufan et al., 2018; Ceccarelli and Grando, 2019); participatory variety selection (PVC), and participatory rural appraisal (PRA) (Gibson et al., 2007; Gasura et al., 2008; Baafi et al., 2015). Therefore, this study was conducted through participatory rural appraisal (PRA) to identify sweetpotato breeding priority and preferred traits by farmers' traders and consumers in Niger and Nigeria. This will allow establishing a scientific database of sweetpotato for consideration for an on-going and future breeding program activity that can help facilitating breeding for acceptable cultivar for both farmer and consumer.

MATERIALS AND METHODS

Description of study area

The survey was conducted in nine villages selected across three states each from Niger (Tahoua, Dosso, and Tillabéri) and Nigeria (Ebonyi, Abia, and Kaduna) as presented in Table 1. A total of 18 villages (9 villages per country) were the study areas and were

known as sweetpotato production areas. Tahoua State is situated in the middle-East part of Niger, while Dosso, and Tillabéri States are situated in the Western part of the country. In Nigeria, Ebonyi and Abia states are located in the South-East, while Kaduna is in the Northern part of the country.

Nature of participants

Farmers, traders, consumers and agricultural extension agents were the nature of the participants. During focus group discussion, the number of attended participants to the focus group discussion ranged from 5 to 40, with a total of 246 persons (Figure 1). The lower number was due to the restriction during COVID-19 pandemic in both countries. However, there were 135 participants in Niger against 111 in Nigeria. The highest number of 40 participants recorded in Niger was gotten before the restriction of COVID-19 started.

Based on Semis Structure Questionnaire (SSQ), a multistage sampling was used. Three states in each country were sampled, and then 1 to 2 district(s) were subsampled. In each district 1 to 3 village (s) was sub sampled in order to get 3 villages per state. This provided 180 farmers (10 from each village), 180 consumers (10 from each village) and 60 traders (10 from each state) for SSQ.

Data collection

Data were collected for both Focus Group Discussion (FGD) and Semi-Structured Questionnaire (SSQ) from Niger and Nigeria republics. Focus Group Discussion was used to collect general information such as current cultivated varieties, sweetpotato production system, and preferred traits. This was done by a team where, and other village key informants with broad knowledge on diverse social issues.

Based on Semis Structure Questionnaire (SSQ), data were collected using established Participatory Rural Appraisal (PRA) tools followed (Baafi et al., 2015). The following data were collected from farmers: participant identification information, sweetpotato production and management, and sweetpotato preferred traits. From marketers and consumers, data were collected on identification information, sweetpotato preferred traits and some aspects related to cooking, consumption, and root conservation. Participatory rural appraisal was applied to identify the role of gender in production and marketing of sweetpotato.

Data analysis

Data were first converted to numerical values for both FGD and SSQ, then analysed using "R" software version 3.1.5 and Microsoft Excel (Windows 8). Cross tabulations were used and results were summarized into frequencies and percentages, and represented in tables for discussion. Barplot simple and barchart group were constructed by R using lattice and ggplot2 packages. Data were analysed in different forms across states and countries. Pearson's Chi-squared test was performed by R software using library "FactoMineR" to draw the inference of relationships between variables.

RESULTS

Farmer demography profile and socio-economic characteristics in Niger and Nigeria

The description of farmers in both countries was

Table 1. List of villages where the study was conducted in Niger and Nigeria.

Country	State	Local government	District	Village	GPS location
Niger	Tahoua	Malbaza	Dogaraoua	Guidan Magagi	N14°08.644' E005°38.327' A 311 m
Niger	Tahoua	Malbaza	Dogaraoua	Kamakamo	N13°07.441' E005°37.531' A 328 m
Niger	Tahoua	Madaoua	Bangui	Bangui	N13°41.002' E006°11.650' A 292 m
Niger	Dosso	Gaya	Bengou	Hamdallaye	N12°01.332' E003°34.134' A 180 m
Niger	Dosso	Gaya	Bengou	Bengou	N11°59.432' E003°35.393' A 186 m
Niger	Dosso	Gaya	Bengou	Koara Tagui 1	N11°58.252' E003°33.963' A 162 m
Niger	Tillaberi	Balleyara	Tagazar	Tabala	N13°46.201' E002°59.498' A 198 m
Niger	Tillaberi	Balleyara	Tagazar	Didjikamat	N13°47.013' E002°57.102' A 216 m
Niger	Tillaberi	Balleyara	Tagazar	Yargargrazargan	N13°45.908' E002°59.059' A 224 m
Nigeria	Ebonyi	Ezza Sought	Amurzu	Amurzu	N06°09.424' E008°01.553' A 96 m
Nigeria	Ebonyi	Ezza Sought	Idembia	Idembia	N06°07.638' E008°00.247' A 104 m
Nigeria	Ebonyi	Ishielu	Nkalagu	Amaru	N06°27.745' E007°45.593' A 64 m
Nigeria	Abia	Isiala Ngwa North	Ama-Asa	Umuomaiukwu	N05°25'22" E007°24'53" A 129 m
Nigeria	Abia	Isiala Ngwa North	Amasa-Ntigha	Ntigha	N05°25'44" E007°23'51" A 132 m
Nigeria	Abia	Isiala Ngwa North	Nsulu	Agburuike	N05°25'05" E007°25'51" A 130 m
Nigeria	Kaduna	Zaria	Zaria	Amuru	N11° 2' E007°43'
Nigeria	Kaduna	Igabi	Kwarau	Kwarau Gari	N10°45.246' E007°29.947' A 638 m
Nigeria	Kaduna	Igabi	Furukwai	Chiritawa	N10°52.675' E007°37.713' A 674 m

Source: Author

presented in Table 2. Hundred percent of farmers interviewed in Niger were males, whereas, 56.67% were females in Nigeria. Kaduna located in northern part of Nigeria; 100% of interviewed were males making difference with the South-East with 85% females as producers. Only less than 1% of respondent was below 20 years old in both countries. In Niger 78.89% were above 40 years old, while in Nigeria 52.22% were between 20 to 40 years old.

Thirty percent of famers had family size varied from 0.5 to 1 ha, with Nigeria having the highest 37.78%, and Niger 22.22%. Moreover, 30% had farm size above 1 ha with also Nigeria with 32.22% and Niger 27.78% of total respondents.

The study also revealed that 41.78, 38.89 and 18.33% had family size less than 8, from 8 to 14, and above 14 persons, respectively. In Niger, 51.11% had from 8 to 14 family size, whereas in Nigeria 67.78% had less than 8 persons.

Current varieties cultivated by farmer

Different varieties were cultivated by farmers in Niger and Nigeria (Table 3). Variety preferences varied by state and country. In Niger, 17 varieties were cultivated with eight in Tahoua, while in Nigeria, 16 were being cultivated with eight cultivated in Ebonyi state. Majority (87.87%) of the varieties cultivated were landraces. In Niger, 100% of cultivated varieties were landraces, while 75.00% in

Nigeria were landraces.

