THE UTILISATION AND LIMITING CONSTRAINTS OF VITAMIN-A BIOFORTIFIED CASSAVA AMONG FARMERS IN SOUTH WEST NIGERIA

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DOI10.51459/jostir.2026.2.1.0119

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History
Received: 08-10-2025
Accepted: 21-03-2026
Published: April, 2026

https://www.futa.edu.ng

JOSTIR
JOURNAL OF SCIENCE, TECHNOLOGY AND INNOVATION RESEARCH
https://jostir.futa.edu.ng

ABSTRACT

Innovation merits no developing or resource commitment if it is not utilized by the target beneficiaries. The study investigates the scales, intensity and level of utilisation of vitamin A biofortified cassava and the constraints limiting its utilisation among farmers in South-west Nigeria. A multistage sampling procedure was used to select a sample size of 264 farmers. Information was elicited using structured interview schedule and analysed using frequency counts, percentages, and mean statistics. Results show a significant proportion of respondents used vitamins A biofortified cassava primarily for domestic purposes across different products with cassava roasted granules *(gari)* recording the highest intensity of usage ($\bar{x}$ = 2.62) for both domestic and commercial purposes. Inadequate technical know-how on processing ($\bar{x}$ = 1.94), inadequate finance ($\bar{x}$ = 1.85), cumbersome processing ($\bar{x}$ = 1.80) and high moisture content ($\bar{x}$ = 1.68) were the major constraints to the utilisation of biofortified cassava. Enlightenment campaigns to popularize other less-utilised products alongside continued research with stakeholders' collaborations to simplify processing while retaining the nutritional content are strongly recommended.

Key words: Utilisation, biofortified, Vitamin A cassava, Intensity and Constraints.

1. | Introduction

Cassava (*Manihot esculenta*), is a woody shrub with an edible root which originated from tropical America and was first introduced into Africa in Congo Basin around 1558 (Food and Agriculture Organization of the United Nations {FAOSTAT}, 2020). In Sub-Saharan Africa (SSA), cassava is primarily a subsistence crop grown for food by small scale farmers who sell the surplus. About 278 million metric tons of cassava were produced worldwide in 2018, of which Africa accounted for over 60%, while in the same year, Nigeria produced 59 million metric tons making it the highest producer globally (FAOSTAT, 2020). In Nigeria, particularly in rural areas where food insecurity and micronutrient deficiencies are prevalent, cassava serves as a very important staple food providing calories for over 100 million people (Akinwale *et al.,* 2020). Cassava has some peculiar characteristics that make it an endearing crop. It grows well in poor soils, resistant to drought, pests and diseases with minimal labour compared to other crops such as maize and melon, and can easily be intercro:ed while the roots can be harvested between 6 months and 3 years after planting (International Institute of Tropical Agriculture {IITA}, 2020). It is rich in carbohydrates with an estimated 37% of dietary energy coming from consumption of cassava. It is available all year round, making it preferable to other seasonal crops such as grains and peas. Despite its role in ensuring food security, conventional cassava is low in essential micronutrients, especially vitamin A, which is critical for vision, immune function, and child development. Nigeria is among the countries with high prevalence of Vitamin A deficiency (VAD), particularly among children under five and women of reproductive age (Ajala *et al.,* 2022).

Vitamin A biofortified cassava (commonly known as yellow cassava) was introduced in Nigeria by HarvestPlus and the International Institute of Tropical Agriculture (IITA) as part of efforts to reduce VAD and promote food security (Mbanasor *et al.,* 2021). Compared to white cassava, biofortified varieties contain significant amounts of provitamin A carotenoids, which can contribute substantially to daily vitamin A intake when regularly consumed. Biofortification differs from ordinary fortification in that it focuses on making plants more nutritious as they grow rather than adding nutrients during processing. Traditional selective breeding was used in the biofortified cassava programme, in which selected plants with desired characteristics are crossed and seeds grown from the hybrid. Biofortification is defined as the process of increasing the nutrient content of food crops through conventional breeding or biotechnology to address micronutrient deficiencies (Bouis and Saltzman, 2017). Unlike su:lementation and industrial fortification, biofortification offers a sustainable, cost-effective, and farmer-driven solution for vulnerable rural populations with limited access to fortified foods or su:lements (Talsma *et al.,* 2019). In Nigeria, biofortified cassava varieties have been developed and disseminated since 2011, with promising results in reducing vitamin A deficiency (Ilona *et al.,* 2017).

