PARTICIPATORY RURAL APPRAISAL OF FARMERS' PREFERENCES FOR YELLOW CASSAVA CULTIVARS AND INTERVENTION THROUGH BREEDING

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ABSTRACT

Farmers' attitudes to new or improved cassava technologies have been rather slow in Nigeria. A participatory rural appraisal (PRA) and sensory evaluation was conducted in Abia, Imo and Ebonyi states of Nigeria to assess farmers' preferences for cassava with yellow storage root. Almost all the farmers consume cassava or its products at least, once daily. More than eighty percent of farmers have not heard or read of high-carotene enrichment present in yellow fleshed storage root cassava or health challenges caused by heavy consumption of white-fleshed cassava storage root low in vitamin A. Seventeen clones were grown in the surveyed areas, with more that seventy percent identified as bitter, indicating the relatively high prevalence of bitter cassava. Some of the farmers' preferred traits include high yield, early maturity, pests and diseases tolerance, yellow fleshed roots, sweetness, high dry matter, easy peeling, marketable roots and roots that keep long in ground without decaying. Dry matter for the most preferred cultivars above forty percent are found to be important in both sweet and bitter cultivars. These traits identified are closely connected and affect each other. In order to increase the awareness, acceptability and adoption rate of yellow-fleshed storage root cassava cultivars, participatory rural appraisal and ex-ante adoption was introduced to the study areas.

Key words: Cassava, Farmer, Nigeria, Vitamin A, breeding

INTRODUCTION

Cassava is a major source of income for most farming households in Nigeria and this has created a lot of employment opportunities for the youth and therefore contributes to poverty alleviation (FMANR, 1997). Also, the diets of over eighty percentage of Nigeria population are based mainly on cassava products (Njoku et al, 2011). Cassava is an energy-rich staple crop but has poor nutritional value in terms of essential vitamins, minerals and protein. This low nutritional composition of cassava is a major factor why it is not rated as a complete staple crop. Notably, vitamin A deficiency is a major health hazard in communities whose nutritional security heavily relies on cassava (Gichuki *et al*., 2010; Onimawo, 2012; Rice *et al*., 2004). Vitamin A is essential for vision and immune competence, as well as, cellular differentiation, growth, and reproduction. Beta-carotene is the most abundant carotenoids which can be converted to vitamin A, and together with vitamin E, ascorbic acid, enzymes and proteins, protect the body against oxidative damage to cells (Kinsky, 1992).

Many International, Regional and National Organizations and Agencies have tried to eradicate these deficiencies by the use of dietary supplementation and food fortification, but shortcomings in time, money, efficiency, logistics, duration of nutrients' efficacy, and sustainability have prevented these strategies from reaching all of those suffering from these deficiencies and they have not proven to be an effective remedies (Njoku et al.,2011). Biofortification is a new approach that relies on conventional plant breeding and modern biotechnologies to increase the micronutrient density of staple crops including cassava (Bouis, 2006). It holds promise for improving the nutritional status and health of poor populations in both rural and urban areas of developing countries like Nigeria. Nigeria government policy of cassava transformation and commercialization by adding values to cassava and diversification will yield a lot of benefits both to consumers and other end-users when yellow fleshed storage root cassava is accepted, adopted and cultivated by majority of cassava farmers.

It is not only necessary to develop cassava cultivars with high carotenoid concentration but these cultivars must be accepted and grown by farmers, their roots consumed, and the carotenoids present in them properly absorbed and efficiently turned into vitamin A. Preferences and adoption rate for new or improved technologies have been rather slow in Nigeria. This is because farmers and other end-users are not included starting from the conception or early stages of the breeding process (Nweke et al. 1994; Benesi 2005). In order to increase the acceptability and adoption rate of yellow-fleshed root cassava cultivars, farmers should be involved in formulating research objectives and in the selection of varieties in their own environments. Participatory rural appraisal (PRA) allows stakeholders to work as a team to understand the target environment, identify the constraints and together formulate the research agenda. It embraces a series of techniques using local peoples' knowledge and skills to understand local conditions, identify local problems, and plan together. More importantly, it allows greater participation of farmers in the research process, leading to more effective and efficient information gathering and quick adoption of new research technologies. Therefore, the aims of these studies were to identify farmers's adoption challenges and preferences for yellow cassava cultivars for future breeding program.

METHODOLOGY

The main study areas were National Root Crops Research Institute, Umudike (Abia state), Owerri (Imo state) and Abakiliki (Ebonyi state), all in South-East geopolitical zone of Nigeria. Umudike (longitude 07^{o} 33'E and latitude 05^{o} 29'N, 122 m above sea level and ultisol) is in the rainforest belt with total annual rainfall of between 2000 to 2571mm. Annual average air temperature varies from a minimum of 22^{o}C to maximum of 42^{0}C with an average of 32^{o}C, Relative humidity varies from 51 to 87% and sunshine hours from 2.69 to 7.86 h per day. There are two distinct seasons experienced; rainfalls which start from March/April to November and the dry season which runs from December to February. This weather conditions may vary in duration from year to year. Cassava is planted all the year round but, for good establishment and abundant pollen for pollination, it is more appropriate to establish crossing blocks between March and April. Flowering of cassava usually starts six months after planting, and occurs from September through February at Umudike, hence crosses were performed during this period.

Different PRA techniques were used to obtain information about the farming problems, preferences, varietal selection criteria, research priorities and opportunities. A combination of three data collection techniques were employed simultaneously. These include (1) survey questionnaires for end-users (market sellers and buyers), (2) focus group discussion (FGD) and (3) sensory evaluation were carried out at NRCRI Umudike with farmers as panelists. Abia, Imo and Ebonyi states of Nigeria are known for cassava production in Nigeria. These states accounted for over 75% of cassava production in the southeastern Nigeria. Interestingly, each state is divided into 3 agro-ecological zones by Nigeria agricultural policy makers for ease of management and participation. One community from each agro-ecology was selected based on historical background as a cassava producing community/village to serve as a venue for that zone in the group discussion and questionnaire answer session.

This study utilized primary data. A structured questionnaire containing both closed and open-ended questions was designed to elicit information relevant to the issue under investigation. The Sampling Frame (SF), from where the sample was drawn, was obtained from the Community list of farmers across the Zones in each of the States. Multistage, random sampling procedures were employed in selecting the sample from where the data was collected. This method ensures a high degree of representativeness by providing the elements with equal chances of being selected as part of the sample. This was used in selecting cassava farmers from the 3 Agricultural Zones of each State (Maximum of 100 farmers/respondents in each state).

Focus group discussions (FGD) were also conducted to determine farmers' perceptions in selecting varieties. Other methods, including pair-wise ranking, matrix ranking, and key informants were also used. Tools such as checklists, semi structured questionnaires, Venn diagrams and seasonal calendars were used to facilitate gathering of information. Yellow cassava landraces were collected and analyzed for beta-carotene content. Village markets were visited to collect information related to market factors on yellow cassava consumption among others. Sensory evaluation was performed at NRCRI with 30 selected farmers/panelists who have grown yellow cassava in their farms. All farmers' and consumers' preferences will be considered in future breeding programmes to increase the adoption rate of yellow cassava in Nigeria.