In Tahoua, varieties "Bera" and "Dakantamini" were the most cultivated varieties, while in Dosso "Dan Tchadi" and Tillaberi "Dan Cameroon". In Ebonyi state, "Oyorima" took the first place, while "Butter Milk" and "Mother Delight" in Abia state, and "Pure water" variety in Kaduna state. Some varieties cultivated but not mentioned during focus group discussion such as "Dan Galmi" in Tahoua, "Ovoleba topia" (which means this gives me joy and laugh), in Ebonyi state and "Dakanta Zawara" (which means wait for me widowed) in Kaduna. The most cultivated varieties in Niger are white/cream flesh colour as well as in Nigeria except in Abia state.

Sweetpotato preferred traits by farmer in Niger and Nigeria

The distribution obtained from dimension 1 and dimension 2 was presented in Figure 2. Results classified the study area as well as the farmer preferred traits in four groups. All the Niger states were classified in group 1. However, Kaduna state was separately classified in group 2 with specific trait (that is, easy to cultivate), while, Abia in group 3, and Ebonyi state in group 4 (Figure 2). In this study, 17 traits were listed across 6 states of Niger and Nigeria as traits preferred by farmers (Table 4). The results from correspondence analysis showed highly significant difference ($\chi^2 = 394.86$; $p < 0.001$) in the choice of farmer in different traits (Table 4). The criteria that

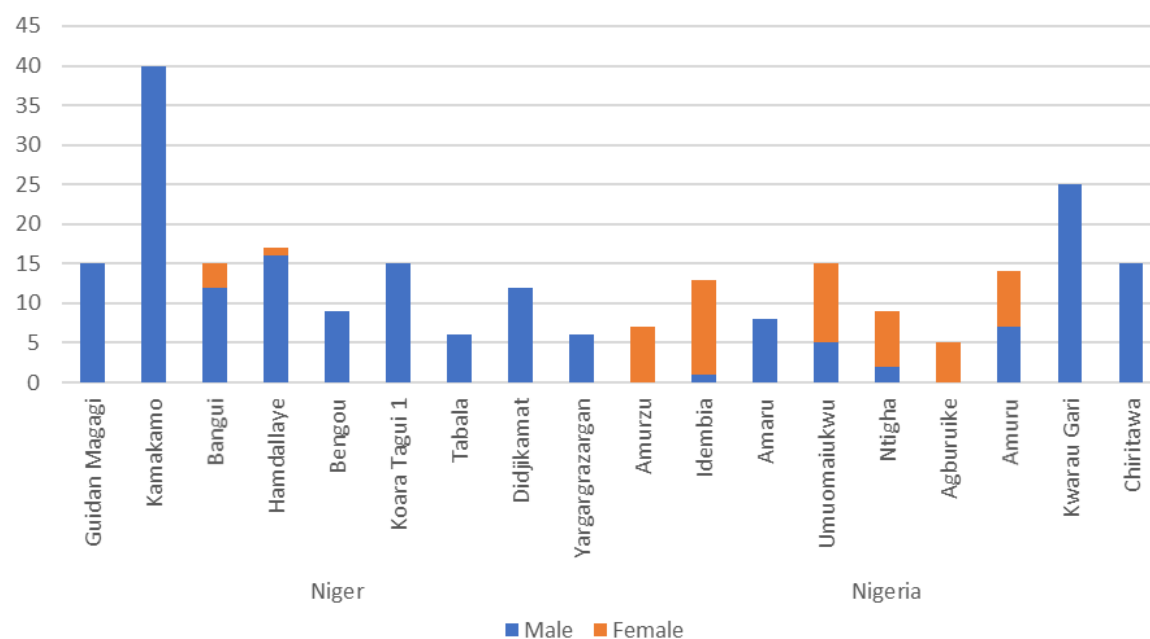


Figure 1. Gender attended participants per village during focus group discussion.
Source: Author

Table 2. Description of farmers' characteristics in Niger and Nigeria.

Variable	Country		Total
	Niger	Nigeria	
Sex			
Male	90 (100)	39 (43.33)	129 (71.67)
Female	0 (0.00)	51 (56.67)	51 (28.33)
Group age (years)			
Below 20	0 (0.00)	1 (1.11)	1 (0.55)
20-40	19 (21.11)	47 (52.22)	66 (36.67)
Above 40	71 (78.89)	42 (46.67)	113 (62.78)
Farm size (ha)			
< 0.1	16 (17.78)	13 (14.44)	29 (16.11)
0.1-0.49	29 (32.22)	14 (15.56)	43 (23.89)
0.5-1	20 (22.22)	34 (37.78)	54 (30.00)
> 1	25 (27.78)	29 (32.22)	54 (30.00)
Marital status			
Single	0 (0.00)	2 (2.22)	2 (1.11)
Married	83 (92.22)	84 (93.34)	167 (92.78)
Divorced	7 (7.78)	3 (3.33)	10 (5.55)
Widowed	0 (0.00)	1 (1.11)	1 (0.55)
Family size			
<8	16 (17.78)	61 (67.78)	77 (42.78)
8-14	46 (51.11)	24 (26.67)	70 (38.89)
>14	28 (31.11)	5 (5.55)	33 (18.33)

The number in parentheses represents the percentage of participants.
Source: Author

Table 3. Varieties used its characteristics and appreciation by farmers in each study area.

State	Village	Variety	Status	Taste	Skin colour	Flesh colour
Tahoua	Guidan Magagi	Bera	Landrace	Sugar	White	White
		Dakantamini	Landrace		White	White
		Dan Izala	Landrace	High sugar	Orange	Orange
	Kamokamo	Bera	Landrace	Sugar	White	Orange
		Dan Izala	Landrace	Sugar	White	White
		Dakantamini	Landrace	Sugar	White	Orange
		Farin Dankali	Landrace	High sugar	White	White
	Bangui	Dan Pateka	Landrace	Good taste	White	White
		Balium	Landrace	Sugar	Orange	Yellow
		Tarho	Landrace	Less sugar	White	Cream
		Tourist	Landrace	High sugar	White	White
	Hamdallahi	Dan Tchadi	Landrace	Sugar	White	White
Dan Addama		Landrace	Less sugar	Cream	White	
Dan Izala		Landrace		Red	White	
Dosso	Bengou	Dan Tchadi	Landrace	Sugar	White	Cream
		Malan Da Yayo	Landrace	Tasteless	White	White
Koara Tagui 1	Dan Tchadi	Landrace	Sugar	White	White	
	Dan Addama	Landrace	Tasteless	Cream	Cream	
	Dan Kawara	Landrace	Tasteless	Red	White	
Tabalat	Dan Cameroun	Landrace	Sugar	White	White	
	Dan Maradi	Landrace		White	White	
Tillaberi	Didjikamat	Dan Cameroon	Landrace	Sugar	White	White
		Dan Bouza	Landrace		White	White
Yargargrazargan	Dan Cameroon	Landrace	Sugar	White	White	
	Dan Bouza	Landrace		White	White	
Amurzu	Oyorima	Improved	High sugar	White	White	
	Ogogo Ocha	Landrace	Sweet	White	White	
	Ogogo Uhie	Landrace	High sugar	Red	White	
	Yellow flesh	Improved	Low sugar	White	Yellow	
Ebonyi	Idembia	Nwitodo	Landrace	Sugar taste	White	Yellow
		Oyorima	Improved	High sugar	White	White
		Anoliben	Landrace	High sugar	White	White
Amaru	Mekebe	Landrace	High sugar	White	Yellow	
	Red flesh	Landrace	Sugar taste	Red	White	
Abia	Umuomaiukwu	Mother delight	Improved	Less sugar	Orange	White
		Butter Milk	Improved		Orange	Orange
		Sologo	Landrace			
Ntigha	Mother delight	Improved	Less sugar	Orange	Orange	

Table 3. Contd.