Vitamin A biofortified cassava is particularly relevant for South West Nigeria, where cassava is a dietary staple processed into *gari, fufu*, and other products. Studies have shown that regular consumption of these biofortified varieties significantly improves vitamin A intake among rural households (Mbanasor *et al.,* 2021)

Bio-fortification programmes have developed crops that are rich in provitamin A which include: maize, golden rice, cassava and Orange Fleshed Sweet Potato (OFSP). Both animal and human studies have shown that provitamin A from biofortified crops is highly bioavailable and has the capacity to improve vitamin A status (La Frano *et al.,* 2014).

Despite wide-scale dissemination efforts, the adoption and utilisation of these varieties among smallholder farmers in South West Nigeria remain varied and influenced by socioeconomic factors, cultural preferences, awareness, and institutional support (Otekunrin *et al.,* 2021). Challenges such as limited access to planting materials, inadequate extension services, market uncertainties, and taste preferences have been identified as potential barriers to sustained uptake (Adeyemo *et al.,* 2022).

Utilisation can be described as s a practical or effective use of something and in this context, it refers to the extent to which farmers incorporate vitamin A cassava into their diets and value additions involved with. Across the country, the utilisation of cassava as a food security crop should be ste:ed up considering the comparative advantage the country has in its cultivation. The utilisation of vitamin A biofortified cassava also largely depends on the awareness of its potential benefits and knowledge of its special characteristics (Ayodele, 2023). Several studies have reported that farmers process biofortified cassava into common products such as *gari*, *eba*, and *lafun* with little difference in preparation methods compared to white cassava (Akinwale *et al.,* 2020). However, preferences for color, texture, and taste sometimes affect household acceptance, especially in urban markets where white cassava dominates (Mbanasor *et al.,* 2021). Understanding the utilisation patterns, and the constraints faced by farmers is crucial for scaling biofortification programme and achieving nutrition security. It is against this backdrop that the following research questions were raised; what are the types of utilisation of the cassava variety, what is the intensity of utilisation for each of the products and what are the constraints limiting the utilisation of the vitamin A cassava variety. The main objective of the study was to evaluate the utilisation of vitamin A cassava variety and its constraints among famers in South West, Nigeria.

2. | Methodology

The study was carried out in South West Nigeria, comprising Ekiti, Lagos, Ogun, Ondo, Osun and Oyo States. The region lies between longitudes 2°31' and 6°00'E and latitudes 6°21' and 8°37'N, with a landmass of approximately 78,505 km² and a population of about 50 million people (NBS, 2012). The region experiences two distinct weather seasons; the rainy (March-November) and the dry seasons (November – February), the latter accompanied by harmattan dust. Annual rainfall ranges from 1500mm to 3000mm while the temperature varies between 21^0C and 34^0C. The study population comprised all cassava farmers in the region. A survey research design was employed, with respondents selected through a multi-stage sampling procedure. First, three states—Oyo, Ogun, and Lagos—were purposively selected as they were among the first to receive biofortified cassava dissemination in Nigeria. Second, stratified sampling was used to include only registered farmers with the Agricultural Development Programme (ADP), the primary dissemination channel. Third, proportional purposive sampling selected 11 ADP zones (4 in Oyo, 4 in Ogun, and 3 in Lagos). Fourth, half of the blocks within each zone were selected, yielding 18 blocks in total. Fifth, stratified sampling selected 30% of cells within each block, resulting in 32 cells. Finally, 8 biofortified cassava farmers were randomly selected from each cell, yielding a total sample of 264 respondents. Primary data were collected using a structured interview schedule while Focus Group Discussions (FGD) was used to elicit more information. Utilisation types were categorised as: domestic only, commercial only, both domestic and commercial use or never utilized by the farmer either purpose. The Intensity of utilisation was measured on a four point Likert type scale of Always–3, Sometimes –2, Rarely –1 and Never –0. Identified constraints were assessed on a four-point Likert type scale and labeled as Very Severe – 3, Severe – 2, Rarely severe – 1, and Not a constraint – 0. Using mean statistic, intensity and constraints were classified into high and low. Those above the mean score (1.5) were regarded as high while those below were regarded as low. Data were analysed using mean, percentages and frequency.