Sensory evaluation using hedonic test

The sensory evaluation took place at NRCRI Umudike on the 19th of Dec., 2010. In attendance were thirty (20) panelists, some scientists and other facilitators. These panelists were drawn from farmers known to grow yellow fleshed root cassava and from the neighbouring villages. They were properly trained on how to fill in the questionnaire/form which actually contained the parameters for the sensory evaluation. The unbiased panelists were trained to evaluate gari produced from four varieties of cassava (TMS 01/1368, TMS 05/1636 and TMS 05/0473), vis-a-vis the control (NR 8082), which was a sample bought from the local market (white fleshed cassava roots processed and fried with red oil/palm oil), based on their dry colour, wet colour, fibre content, taste, texture, mealiness and general assessment. The sensory evaluation was conducted using a 4-point hedonic scale adapted from Watts et al., 1989 indicating degree of liking for colours, texture, mealiness, appearance and taste. 20 panelists were used. The test consists of a 4-point scale ranging from like extremely, through neither like nor dislike, to dislike extremely, with varying numbers of categories. The panelists were given the gari samples alongside with the hedonic test form to indicate their degree of liking for the colour, texture, mealiness and taste of each gari sample by choosing the appropriate category.

Gari production: The cassava tubers used were obtained from the parental materials used in the crossing block to generate F1 population at National Root Crops Research Institute (NRCRI), Umudike, Abia state. The other materials such as the processing machine i.e. the grinder and the presser, bags, plates, wash-hand basin, water (Hot and cold), all were also gotten from the institute. The tubers of the matured cassava were harvested and manually peeled with a knife. Thereafter, they were washed and grated with a field-marshed (7.5hp) diesel engine. This grating was done variety by variety. The grated cassava was packed in bags and de-watered with a hydraulic presser. After this, each sample (variety) was sieved and fried manually using the local method.

The flow chart for the gari processing

Cassava tuber
↓
Peeling
↓
Washing
↓
Grating
↓
De-watering
↓
Sieving
↓
Frying

The fried gari from various samples were all prepared into “ eba” as it is popularly called. The panelists evaluated the gari in dry samples vis-a-vis the wet samples into two sample specimens i.e, wet samples (A, B, C and D) and dry samples (A, B, C and D). The judgment was based on how the various characteristics for each variety appealed to them individually (Fig. 1).
Data from questionnaires for individual and group interview were coded and analyzed using SAS computer software package (Version 12.0). Average scores and ranks were calculated from data obtained from both the discussions.

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RESULTS AND DISCUSSION

The results in Table 1 showed that, in Ebonyi state, 78% of the farmers were females while 22% were males. In Imo state, 64% of the farmers were females while 36% were males and for Abia state, 71% of the farmers were females while 29% were males. Women constitute a greater percentage of those who plant cassava. Gender issues in agricultural production and technology adoption have been investigated for a long time. Most show mixed evidence regarding the different roles men and women play in technology adoption. Doss and Morris (2001) in their study on factors influencing improved maize technology adoption in Ghana, and Overfield and Fleming (2001) studying coffee production in Papua New Guinea show insignificant effects of gender on adoption. The latter study notes “effort in improving women’s working skills does not appear warranted as their technical efficiency is estimated to be equivalent to that of males”. Since adoption of a practice is guided by the utility expected from it, the effort put into adopting it is reflective of this anticipated utility. It might then be expected that the relative roles women and men play in both ‘effort’ and ‘adoption’ are similar, hence suggesting that males and females adopt practices equally. Almost all the respondents in study area were married as shown in Table 1 with Ebonyi having 96%, Imo 100% and Abia 91% married. The analysis also revealed that 84.45%, 60% and 50% of the farmers were full-time farmers in Ebonyi, Imo and Abia, respectively.

The analysis further revealed that 77.77% of the farmers in Ebonyi had no formal training while 20% and 2.23% attained primary and secondary school, respectively. This implies that the study area is largely dominated by illiterate farmers. Farmers with low level of education or without education would be less receptive to improved farming techniques (Okoye, *et al*. 2004; Ajibefun and Aderinola, 2004). However, in Imo and Abia states, all the respondents interviewed were literate, having some level of formal education. This implies that they were better positioned to understand and adopt new technologies. This agrees with Waller *et al*., (1998); Caswell *et al*., (2001) who posited that education creates a favorable mental attitude for the acceptance of new practices. Rogers, (1983) in his adoption literature, however says technology complexity has a negative effect on adoption. Education also is thought to reduce the amount of complexity perceived in a technology thereby increasing a technology's adoption.

Furthermore, the analysis showed that over 90% of the farmers were less than 56 years of age in both Abia and Ebonyi State respectively. The trend changed slightly in Imo where about 75% of the farmers were less than 56years. This agrees with Iwueke (1988) who reported that young people adopt innovations more than the old people. Age is said to be a primary latent characteristic in adoption decisions. However, there is contention on the direction of the effect of age on adoption (Bonabana-Wabbi, 2002). Nwaru (2004) found that the ability of a farmer to break risk is innovative but decreases with age.

About 95.56% of the respondents in Abia, Imo and Ebonyi state, respectively, cultivated less than 5ha of land indicating that they are small-holder farmers. Farm size affects adoption costs, risk perceptions, human capital, credit constraints, labor requirements, tenure arrangements and more. With small farms, it has been argued that large fixed costs become a constraint to technology adoption (Abara and Singh, 1993) especially if the technology is costly. The analysis also showed that, cumulatively, 96% of farmers in Abia state, 100% in Imo and 97.76% in Ebonyi, had income of less than ₦400, 000. This indicates that the farmers were low income earners.

Table 1: Percentage distribution of Cassava Farmers with respect to their sex, marital status and occupation status.

Variable	Abia	Imo	Ebonyi
Sex			
Male	29	36	22
Female	71	64	78
Marital Status			
Married	96	91	100
Single	4	9	0
Occupational Status			
Full-time	50	60	84.45
Part-time	50	40	15.55
Educational Level			
No Schooling	0	0	77.77
Primary	43	20	20.00

Secondary	39	55	2.23
Tertiary	18	25	0
Age (year)			
15-25	5	10	21
26-35	12	5	35
36-45	51	30	30
46-55	30	30	11
56 and above	3	25	3

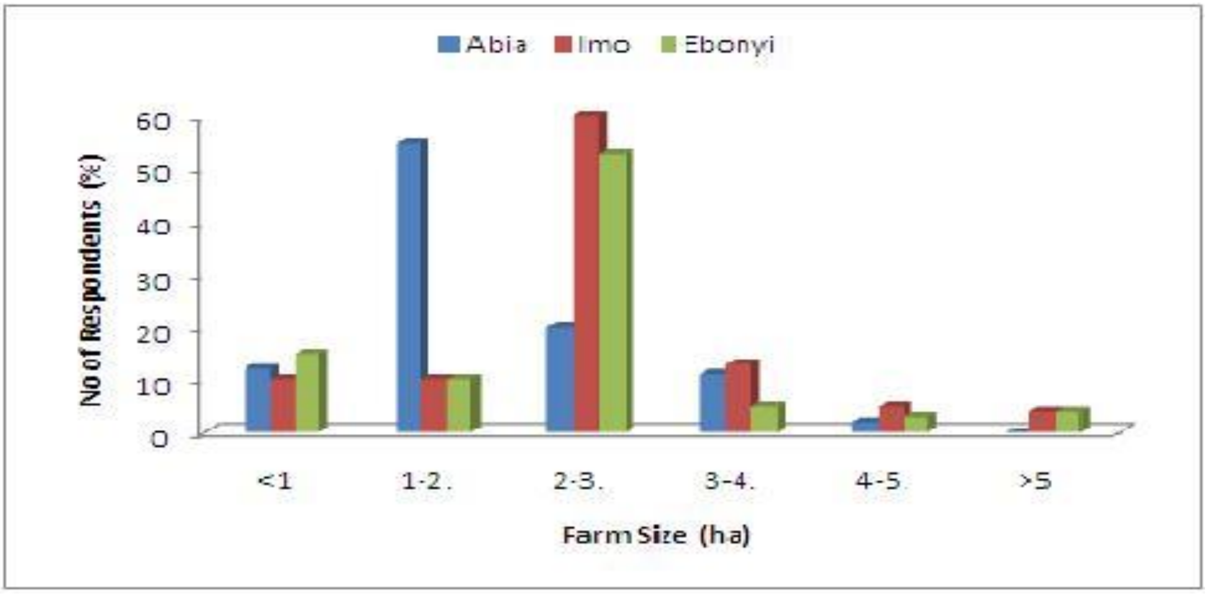

Fig 1: Percentage distribution of Cassava Farmers with respect to their farm size.