	Agburuike	Mother delight Butter Milk	Improved Improved	Less sugar	Orange White	Orange White
	Amuru	Pure water Dan Bakalori Karass	Landrace Landrace Landrace	High sugar Moderate sugar Less sugar	White Red White	Cream White White
Kaduna	Kwarau Gari	Pure water Dan Bakalori	Landrace Landrace	High sugar High sugar	White Cream	Cream Yellow
		Dan Izala Karass	Landrace Landrace	Less sugar Less sugar	Cream Orange	White Orange
		Chiritawa	Pure water Karass Dan Sokoto	Landrace Landrace Landrace	Less sugar High sugar Less sugar	White White Orange

Source: Author

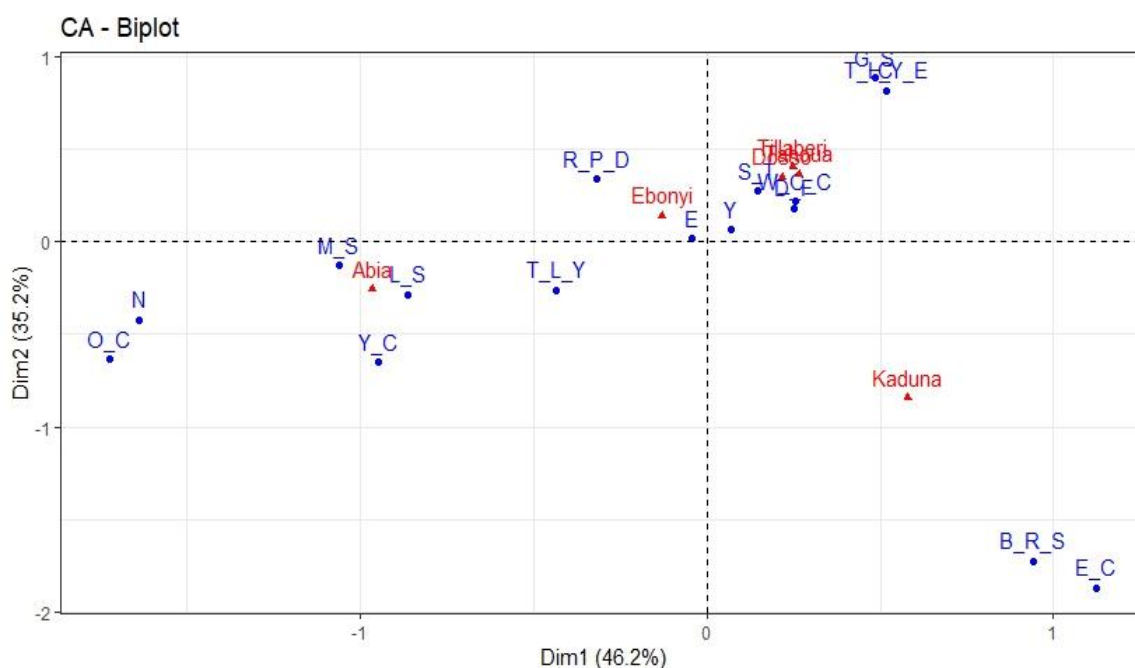


Figure 2. A Biplot from correspondence analysis showed the area of study and their correspondent farmer traits.
Source: Author

push farmers to identify good sweetpotato varieties are summarized into agro-morphological and culinary-quality traits (Figures 3 and 4). In Niger, the first five preferred traits by farmers were high yield (100% frequencies), white/cream colour (82.22%), drought tolerant (71.11%), earliness (26.66%), and resistance to pests and diseases (23.33%). In Nigeria, order of importance of the traits was high yield (100% frequencies), white/cream colour

(56.66%), earliness (54.44%), drought tolerant (51.11%) and big size (26.26%). Yield has been mentioned as the first preferred trait by almost all farmers. Other traits have been mentioned and the breeder has to have a look at it such as orange-fleshed, sugar taste, big size, taste like yam, yellow colour etc. Orange-fleshed has not been mentioned in Niger. Farmers described sugar taste as high sugar content, moderate and low, while flesh colour

Table 4. Chi-square in sweetpotato farmer preferred traits across study areas.

Preferred traits	Chi-square	df	p-value
Farmer preferred traits			
Yield			
Drought tolerance			
White/cream colour			
Orange colour			
Yellow colour			
Earliness			
Big size			
Resistant to pests and diseases			
High sugar taste	394.86	80	0.000
Moderate sugar			
Low sugar			
Easy to cultivate			
Taste like yellow egg			
Taste like yam			
Consistent			
Good in storage			
Nutritional			

Source: Author

has been described mostly in Nigeria as white, orange and yellow flesh colour. Farmers considered white or cream colour as white.

Sweetpotato preferred traits by traders and consumers in Niger and Nigeria

Eleven traits were listed across 6 states of Niger and Nigeria as marketer traits preferred (Table 5). The results showed high significant difference ($\chi^2 = 82.38$; $p < 0.01$) in the choice of trader in different traits (Table 5). Various characteristics of good sweetpotato storage roots were identified by sellers. Thirty traders in each country were interviewed through Semi-Structured Questionnaire (SSQ). In Niger, healthy/clean root (83.33%), white/cream flesh colour (83.33%), big root (80.00%), high sugar taste (26.26%) and conservation (10.10%) were the first preferred traits by traders across the states as well as across countries (Figures 5 and 6). The order of importance was as follows in Nigeria: big root (90.00%), white/cream colour (83.33%), healthy/clean (76.67%), orange-fleshed (16.16%), and low sugar taste (10.10%).

Ninety consumers in each country were interviewed which made it one hundred and eighty consumers. From these consumers, eleven traits were listed as traits preferred (Table 5). The results showed highly significant difference ($\chi^2 = 207.48$; $p < 0.001$) in the choice of consumer in different traits (Table 5). Consumer preferred traits in Niger were white/cream fleshed (81.11%), healthy (74.44%), big root (32.22%), high sugar (30.00%),

and powder taste (13.33%). Similar trend was observed in Nigeria as healthy/clean (87.78%), white/cream fleshed (70.00%), big root (55.56%), orange-fleshed (27.78%), and low sugar (25.56%) (Figures 7 and 8). In sugar taste, Niger consumers mentioned high sugar as preferred trait, while in Nigeria low sugar was preferred. Other traits have been mentioned like powder taste. Besides, orange-fleshed as well as yellow-fleshed was mentioned in Abia state.