3. | Results and Discussion

3.1 | Scales of Utilisation of Vitamin A Biofortified Cassava

Table 1 reveals that boiled tubers (43.6%), stem cuttings (40.5%), leaves (37.9%), *lafun* (35.6%), and *fufu* (30.3%) were the most common forms utilized exclusively for domestic purposes. This pattern indicates that household consumption remains the dominant mode of utilisation, particularly for traditional food forms and planting materials. The relatively high domestic use of stem cuttings suggests a strong interest in maintaining the crop for subsistence production and replanting. Few forms of vitamin A biofortified cassava are used solely for commercial purposes: Only starch (10.2%), livestock feed (17.5%), chips (6.4%), and ethanol (3.4%) a:ear notably in this category. This suggests minimal industrial uptake, with only a small percentage of farmers processing or selling these products commercially. This implies a low commercialization of the biofortified cassava despite its potential for income generation. Furthermore, Table 1 shows that several cassava products are used both domestically and commercially, indicating their potential economic importance. Cassava roasted granules (*gari*) recorded the highest dual-use rate

(83.0%). *Fufu* (45.5%), stem cutting (31.1%), *lafun* (23.5%), and livestock feed (18.6%) also fall within this dual-use category. This study shows that *Gari* remains the leading form of utilisation across both scales, reflecting its cultural and economic relevance in Southwestern Nigeria. A large proportion of respondents indicated no utilisation for several products of biofortified cassava. Ethanol (96.6%), *abacha* (94.7%), *pupuru* (91.7%), chips (90.5%), and pounded cassava (86.4%) recorded extremely low usage. This suggests unta:ed utilisation o:ortunities particularly in industrial processing (ethanol, starch) and non-traditional food items (chips, abacha) which could become new market avenues with proper training and market development. The findings of this study are consistent with other empirical evidence that households that adopts biofortified cassava mainly consume the product rather than using it for large scale commercial purposes (HarvestPlus, 2023). From a nutrition standpoint, this preference for domestic consumption is well justified: rigorous intervention trials in Nigeria have shown that regular consumption of vitamin A biofortified cassava improves serum retinol and hemoglobin concentrations in children (Afolami *et al.,* 2015). That shows consumption of Vitamin A cassava can serve as a means of addressing some health-related problems and also serve as a food security crop.