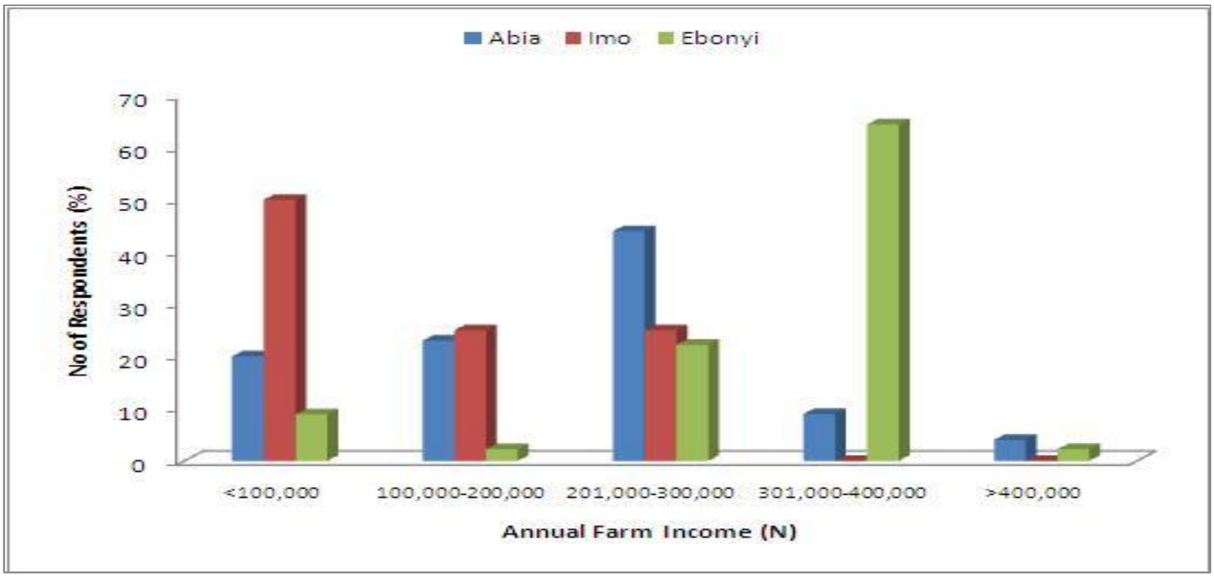

Fig 2: Percentage distribution of Cassava Farmers with respect to their Annual Farm Income.

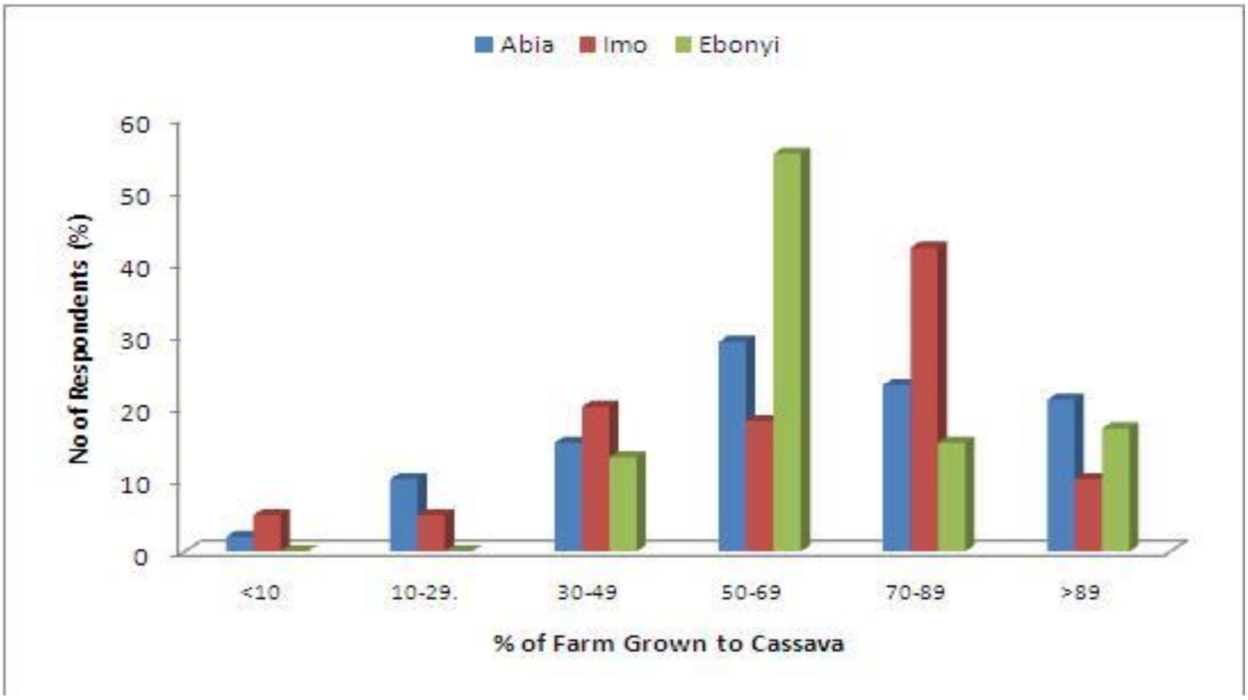

Fig 3: Percentage distribution of Cassava Farmers with respect to their Farm growth.