DISCUSSION

Demography profile and socio-economic characteristics based on SSQ

In Niger, sweetpotato management is a man business in term of production, and marketing since it requires too much labour and financial resources. This is due to its large area of cultivation by farmers and it is for cash crop in all the villages. Sweetpotato however is men's crop in Niger. The highest percent of large production area obtained from Nigeria was increased by those from Kaduna state. In Niger, the raw or boiled sweetpotato is sold at the market by males, but young female could be sellers (of boiled or processed potato) after buying from the wholesalers. In Nigeria, Kaduna is similar to Niger due to huge production and purpose of which was to export to Lagos for other uses. In the South-East of Nigeria, women are more willingly producers and marketers because it is produced as food crop and

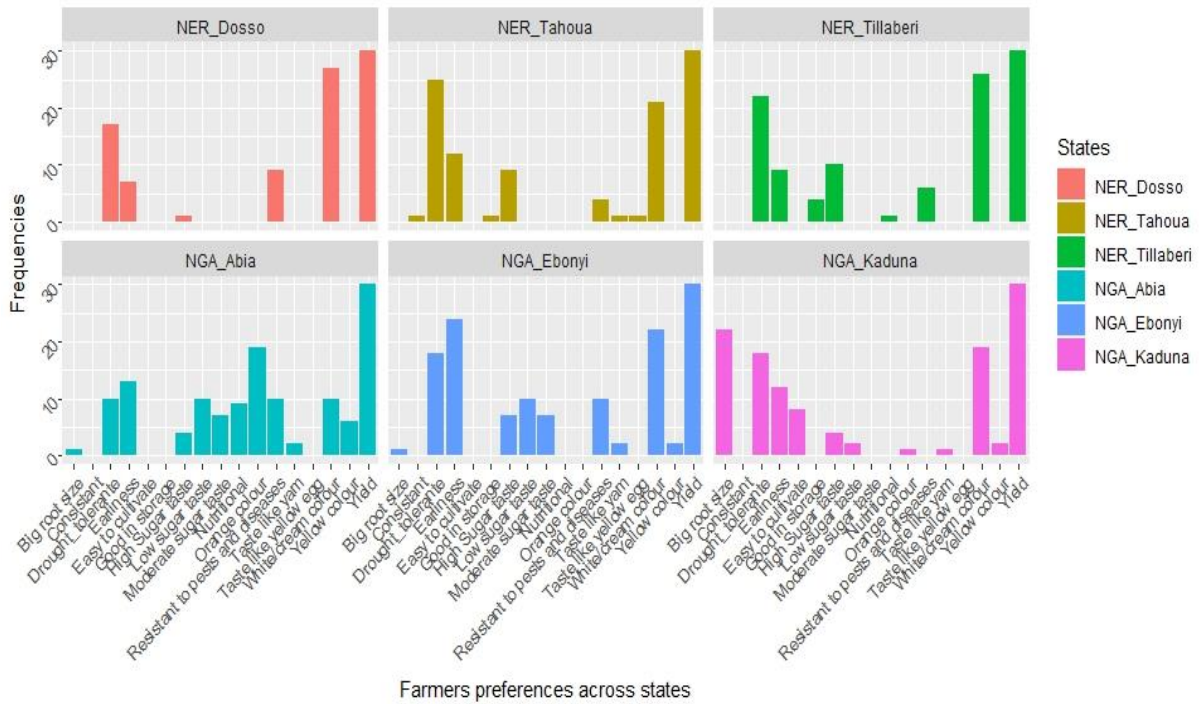


Figure 3. Farmers' preferred traits across States of Niger and Nigeria. Source: Author

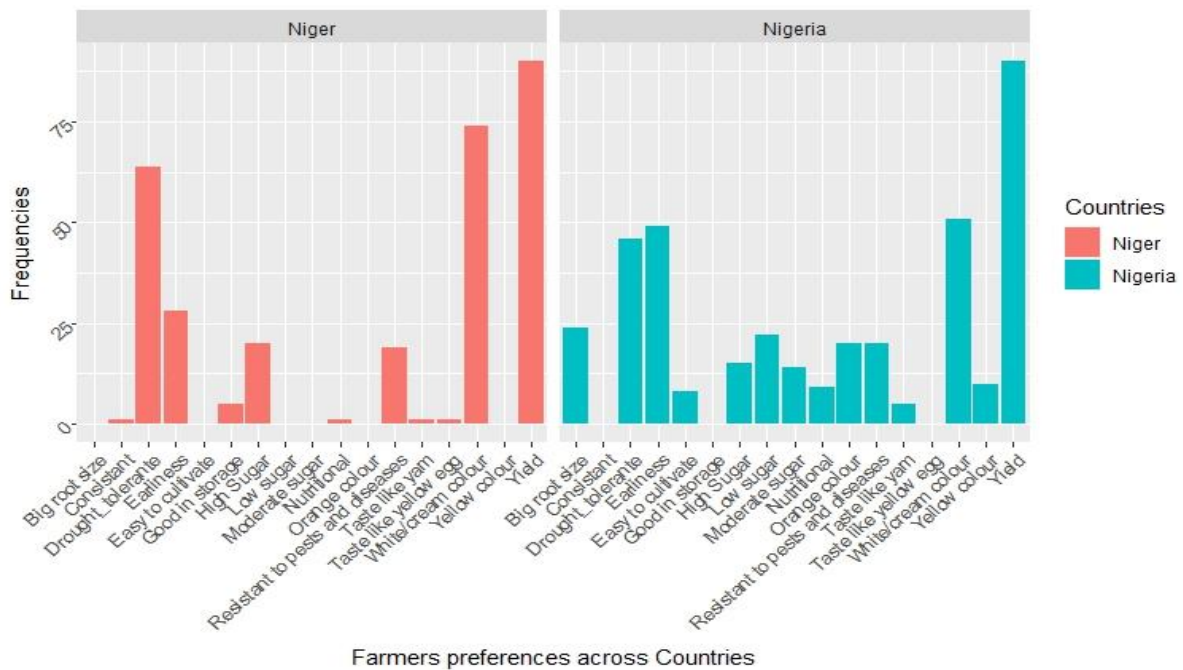


Figure 4. Farmers' preferred traits across countries. Source: Author

considered as women's crop when men are more occupied by yam, and cassava production, which are the

main cash and food crops too. This suggests a relatively greater importance of women in sweetpotato production

Table 5. Chi-square in sweetpotato farmer preferred traits across study areas.

Preferred traits	Chi-square	df	p-value
Trader preferred traits			
Healthy			
White colour			
Orange fleshed			
Yellow fleshed			
Big root			
Medium size	82.38	50	0.003
Small root			
Powder taste			
Sugar taste			
Consistent skin			
Storage			
Consumer preferred traits			
Healthy			
White/cream fleshed			
Orange fleshed			
Yellow fleshed			
Big root			
Small root	207.48	55	0.000
Powder taste			
High sugar			
Moderate sugar			
Low sugar			
Consistent skin			
Free of fibre			

Source: Author

in South-East Nigeria.