Table 1 | Scales of Utilisation of Biofortified Cassava

	Scales of Utilisation							
Cassava Products	Domestic only		Commercial only		Both		None	
	F	%	F	%	F	%	F	%
Cassava roasted granules (*Gari*)	45	17.0	0	0.0	219	83.0	0	0.0
Fufu	80	30.3	1	0.4	120	45.5	63	23.9
Lafun	94	35.6	2	0.8	62	23.5	106	40.2
Stem cutting	107	40.5	0	0.0	82	31.1	75	28.4
Livestock feeds	62	23.5	46	17.5	49	18.6	107	40.5
Starch	52	19.7	27	10.2	28	10.6	157	59.5
Tapioca	74	28.0	0	0.0	47	17.8	147	54.2
Boiled tubers	115	43.6	0	0.0	0	0.0	149	56.4
Leaves	100	37.9	0	0.0	0	0.0	164	62.1
Chinchin	36	13.6	0	0.0	25	9.5	203	76.9
Combo strips	59	22.3	0	0.0	25	9.5	180	68.2
High Quality flour	5	1.9	29	11.0	11	4.2	219	83.0
Manure	39	14.8	0	0.0	0	0.0	225	85.2
Bread	53	20.1	0	0.0	8	3.1	203	76.9
Pounded cassava	36	13.6	0	0.0	0	0.0	228	86.4
Chips	0	0.0	17	6.4	8	3.0	239	90.5
Pupuru	8	3.0	2	0.8	12	4.5	242	91.7
Abachai	9	3.4	0	0.0	5	1.9	250	94.7
Ethanol	0	0.0	9	3.4	0	0.0	255	96.6

Source | Field Survey, 2024. Mean = 1.5

3.2 | Intensity of Utilisation of Vitamin A Biofortified Cassava

Table 2 presents the intensity of utilisation of biofortified cassava from the most utilised to the least utilised using the mean. The Table shows that cassava roasted granules (*gari*) ($\bar{x}$ = 2.62) was the most utilised and the only cassava product having a mean score above the mean of 1.5 of all the identified products from biofortified cassava. *Gari* is a partly roasted, free flowing granular flour with a slightly fermented flavour. According to Sanni *et al.,* (2009), *gari* is popular because it is a convenience food with very good storability and better market demand than other products from cassava roots. It enjoys some advantages over cereals such as maize, sorghum and rice that may require cooking for a relatively long time before consumption. The cultural acceptability of *gari* also explains why the intensity of utilisation is very high. *Fufu* ranked second ($\bar{x}$ = 1.35) in the intensity of utilisation of cassava products. *Lafun* ranked third ($\bar{x}$ = 1.29), stem cutting ($\bar{x}$ = 1.29) ranked 4th, while the use for livestock feed ranked 5th. It was shown from the study that starch ($\bar{x}$ = 0.95) was not among the first five in the intensity of utilisation. It was discovered from a key informant in the course of the study that the yellow colouration does not make it readily acceptable to industries for the purpose of starch production. *Tapioca,* a granular product made from partly gelatinised cassava starch with a mean of ($\bar{x}$ = 0.78) did not also have a high intensity of utilisation due to the cumbersome nature of processing. Sanni *et al.,* (2009) affirms that *tapioca* processing steps are very labour demanding and this makes the product very expensive. Biofortified cassava roots were also boiled and eaten directly like yam ($\bar{x}$ = 0.71). The cassava roots were also processed into flour for use as pastries such as *chinchin* ($\bar{x}$ = 0.50), *combo* strips ($\bar{x}$ = 0.43) and bread ($\bar{x}$ = 0.31). Its use as pounded cassava ($\bar{x}$ = 0.31) was not high. This could be as a