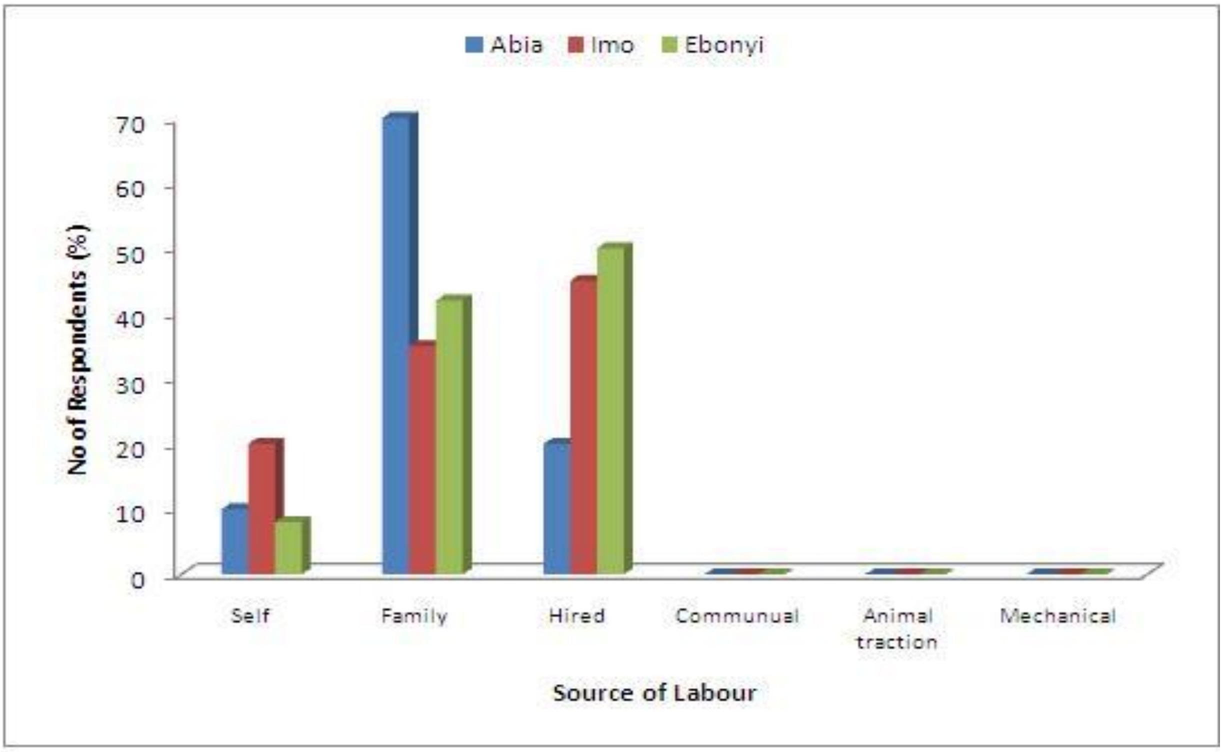

Fig 4: Percentage distribution of Cassava Farmers with respect to their Labour source

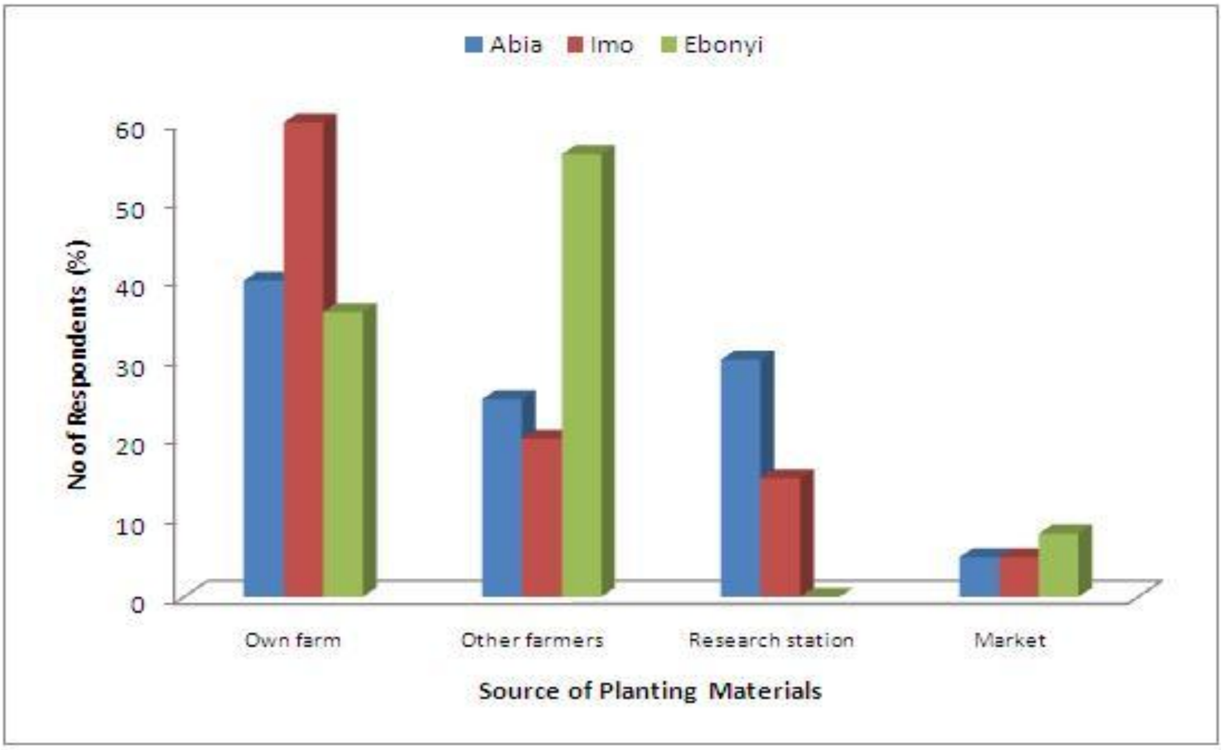

Fig 5: Percentage distribution of Cassava Farmers with respect to their Source of planting materials.

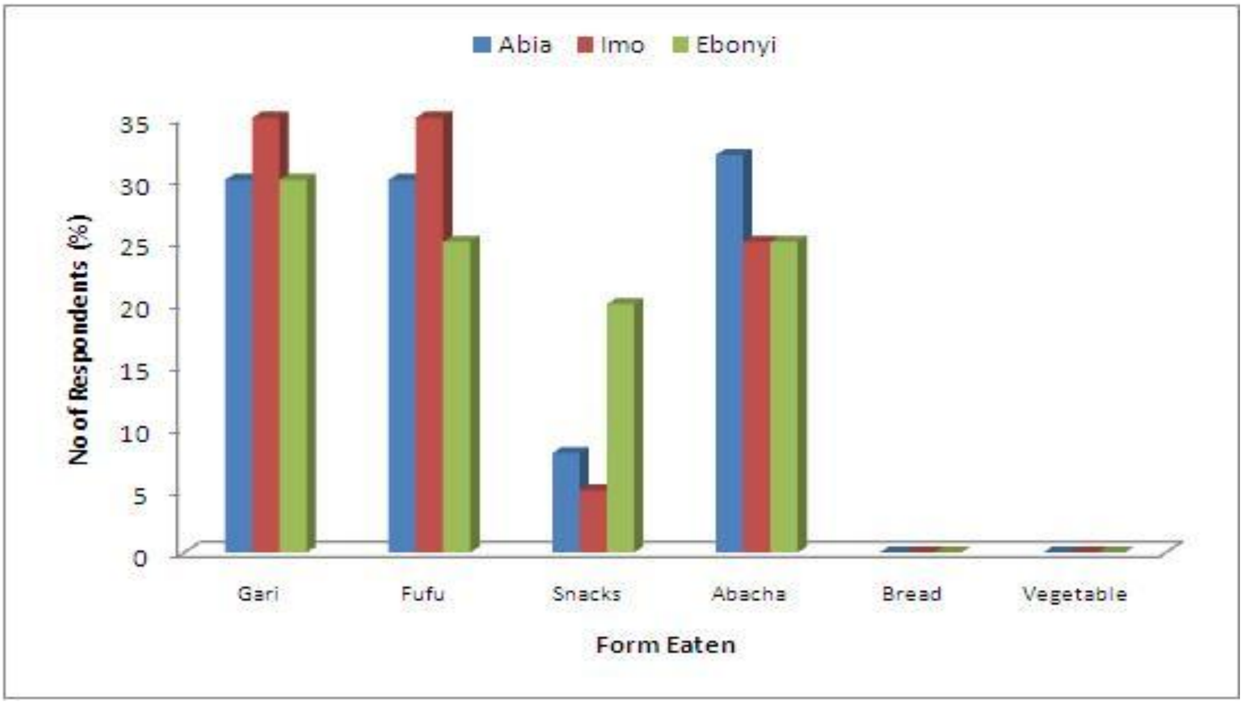

Fig 6: Percentage distribution of Cassava Farmers with respect to their form of eating.