The involvement of more married females in sweetpotato production in Abia and Benue states could be due to the role of sweetpotato as a food security crop (Afuape et al., 2021). In general, the crop is more important for men than women in Nigeria (Olagunju et al., 2013). Other reports indicated the importance of women than men in sweetpotato production in Western Tanzania (Filson et al., 2018), and implication of 52.00% of female (as farmers, traders and consumers) in Ghana (Baafi et al., 2015). However, (Stathers et al., 2013) grouped gender roles and their responsibilities in sweetpotato production chain into three categories, namely sweetpotato as i) a male's crop with few or no women growing it, ii) female's crop with few or no men growing it, and iii) sweetpotato grown by both men and women on individually or family-owned plots. The increasing role of sweetpotato as a cash crop in South Nyanza in Kenya has attracted male involvement in sweetpotato production (Low, 2004), and increased sweetpotato market demand has brought changes in the roles and responsibilities of gender in Eastern Tanzania (Ngailo et al., 2016). Market

demand can greatly influence men participation in sweetpotato production. In Niger 78.88% were above 40 years old, while in Nigeria 52.22% were between 20 to 40 years old, indicating that sweetpotato farmers were still in their active year of production. Similar age range of 20-60 years for over 90% was reported in Nigeria (Afuape et al., 2021) and above 40 years for over 52.00% was reported in Ghana (Baafi et al., 2015). For consumers, in Niger and Nigeria, sweetpotato consumption is not related to sex or age group. However, the tendency of males or females from one state to another is due to their availability during the administration of questionnaire, and or the management status of the crop in such area.

Current varieties cultivated by farmer based on FGD

Seventeen varieties were cultivated in the study area of Niger. A previous study reported 36 varieties cultivated in Western Niger (Ayerou, Gaya and Balleyara) (Harouna et al., 2015). The use of "Bera" variety could be explained by its introduction (into two villages that is, Guidan

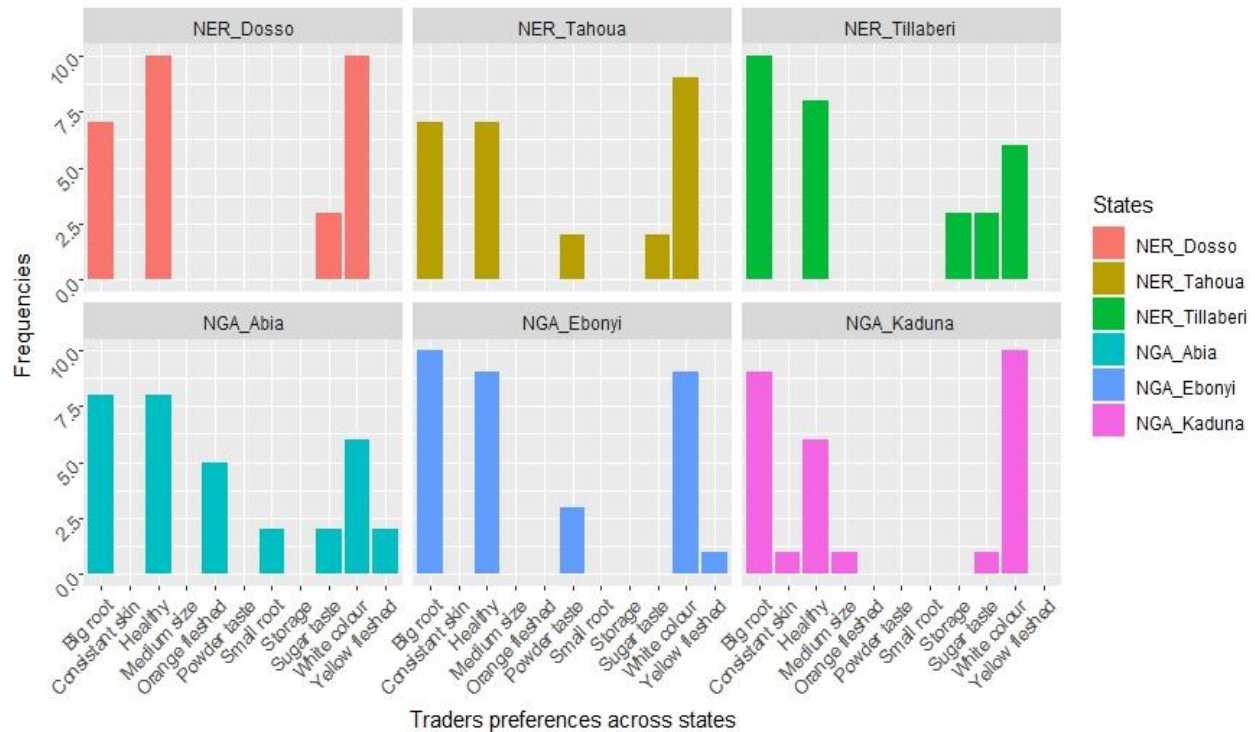


Figure 5. Sweetpotato trader preferred traits across states of Niger and Nigeria. Source: Author

Magagi and Kamakamo) by agricultural extension agent, which is why farmers do not have a choice since they are new growers. The third village of Tahoua (Bangui) is the most experimented one and 'Tourist' and "Dan Pateka" are the most cultivated. This choice if was due to the high yield of "Tourist" variety but "Dan Pateka" variety is more consistent. In Western Niger, "Dan Tchadi" and "Dan Cameron" varieties were the most cultivated in Dosso (Gaya), and Tillaberi (Balleyara), respectively because of their high yield, big root and white flesh colour. Earliness varieties with big storage roots were the most appreciated, which explained the cultivation of "Dan Maradi" variety by about 50% of farmers (Harouna et al., 2015). Previous report (Harouna et al., 2015) did not mention "Dan Cameroon" as a variety, which suggests that "Dan Cameroon" was not introduced at that time. In Ebonyi state, "Oyorima was the most cultivated because of its high yield, and as the name implies "plenty storage roots". "Butter Milk" and "Mother Delight" which were improved varieties were the most cultivated in Abia state, while "Pure water" was mostly cultivated in Kaduna state. The choice of "Pure water", could be explained by its less requirement of practice, drought tolerant, and it can be harvested twice, but it is less conservable compared to other varieties (that is, "Dakanta Zawara" variety which is better in conservation). The most cultivated varieties in both countries are either white or cream-fleshed except "Mother Delight" which is orange-fleshed. This study

revealed that variety preferences depend on state and country. Similar result was reported that variety preferences in Tanzania vary by district and sex (Mulwa et al., 2021).