Table 1 | Scales of Utilisation of Biofortified Cassava

Forms of Utilisation	Intensity of Utilisation/Consumption n = 264 Never F	%	Rarely F	%	Sometimes F	%	Always F	%	Mean
Cassava roasted granules	0	0.0	26	9.8	48	18.2	190	72.0	2.62
Fufu	63	23.9	79	29.9	89	33.7	33	12.5	1.35
Lafun	106	40.2	32	12.1	70	26.5	56	21.2	1.29
Stem cutting	75	28.4	64	24.2	101	38.3	24	9.1	1.28
Livestock feeds	107	40.5	56	21.2	56	21.2	45	17.0	1.15
Starch	157	59.5	17	6.4	35	13.3	55	20.8	0.95
Tapioca	143	54.2	58	22.0	51	19.3	12	4.5	0.74
Boiled tubers	149	56.4	59	22.3	41	15.5	15	5.7	0.71
Leaves	164	62.1	38	14.4	43	16.3	19	7.2	0.69
Chinchin	203	76.9	1	0.4	44	16.7	16	6.1	0.52
Combo strips	180	68.2	64	24.2	11	4.2	9	3.4	0.43
High Quality flour	219	83.0	10	3.8	22	8.3	13	4.9	0.35
Manure	225	85.2	9	3.4	18	6.8	12	4.5	0.31
Bread	203	76.9	43	16.3	14	5.3	4	1.5	0.31
Pounded cassava	228	86.4	5	1.9	14	5.3	17	6.4	0.31
Chips	239	90.5	5	1.9	10	3.8	10	3.8	0.21
Pupuru	242	91.7	7	2.7	10	3.8	5	1.9	0.16
Abachai	250	94.7	3	1.1	7	2.7	2	0.8	0.09
Ethanol	255	96.6	7	2.7	2	0.8	0	0.0	0.04

Source | Field Survey, 2024. Mean = 1.5

result of the low starch content as it does not stick together as explained by a key informant in the study area. while ethanol ($\bar{x}$ = 0.04) ranked the least on the Table. This study affirms that biofortified cassava is primarily used for food products. Cassava utilisation patterns vary globally. For instance, in West African region, approximately 90% is consumed directly by humans, less than 10% semi-processed for on-farm animal feed (Sanni *et al.,* 2009). In Nigeria, only about 3% meets industrial demand for high-quality cassava flour (HQCF) used in biscuits, confectioneries, adhesives, starch, hydrolysates for pharmaceuticals, and seasonings, while 70% is processed for human consumption (Ojide *et al.,* 2022).

3.3 | Level of Intensity of Utilisation of Biofortified Cassava

Table 3 reveals that 62.1% of respondents exhibited low utilisation while only 37.9 % demonstrated high utilisation of biofortified cassava products. The implication is that biofortified cassava products were grossly underutilised in the study area. The findings suggest a significant shortfall in the utilisation of the various products. The FGD confirmed that most of the respondents were not familiar with some of the products and they equally possessed limited knowledge on value addition to the products.

Table 3 | Level of Intensity of Utilisation of Biofortified Cassava

Utilisation Level	Score range	F	%	Pooled Mean ±SD
Low	1 – 14	164	62.1	13.47 ± 8.35
High	15 – 44	100	37.9	
Total		264	100	

Source | Field survey, 2024. Minimum – 1, Maximum – 44.

3.4 | Constraints Limiting the Utilisation of Biofortified Cassava

Constraints limiting the utilisation of biofortified cassava are presented on Table 4 in descending order based on the mean score. The results show that inadequate technical knowledge ($\bar{x}$ = 1.94) on processing ranked the most severe constraint. This implies that the respondents did not have adequate knowledge on the technicalities of the processing of the biofortified cassava as the processing is quite different from the processing of the conventional varieties. Mbanasor *et al.* (2021) similarly identified inadequate farmers' training as a major barrier in the adoption and utilisation of vitamin A cassava. Inadequate finance ranked second ($\bar{x}$ = 1.85), while cumbersome processing and value addition ($\bar{x}$ = 1.80) ranked third. This further underscores that processing biofortified cassava is more difficult and labour intensive than processing other cassava varieties. Other constraints with mean score above 1.5 included; high moisture content ($\bar{x}$ = 1.63), yellow colouration ($\bar{x}$ = 1.59), high perishability of tubers ($\bar{x}$ = 1.59), low patronage by starch industries and cassava roasted granules processors ($\bar{x}$ = 1.52). These findings suggest that the yellow colouration and other characteristics of the biofortified cassava such as the non-sticky texture when prepared for eba and fufu posed a great constraint on utilisation. This is in line with Ajala *et al.* (2022) that some consumers perceive the yellowish color of biofortified cassava as inferior. Also, the high moisture content discourages *gari* processors from patronising farmers because the yield after processing is usually lower than that obtained from other varieties. These attributes contribute substantially to low marketability and profitability of biofortified cassava products. Furthermore, processing of biofortified cassava is more difficult and cumbersome than for other conventional varieties. In Nigeria, poor storage facilities are widely known to contribute a great threat to agriculture. Sanni *et al.,* (2009) corroborates these findings that specifically, the cassava industry is faced with the threat of low-level use of a:ropriate or modern technology for operations such as drying, pressing and peeling; poor storage facilities; unfavourable market climate for sustainable market growth, high cost of labour especially harvesting and financial involvement. Ohimain (2014), identified policy inconsistencies between different governments, manual processing which affects the production of High Quality Cassava Flour (HQCF), the high volume of wastes resulting in low conversion ratio and high environmental pollution as the major challenges confronting the utilisation of cassava in Nigeria. The least two constraints on the Table are non-acceptance of cassava as important food crop in Nigeria ($\bar{x}$ = 0.70) and perception of biofortified cassava as genetically modified crop (GMC). The mean values indicate that these are not really great constraints to the utilisation of biofortified cassava. As shown in the following FGD report conducted with farmers in Egbeda Zone in Oyo State.