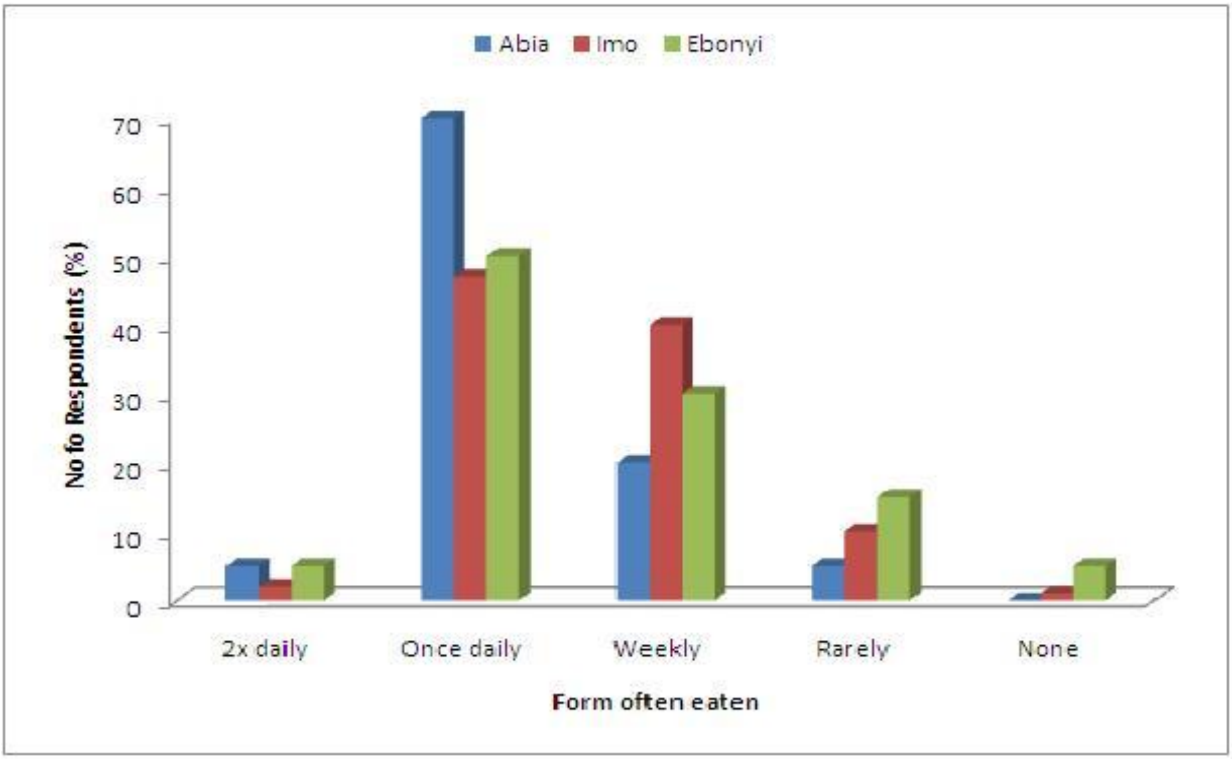

Fig 7: Percentage distribution of Cassava Farmers with respect to their eating habit.

The results in Fig 8-14 below show the distribution of farmers according to perceptions, level of awareness and consumption of Yellow Root Cassava (YRC) varieties. It was shown that the majority (91.12%, 94% and 80%) of the farmers from the three states had no knowledge of YRC varieties. This leans to the fact that this technology is new to Nigeria farmers who are used to white fleshed root cassava. Although there are few literature on the cultivation of yellow cassava in west Africa in the past (in the 1960s) (Oduro et al,1981, 1984, 1996; Safo-kantanka et al, 1984), it's popularization started recently through the efforts by Harvest-Plus, IITA and NRCRI cassava breeding programmes. And the sensitization is as a result of increase in vitamin A deficiency prevalence among heavy cassava consuming population in Sub-Saharan Africa (Esuma et al 2012). However, about 60% of the farmers indicated that they liked YRC very much and would like to grow it.

The study also shows that 61.15% of the farmers add palm oil to white fleshed root cassava during processing, and this is done to make it likeable, improve the food quality and to increase the market value. In doing that, about 18.18%, 7.27% and 27.27% of farmers interviewed add 3litres, 0.5litre and 0.25litres of palm oil to 50kg of processed gari respectively while 14.54% farmers add 2 litres and 1litre. Gari is one of the products of cassava (*Manihot esculenta*, *Crantz*) and various literatures exist on its processing steps (Ogunleye et al., 2008; FAO, 1998). Gari is a fermented and roasted or fried granular product from cassava. It is cheap and provides an instant source of vital energy. Gari production involves peeling, grating, dewatering, fermenting, sieving, frying and finally bagging. This process gives white or creamy-white gari while the addition of palm oil prior to de-watering or during roasting/frying adds a yellow colour to gari.

In comparing the cost of a unit of yellow and white gari, a kilogram of yellow gari can cost ₦150.00-N200.00 compared to ₦100.00 for the same unit of white gari. Yellow gari is preferred and can cost twice as much, making it less available to cost more to poorer households (Orewa and Egware, 2012; Njoku et al, 2011). About 55.55% of the farmers consume gari 7 times in a week, 17.77% consume gari 6 times and 4.44% consume gari once in a week. Gari is commonly consumed either as a paste soaked in cold water with sugar, coconut, roasted peanut, fish or boiled cowpea as complements (Ezedinma et al., 2007). Greater proportion (55.56%) of the farmers like yellow gari while 44.44% preferred white. Also, about 64.44% indicated that pregnant women are encouraged to eat yellow gari to help their fetus from jaundices (personal communication).

However, 100 percent of the respondents were eager to know when the yellow varieties of cassava will be introduced to them. About 80 percent of the respondents (Imo) were eager to know what will happen to the colour of yellow root cassava if process into gari; that is, whether the colour will diminish or be brighter when it undergoes frying process. 75 percent of the respondents suggested that they will prefer yellow cassava which is high yielding, pest and disease tolerant, good starch and dry matter content with low cyanide.