Sweetpotato preferred traits by farmers in Niger and Nigeria

There was highly significant difference ($\chi^2 = 394.86$; $p < 0.001$) in the choice of farmer in different traits among study areas. As confirmed by the Figures, yield was the most preferred trait following by white/cream coloured and drought tolerant cultivar. The choice of yield as first trait in both countries explained that farmer firstly focuses to high yield in choosing genotype. This confirmed the usual first breeding objective which is high yield. The study revealed five important traits viz. high yield, white/cream colour, drought tolerant, earliness, and resistance to pest and disease. Similar results were found where stated that yield, drought tolerant, maturity period, resistant to pathogens and pests, taste, nutritive value, multipurpose used, market demand and external appearance of leaves and roots constituted the criteria of smallholder farmers to adopt sweetpotato varieties in Sub-Saharan Africa (Low et al., 2017). Study in Niger discovered that the most preferred traits in Western part were earliness, taste, root size and resistant to pests and

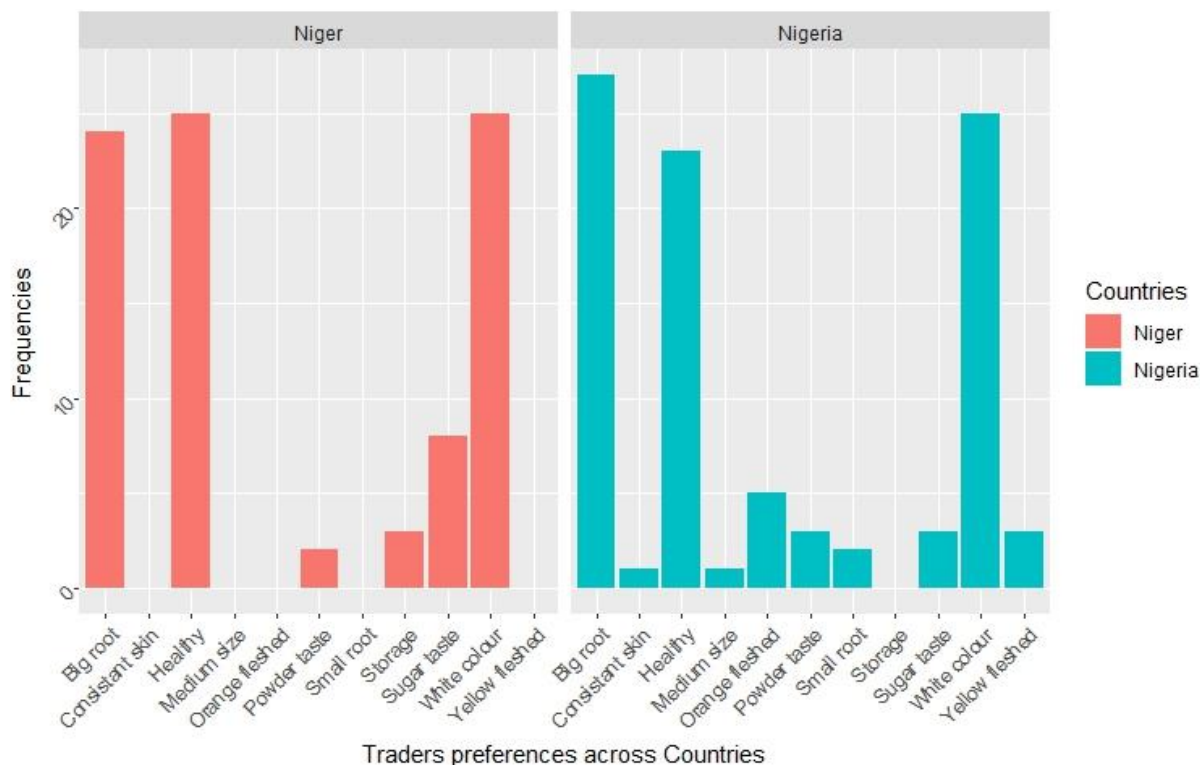


Figure 6. Sweetpotato trader preferred traits across countries.
Source: Author

pests (Harouna et al., 2015). Other researchers in Tanzania reported the first three preferred agronomic traits were yield, drought tolerant and pest and disease resistant (Ngailo et al., 2016; Filson et al., 2018). In Rwanda, the selection of cultivar by farmers is tightly linked to farmers' preferred traits cultivar and this cultivar should be high yield, early maturity and drought tolerant (Rukundo et al., 2015).

The drought tolerant trait as 3rd preferred trait in Niger could be explained by the production of sweetpotato under irrigation (65.55%). Therefore, farmers need to save time and energy for other works as well as fuel money which is expensive in Niger (1 litre at 0.98 US Dollar). Such kind of variety can be highly accepted by farmer. Earliness as 3rd trait in Nigeria could be explained by the high percentage of the production of sweetpotato under rain (92.22%). Thus, earliness genotype can be easily accepted in Nigeria since it can escape drought to complete its cycle before the end of rain (Levitt, 2012). Resistance to pests and disease is due to the influence of these enemies in the productivity. In fact, sweetpotato weevil is the first pest in Niger (Doumma et al., 2008), and in Southern Nigeria (Uwaidem et al., 2018) with 61.11 and 33.33%, respectively. Orange feshed mentioned in Abia state can be explained by the membership of the producers to Sweetpotato Producers Association of Nigeria (SPAN). This was explained by

their relationship with the NRCRI of Nigeria which can be easy to access to more benefit. In Kaduna, farmers mentioned "easy to cultivate" as trait because of their variety "Pure water" which is highly preferred and very easy to manage. Sweetpotato breeding programs should consider the preference of farmers in developing new varieties for easy adoption.

Sweetpotato preferred traits by traders and consumers in Niger and Nigeria

There was high significant difference ($\chi^2 = 82.38$; $p < 0.01$) in the choice of traders, and highly significant difference ($\chi^2 = 207.48$; $p < 0.001$) in the choice of consumers in different traits across both countries. Healthy/clean root, white flesh colour, and big size of storage root were the first 3 most significant preferred traits by traders and consumers in Niger and Nigeria as confirmed by the Figures. Traders' traits depend to consumers' preferred traits. Consumers were more attracted by white/cream colour due to the beauty and consistence when frying or boiling. For the mouth-feel of boiled roots, Afuape et al. (2021) reported that more than half of the respondents in Benue state (70%) and Abia state (52%) preferred hard boiled sweetpotato storage roots (roots with boiled white yam texture). This is related to high dry matter which