We mostly produce to take care of our immediate families. Even if we want to expand our production, we are confronted with poor infrastructures especially, storage facilities. Cassava is highly perishable and so it must be processed almost immediately. We use generator or diesel engine for some of our processing activities because of poor power supply and it is very expensive to buy diesel or petrol thereby reducing our profit. Also, we are confronted with inadequate and good water supply. The bill that water corporation brings monthly is expensive at this processing center. The cost of sinking borehole is equally high. Again, the technical-know-how is equally inadequate for the processing. Biofortified cassava requires special skill for its processing that is different from the convectional variety. Take for instance, it must be processed within maximum of two days of harvesting to get high quality products and too much of heat and exposure to sunlight reduces the Vitamin A content. There is need for capacity building and training for us to be engaged in value addition. Unfavourable

Table 4 | Constraints Limiting Utilisation of Biofortified Cassava

Constraints	Mean	±SD
Inadequate technical know-how on processing	1.94	0.99
Inadequate finance	1.85	0.98
Cumbersome processing/ Value addition	1.80	0.97
High Moisture content	1.63	1.66
Yellow colouration and general quality of product	1.59	0.97
High perishability of tubers /inadequate storage facilities	1.59	0.97
Low patronage by starch industries and cassava roasted granules processors	1.52	1.07
Low yield after processing	1.21	0.96
Harvesting of cassava tubers difficult during dry season	1.21	0.80
Low profitability and marketability	1.20	0.96
Scarcity of cassava tubers	1.20	0.81
Scarcity and high cost of operating modern equipment	1.19	1.02
Low products diversification /Low value addition	0.97	0.93
High cyanogenic glycosides content	0.88	0.84
Non acceptance of cassava as an importance food crop	0.71	0.59
Perception as a GMO crop	0.70	1.60

Source | Field Survey, 2024 (F- Frequency, SD – Standard deviation), Mean = 1.5.

market and relative poor prices among others are the problem confronting us in the utilisation of the product. The non-sticky texture is another major challenge, to use it for fufu at times, we have to mix with the convectional varieties.

4. | Conclusion and Recommendation

Biofortified Vitamin A cassava is still largely utilised as a household food and seed crop, rather than as a commercial commodity. *Gari, fufu and lafun* were the most utilised products from Vitamin A biofortified cassava and they are the leading forms through which it enters informal markets for both domestic and commercial purposes. Inadequate technical knowledge and limited access to finance were the major constraints to product utilisation. The study therefore recommends that to achieve broader utilisation and value chain impact, interventions should focus on awareness creation, farmers training and innovation in product diversification, as well as strengthening linkages with agro-industries to support processing technologies and market development for both food and industrial applications.

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