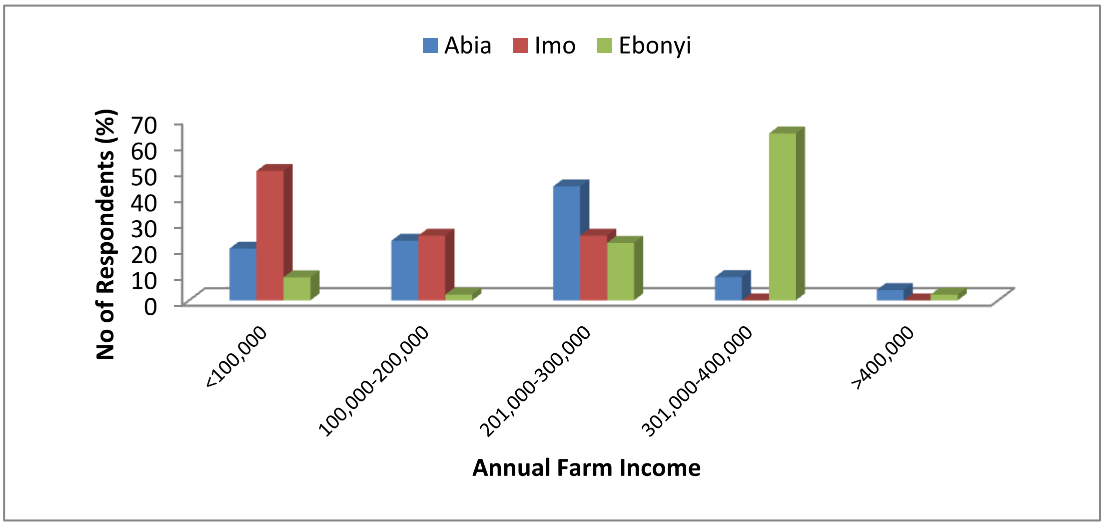

Fig 8: Percentage distribution of Cassava Farmers on annual farm income

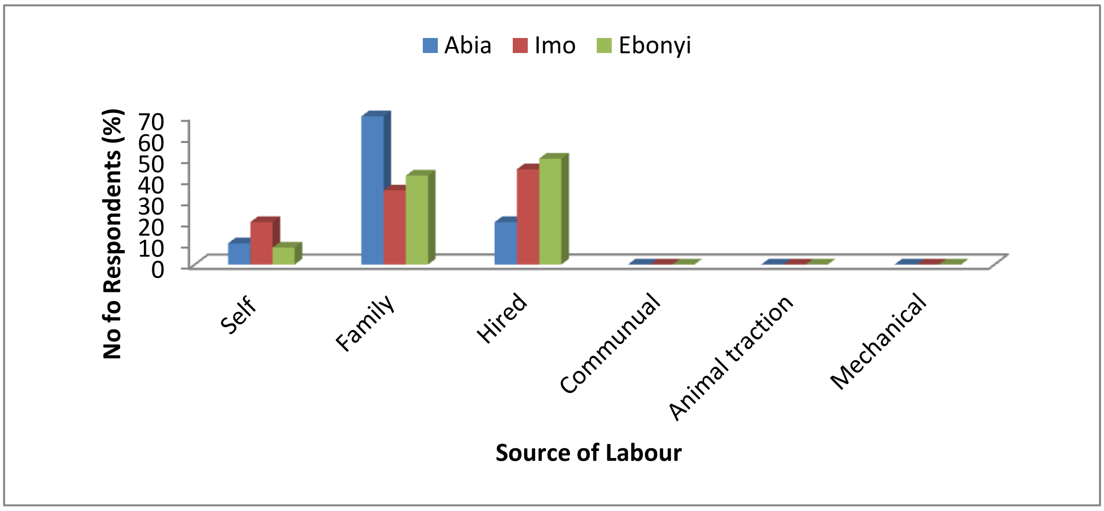

Fig 9: Percentage distribution of Cassava Farmers on sources of labour.

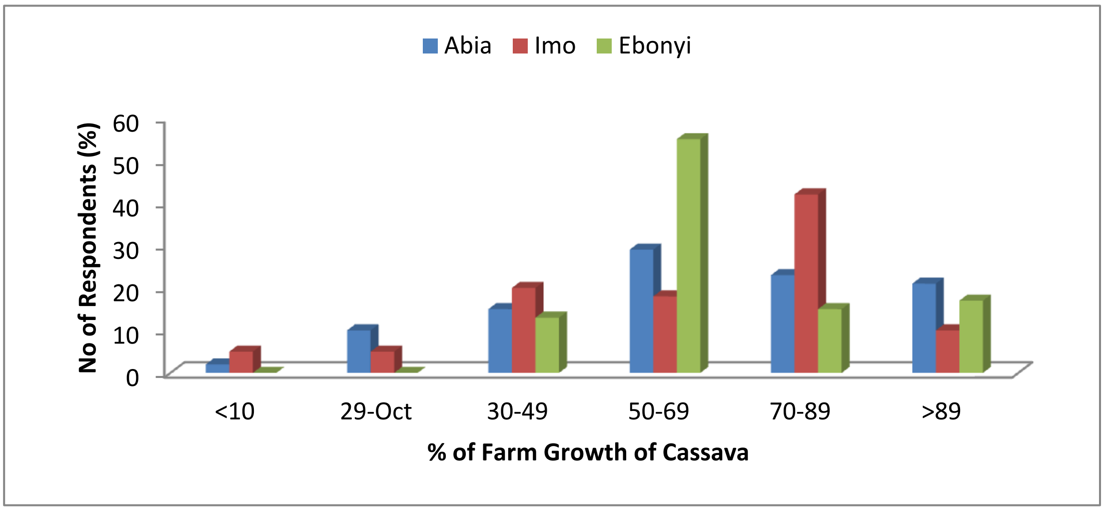

Fig 10: Percentage distribution of Cassava Farmers on farms grown with cassava.

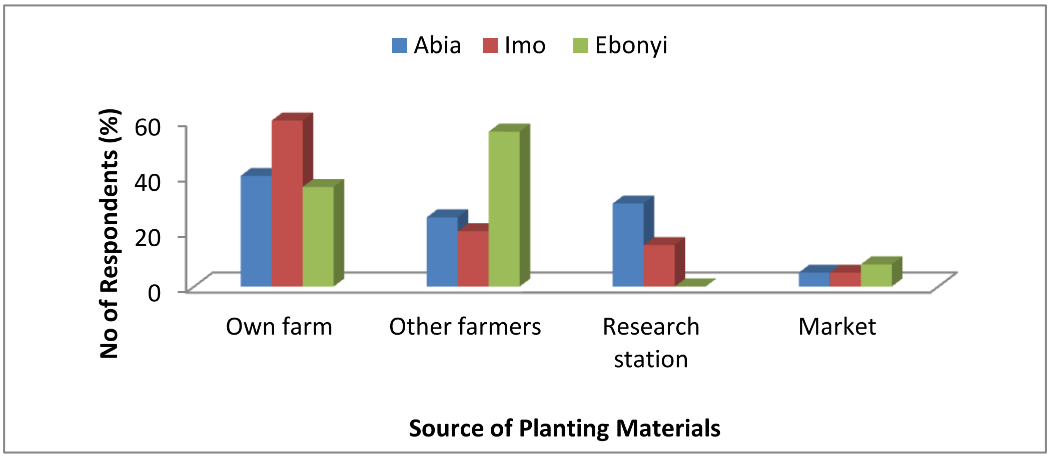

Fig 11: Percentage distribution of Cassava Farmers on sources of planting materials.

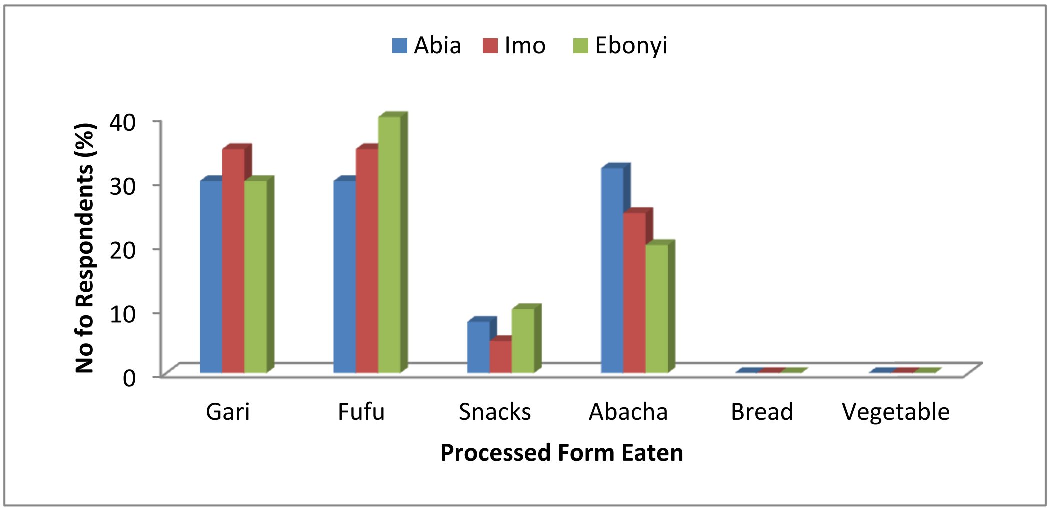

Fig 12: Percentage distribution of Cassava Farmers on processed form of cassava eaten