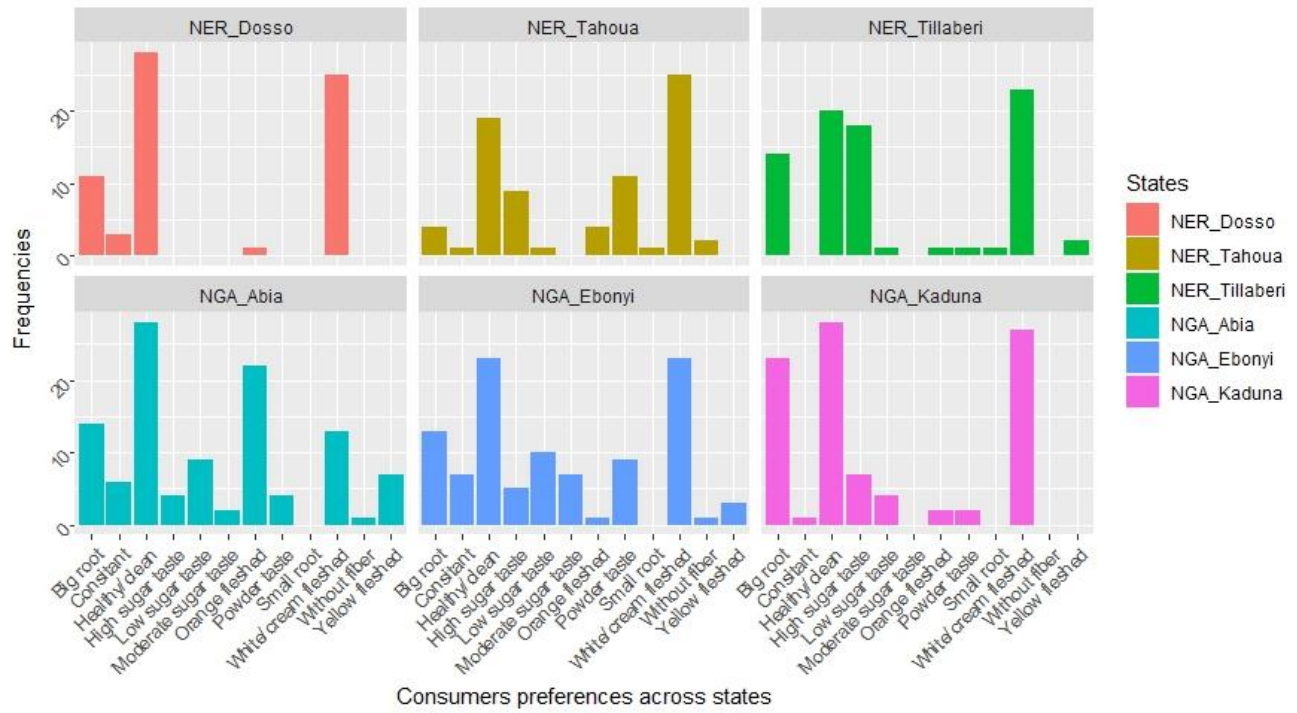


Figure 7. Sweetpotato consumer preferred traits across states of Niger and Nigeria. Source: Author

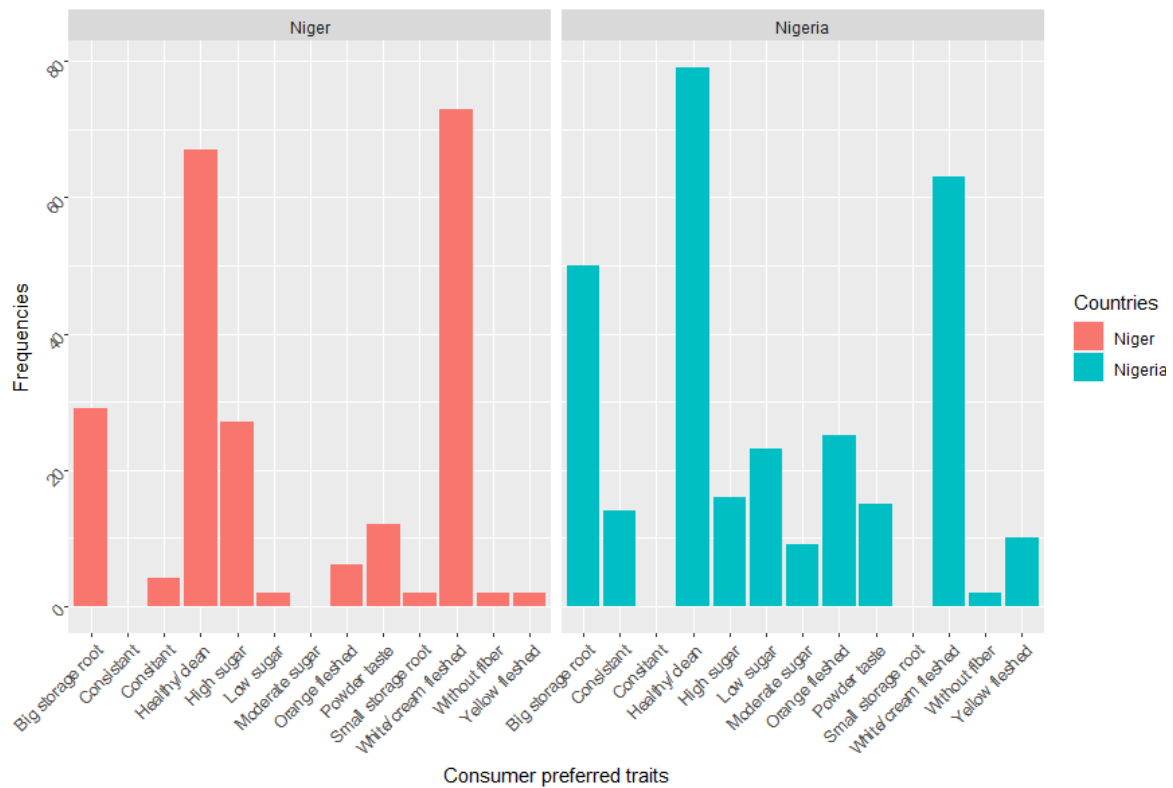


Figure 8. Sweetpotato consumer preferred traits across Countries. Source: Author

contains high carbohydrate. In contrast, in Tanzania consumers preferred sweetpotato with medium to large storage root size, purple skin colour high dry matter content, sweet taste and well-shaped roots (Mulwa et al., 2021). Staple sweetpotato types typically have white to cream flesh with dry weight contents ranging from 30-35% (la Bonte et al., 2000), while dessert sweetpotato types generally have cream to orange flesh with dry matter ranging from 17.7 to 26.3 % (Picha, 1987). Carbohydrate is the most constituent of dry matter in sweetpotato with up to 80-90% (Mcharo and La-Bonte, 2007). This could explain the less choice of orange-fleshed which contains high beta-carotene, but with less dry matter. However, the choice of orange-fleshed sweetpotato in Abia state could be explained by their relationship with NRCRI of Nigeria, and their appurtenance as membership of sweetpotato producers' association of Nigeria (SPAN). The selection of new cultivars by urban consumers depends on sensory profiles, knowledge, level of promotion of the crop, and previous experiences of consumers on similar crops among others (Birol et al., 2015). The storage root is mainly starch. Cooking method and utilization form have a critical influence on taste and consumptive quality (Sugri et al., 2012). Cooking leads to the changes in physical, sensory and chemical characteristics of the final product (Fontes et al., 2011). However, low dry matter content like orange flesh types lose their cooking quality (mealiness) when cooked affecting textural characteristics. Frying enhances sensorial characteristics such as texture, flavour, smell, colour, as well as overall palatability (Sugri et al., 2012).

Conclusion

Sweetpotato is among staple food in South-East of Nigeria in difference with Niger. The study revealed that in Niger farmers preferred high yielding white flesh colour and drought tolerant varieties, while in Nigeria farmers desired high yielding white flesh colour and earliness varieties. Consumers preferred white flesh colour with large storage root size. However, in Niger consumers preferred high sugar, but in Nigeria low sugar was preferred. All the varieties cultivated in Niger were landraces, and majority in Nigeria were landraces too. Therefore, there is urgent need of sweetpotato breeding program in Niger, and the breeding program should adjust to breeding cultivars with high yield, white-fleshed colour and tolerance to drought stress. It is also important for an integrated team for introducing new varieties with high nutritional value like orange fleshed sweetpotato (OFSP).