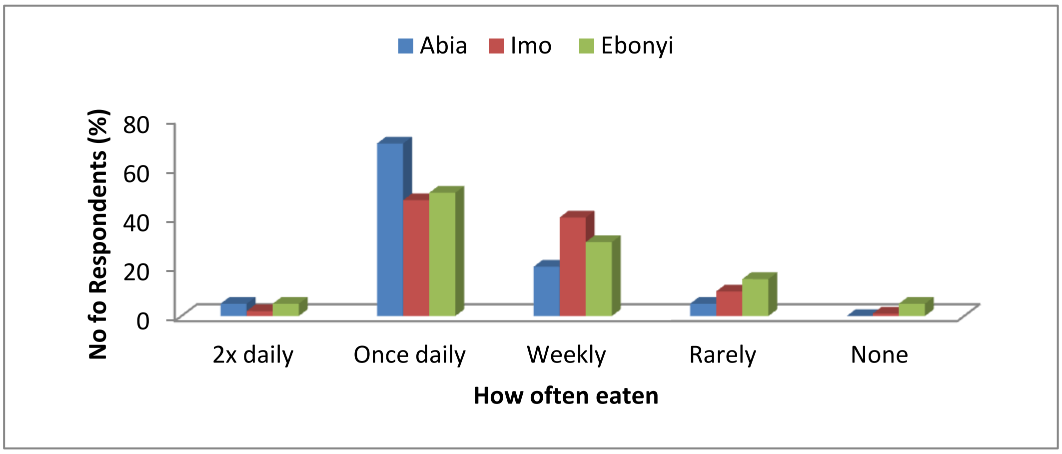

Fig 13: Percentage distribution of Cassava Farmers on how often they eat cassava.

Fig14, revealed that cassava variety TMS 05/1636 was the most preferred in dried form. This was followed by TMS 01/1368 and NR 8082, while TMS 05/0473 had the least score by the panelists. In terms of wet colour, the panelists preferred TMS 01/1368 followed by NR 8082, TMS 05/0473 and TMS 05/1636 in that order. Colour is major response variable governing food acceptance (Mega and Kim, 1989). The old adage that the eye accepts the food before the mouth is very true. Interestingly, some of the sensory panelists observed the presence of small fibrous strands in both the wet (eba) and dry gari in all the varieties but more in TMS 05/1368. Nutritionally, it had been reported that the average daily intake of dietary fibre of a person in industrialized countries is frequently inadequate (< 20 g) as compared with the 40-50 g for African and Asian communities (Burkitt, 1980). This calls for more research on the nutritional status of fibre in different cassava genotypes for human needs.

Similar preference was expressed in TMS 01/1368 and 05/1636 as both of them had equal scores in gari texture compared to the locally processed gari sample (NR 8082). Texture is an important index of quality in many food products (Wilkinson et al., 2001). It is a multidimensional attribute and a collective attribute that encompasses the structural and mechanical properties of a food and its sensory perception in the hand and in the mouth (Bourne, 2002). However, differences in texture result in different chewing time, moistening and sizes of particle after mastication (Hoebler et al., 2000). In most cases, texture is important for flavour release and perception (FAO, 2000). The result also revealed that the panelists preferred the gari mealiness of TMS 01/1368 followed by TMS 05/1636, while NR 8082 was adjudged better than TMS 05/0473. Mealiness is an important textural characteristic influencing many food forms of cassava especially in the boil-and-eat cassava (iwa-panya) food culture common in the Eastern Nigeria.

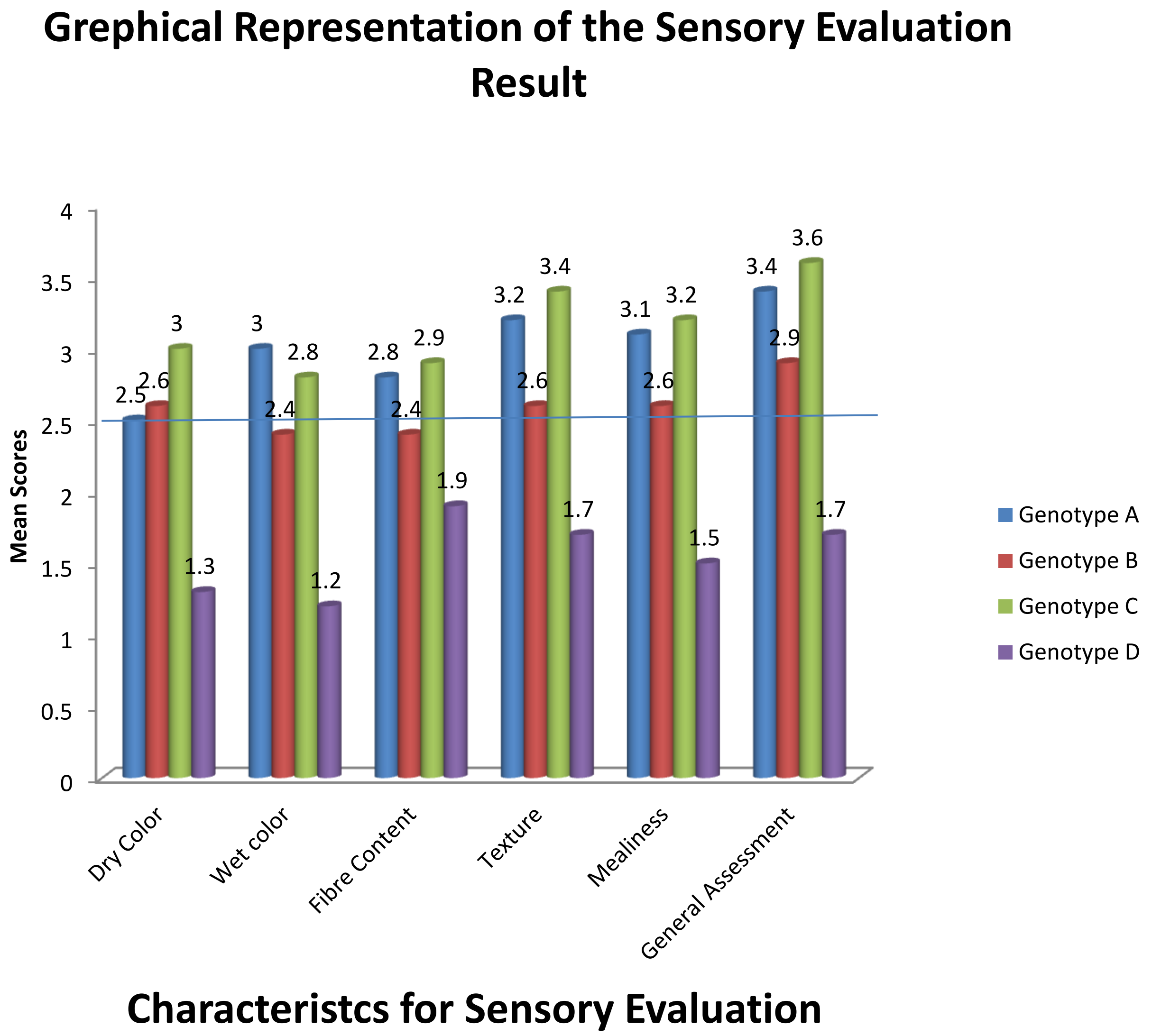

Fig. 14: Characteristics for sensory evaluation of four cassava varieties in NRCRI, Nigeria.

Key: Numbers on the Vertical column= mean score, Horizontal Variables= Sensory Characteristics, Numbers on each bar= Individual mean score, Genotype A= 05/1636; Genotype B= NR 8082; Genotype C=TMS 01/1368; Genotype D= 05/0473

Similar preference was expressed for taste of the genotypes. According to FAO (2000) report, the perception of taste is the result of many sensations including smelling, tasting, texture, sound, temperature, appearance, chemical pain; as well as cognitive factors such as knowledge and expectation. Taste is an important parameter when evaluating sensory attribute of cassava and cassava products. The product might be appealing and having high energy density but without good taste, such a product is likely to be unacceptable. TMS 01/1368 was preferred the best variety.

The essence of this sensory evaluation was to ascertain the acceptability of these selected biofortified varieties of cassava: 01/1368, 05/0473, 05/1636 and the gari made from non-biofortified cassava variety (NR 8082) as control, to the consumers and rural dwellers whose nutritional improvement is being targeted. Also, the sensory quality of cassava roots is an important factor for the acceptance of new improved cultivars by farmers (Safo-Kantaka et al., 2002). The advantage of using farmers as panelists is that they are the major end users as well as heavy cassava consumers, and they can give a real life assessment of the crop. However, the result of the evaluation revealed that the panelists on a general term preferred the gari sample of genotype TMS 01/1368 (C), followed TMS 05/1636 (A) and local market sample (NR 8082 fried with red palm oil-B) and TMS 05/0473 (D) in that order (Fig. 2).

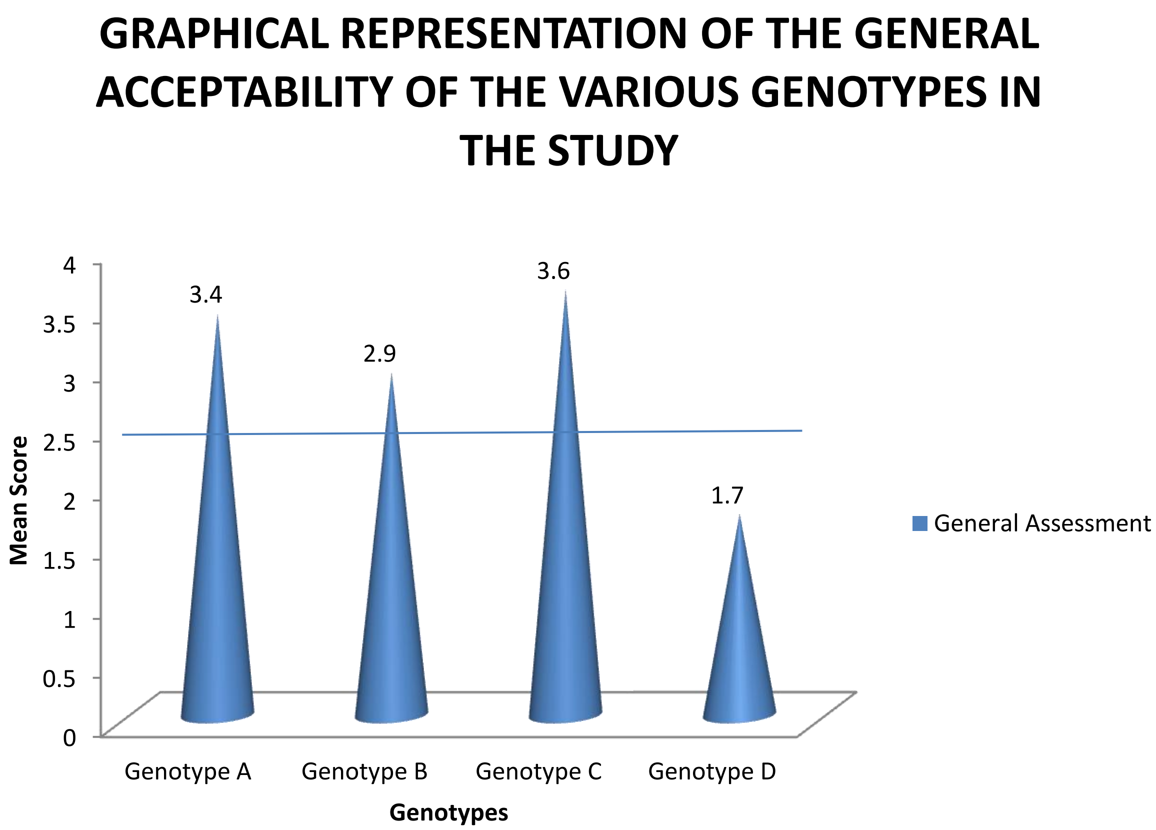

Fig.15: General acceptance and preference of cassava varieties at NRCRI, Nigeria

Key: Numbers on the Vertical column= mean score, Horizontal Variables= Genotypes, Numbers on each bar= Individual mean score, Genotype A= 05/1636; Genotype B= NR 8082; Genotype C=TMS 01/1368; Genotype D= 05/0473

Table 3 showed the correlation data between sensory characteristics (fibre content, texture and mealiness) and overall general acceptability of four genotypes (TMS 01/1368, TMS 05/1636, TMS 05/0473 and NR 8082). The results showed that there was a significant and positive correlation among the various genotypes tested. Farmers can accept any cassava genotypes that are available but will always prefer a better genotype both for cultivation and consumption.

Table 3: Correlation between sensory characteristics and overall general acceptability of various genotypes in the study.

Genotype	r (correlation coefficient)
TMS 01/1368	
Fibre content	**0.83**
Texture	**0.92**
mealiness	**0.91**
TMS 05/1636	
Fibre content	**0.85**
Texture	**0.79**
mealiness	**0.90**
TMS 05/0473	
Fibre content	**0.64**
Texture	**0.52**
mealiness	**0.59**
NR 8082	
Fibre content	**0.78**
Texture	**0.71**
mealiness	**0.80**

Excel 2007 was used to calculate r by pearson's correlation at $p < 0.5$

Table 4 shows some colour characteristics of improved cassava varieties that would be of interest to food processors, caterers and nutritionists. For instance, yellow bread is more costly than white bread since the pronouncement and enforcement of 20 percent of cassava flour in all flour made in Nigeria. The yields and carotene levels are high and the dry matter content are moderately expect for the control.

Table 4: Colour assessment of four improved cassava varieties for consumer acceptance

Variety	Root cortex	Fresh root colour	Petiole colour	Leaf colour	Nutritional value
TMS 05/1636	**Cream**	**yellow**	**Reddish-green**	**green**	**biofortified**
TMS 05/0473	**Pink**	**cream**	**Greenish-red**	**green**	**biofortified**
TMS 01/1368	**Purple**	**yellow**	**Reddish-green**	**green**	**biofortified**
NR 8082 (control)	**cream**	**white**	**green**	**green**	**Non-biofortified**

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