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

This work was part of Ph. D project granted by the European Commission's Education, Audio-visual and Culture Executive Agency (EACEA), for awarding Issa Zakari Mahaman Mourtala Ph. D scholarship.

REFERENCES

- Afuape SO, Abimbola OO, Alfonso CO, Kolawole OF, Adesina AB (2021). Farmers trait preferences for desirable cultivars: implications for demand-led sweetpotato [*Ipomoea batatas* (L.) lam] varietal development. *Nigerian Agricultural Journal* 52(2):15-26.
- Baafi E, Manu-Aduening J, Carey EE, Ofori K, Blay ET, Gracen VE (2015). Constraints and Breeding Priorities for Increased Sweetpotato Utilization in Ghana. *Sustainable Agriculture Research* 4(4):1-16.
- Birol E, Meenakshi Jv, Oparinde A, Perez S, Tomlins K (2015). Developing country consumers' acceptance of biofortified foods: a synthesis. *Food Security* 7(3):555-568.
- Ceccarelli S, Grando S (2019). *Participatory plant breeding: Who did it, who does it and where?* Cambridge University Press. *Experimental Agriculture* 56(1):1-11.
- Doumma A, Haougui A, Toufique BM, Adamou I (2008). *Connaissances et maîtrise des problèmes parasitaires de la patate douce au Niger*. FAOSTAT (2019, December 4). Available on line. <http://www.Fao.Org/Faostat/En/>.
- FAOSTAT (2023, January 26). Production of commodity in selected country, production share by region. FAO. <https://doi.org/https://www.fao.org/faostat/en/#data/QCL/visualize>.
- Filson K, Hussein S, Julia S (2018). Sweetpotato weevil damage, production constraints, and varieties preferences in Western Tanzania: farmers' perception. *Journal of Crop Improvement* 32(1):107-123.
- Fontes LCB, Oliverira FG, Collares-Queiroz FP (2011). Optimization of the Deep Fat Frying Processes of Sweetpotato Chips in Palm Olein or Stearin. *American Journal of Food Technology* 6(5):348-361.
- Gasura E, Mashingaidze AB, Mukasa SB (2008). Genetic variability for tuber yield, quality, and virus disease complex traits in Uganda sweetpotato germplasm. *African Crop Science Journal* 16(2).
- Gibson RW, Byamukama E, Mpembe I, Kayongo J, Mwangi ROM (2007). Working with farmer groups in Uganda to develop new sweetpotato cultivars: Decentralisation and building on traditional approaches. *Euphytica* 159:217-228.
- Gurmu F, Hussein S, Laing M (2014). The potential of orange-fleshed sweetpotato to prevent vitamin A deficiency in Africa. *International Journal for Vitamin and Nutrition Research* 84(1-2):65-78.
- Harouna IA, Doumma A, Toufique, BM (2015). Inventaire des variétés, des méthodes locales de stockage et de protection contre les ravageurs de la patate douce (*Ipomoea batatas* L.) dans la bande Ouest du Niger. *International Journal of Biological and Chemical Sciences* 9(4):1962.
- la Bonte DR, Picha DH, Johnson HA (2000). Carbohydrate-Related Changes in Sweetpotato Storage Roots during Development. *Journal of the American Society for Horticultural Science* 125(2).
- Levitt J (2012). *Responses of plants to environmental stress* (1st ed.). Academic Press.
- Low J (2004). The changing role of sweetpotato in South Nyanza, Kenya. In: K Ehui S, J Lynam, and I Okike (Eds.), *Adapting social science to the changing focus of international agricultural research*. International Livestock Research Institute pp. 95-118.
- Low JW, Mwangi ROM, Andrade MI, Carey E, Ball AM (2017). Tackling vitamin, A deficiency with biofortified sweetpotato in sub-Saharan Africa. *Global Food Security* 14:23-30.
- Mcharo M, La-Bonte D (2007). Genotypic variation among sweetpotato clones for β -carotene and sugar content. *Proceedings of the 13th ISTRC Symposium* pp. 746-754.
- Mulwa CK, McEwan M, Mussa H, Ogero K, Rajendran S, Wanjohi L (2021). Gender-differentiated trait preferences for sweetpotato

- varieties in Tanzania. A focus group discussion report. <https://doi.org/10.4160/9789290606086>
- Ngailo S, Mtunda K, Shimelis HA, Sibiya J (2016). Assessment of sweetpotato farming systems, production constraints and breeding priorities in eastern Tanzania. *South African Journal of Plant and Soil* 33(2):105-112.
- OCED, FAO (2016). Agricultural outlook (2016–2025). https://www.oecd-ilibrary.org/Agriculture-and-Food/Oecd-Fao-Agriculturaloutlook-2016-2025/Roots-and-Tubers-Projections-Production-and-Food-Consumption_agr_outlook-2016-Table166-En. <https://doi.org/10.1787/19991142>
- Olagunju FI, Fakayode SB, Babatunde RO, Ogunwole-Olapade F (2013). Gender Analysis of Sweetpotato Production in Osun State, Nigeria 2:(1) www.sciencedomain.org
- Picha DH (1987). Carbohydrate changes in sweetpotatoes during curing and storage. *Journal of American Society of Horticultural Science* 112:89-92.
- Rukundo P, Hussein S, Mark L (2015). Farmers' perception and productivity constraints, preferences, and breeding priorities of sweetpotato in Rwanda. *Horticulture Science* 5(1):36-43.
- Stathers T, David S, Low JW, Mulongo G, Mbabu A (2013). Everything you ever wanted to know about sweetpotato. Reaching agents of change ToT manual, vol. 2: Orange fleshed sweetpotato and nutrition. International Potato Centre.
- Sugri I, Nutsugah SK, Wiredu AN, Johnson PNT, Aduguba D (2012). Kendall's Concordance analysis sensory in Ghana_Sugri et al 2012. *Journal of Food Technology* 7(3):142-150.
- Trancoso-Reyes N, Ochoa-Martínez LA, Bello-Pérez LA, Morales-Castro J, Estévez-Santiago R, Olmedilla-Alonso B (2016). Effect of pre-treatment on physicochemical and structural properties, and the bio accessibility of β -carotene in sweetpotato flour. *Food Chemistry* 200:199-205.
- Tufan HA, Grando S, Meola C, Grando S, Vasquez Z, Lima RC (2018). State of the Knowledge for Gender in Breeding: Case Studies for Practitioners CGIAR Gender and Breeding Initiative Working Paper. 3. www.rtb.cgiar.org/gender-breeding-initiative.
- Uwaidem YI, Borisade OA, Essien RA, Akpan EA (2018). Insect Pest Complex and Beneficial Insects Associated with Sweetpotato (*Ipomoea batatas*) (Lam.) in Southern Nigeria and Key Pests to Consider in Control Programmes. *Journal of Agriculture and Ecology Research International* 16(2):1-9.
- Wang S, Nie S, Zhu F (2016). Chemical constituents and health effects of sweetpotato. *Food Research International* 89(1):90-116.