State Of Knowledge For Gari/Eba In Nigeria

Food Science, Gender & Market

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ABSTRACT

Highlights

- **There is a diverse range of preferences of *gari* and *eba* related to ethnicity and socio-economic status.**
- **In general, processing is largely conducted by women. Processing and preparation steps differs according to variation in regional and ethnic preferences.**
- **South West (SW) consumers generally like a soft, low elasticity *eba* and a sour and an off-white, ivory, butter-like color for *gari*. Greyish *gari* is least liked, but is less expensive. *Gari* and *eba* are usually "cooked" less long, prepared by ending with adding hot water to *gari*.**
- **South South (SS) and South East (SE) consumers generally prefer hard, elastic *eba* and non-sour, white or yellow *gari*, the latter achieved from the addition of palm oil, which in turn might reduce storability. "cooking is longer" This is usually prepared by adding the *gari* to boiling water.**
- **SS like *eba* and *gari* can connect to the needs of specific occupations: In SW construction workers prefer a SS like *eba*, it takes more time before they get hungry again.**
- **Some food science expert key informants state that unfermented *gari* and *eba* have a lower glycemic index than fermented *gari/eba*. This needs clarification. It seems it is mainly the difference in cooking time/rehydration that creates the difference.**
- **Varieties with low starch may affect a *gari* that is traditionally cooked for a short time (SW): after preparation there will not be enough rehydration of the starch to make the *eba* hold together well. Also, higher dry matter and starch provide more *gari* yield. *However the drawability and hardness of the eba seems majorly determined by the way eba is made: longer cooking means more rehydration and complete gelatinization and a harder more drawing eba.***
- **Sun drying to complete the drying of *gari* after roasting (SouthWest) effects the color as fermentation continues during sun drying.**
- **Swelling of *gari* is important: the higher bulk density of the gari, the higher the volume expansion from gari to *eba*, and the lower the bulk density the higher the volume of the eba per gram of *gari***
- **Swelling of gari in cold water is significantly higher for fermented gari. This is a preffered trait for people that drink *gari*.**
- **Granule size is an important quality, which is influenced by the equipment used, but mainly by the contact temperature between the mash and the roasting board/pan (controllable by the speed of stirring and amount added per batch). Granules that are fine but not too fine are most liked.**
- **Consumer preferences for granule size requires clarification. Especially the general accepted idea in the literature that fermented *gari* is smaller in granule size**
- **Attractiveness, particularly color, is highly valued by consumers. Color is affected by fermentation, variety and sanitation during processing. A key informant stated that whiteness is achieved through peeling by de-wrapping opposed to peeling with a knife**
- **A significant indicator of the quality of *gari* and *eba* lies in the expertise with which it is processed, however, low dry matter /starch content and variety specific mash color after pressing can contribute to a lower quality product.**

- **Additional information is required on how and what kind of *gari* from the rural areas is assembled in towns/suburbs before it is bulked and sold as wholesale in cities.**
- **Processing equipment in processing centres is usually owned by men which women access through small fees. The future dynamics of this with regards to equity requires investigation.**
- **Cassava and gari have been an important historically providing a way for women in the South East and South South to empower themselves given the inequalities created by male dominated colonial rule. This still explains some gendered roles today.**
- **<u>If we want to know the specific preferences of *gari* and *eba* in relation to the production and especially the processing steps and product quality, it is mostly experienced women that we have to consult</u>.**
- **There is high demand for *gari*, and the market is characterized by perfect competition: there are many buyers and sellers who are not in a position to influence marketing transactions by refusing to either sell or buy.**
- **The largest *gari* supply is in the SW. Wholesale prices for *gari* in the SW are higher than the SE, where rural markets in the SW are closer to city markets compared to the SE, and a long fermentation period in the SW could impact prices.**
- **Most of the *gari* traded is white *gari* but a substantial part is yellow *gari*, traded in SS or SE as a result of adding palm oil, and its market price is higher; not only because of the palm oil added but also because of the more limited shelf life. About 1/3th - 1/4th of the *gari* traded in Lagos is yellow *gari*.**
- **There is *gari* supply from Taraba state in the North East. Kano is also a hub for export of *gari* from the Southern belt to the North, including North Cameroon, Chad, Niger, Burkina Faso and Mali. This shows the large role of *gari* in Nigeria, as a dry (transportable) and storable food product (in that respect comparable to rice).**

1. INTRODUCTION

This report is based on a series of reviews in relation to the quality characteristics of a cassava food product named *eba*. *Eba* is made from *gari,* a fermented and roasted granular product made from cassava roots. It is most common in Nigeria and this report will cover the variations of *gari* and *eba* within Nigeria.

Gari is consumed in different ways:

- dry (in little quantities, limited to occasional snacks)
- as a dressing over food, sprinkled over cooked beans, or mixed with red palm oil just before consumption, which provides the food with an extra crunchy texture,
- added to cold water, sugar, groundnuts or other ingredients according to consumer preference, like this the *gari* is consumed as a drink and the practice is also known as 'to drink *gari*'
- cooked -as a paste called *eba,* by adding boiling water to *gari* (the major and most common practice if *gari* is to be used as the carbohydrate source of a meal). In the southwest the word *gari* is often also used to refer to this paste.
- as a crumbly paste-like crumbly substance called *feselu (uncooked gari-eba)*, by mixing cold water and *gari* (not too common but can however possibly be important as an instant food for poor people). In this case the obtained substance does not bind well because of the cold water added. It can be seen is a kind of thick form of drinking *gari*. It is not dealt with here as it is only mentioned in some informal conversations and not by key informants, neither could it be found in the literature

This report focuses mainly on *eba* and therefore on the *gari* characteristics that are relevant for making a good *eba,* and how this relates to the quality of fresh cassava roots. We realize that such preferred characteristics differ by region, socio-economic status, gender, and culture, and that more than one kind of *eba* is common in one region. Therefore, the objective of this study was to gain a better understanding about the diversity of preferences, the scale of production of the product and the market demand for these different types. This report is based on a modest literature review of food science, social science and economic literature related to *gari* and *eba,* and its practices of production, processing, preparation and consumption. A series of key informant interviews were also held with IITA and university staff, food vendors and *gari* processors. All key informants where asked questions from a problem focused rather than a disciplinary focused approach and therefore included three major perspectives: a social cultural, a food science and a marketing economics perspective. Key informants could steer the conversation into the direction they felt most comfortable with and into the issues they felt most knowledgeable about rather than formally sticking to the questions provided by the State of Knowledge (SoK) guide. This was highly effective as key informants could freely talk about the aspects that motivated them.

2. GENERAL PROCESSING STEPS BASED ON REGIONS AND ETHNIC GROUPS.

The general steps for making *gari* that we encountered in the field and are:

- Peeling freshly harvested cassava roots
- Grating the roots with a motorized grater (most common) or hand grater. (following a tradition common in the south east on can add some palm oil at this stage to color the *gari* yellow)
- Pressing the mash lightly by tightening the sack and storing for 1 up to 4 days to ferment if desired.
- Pressing the mash in a permeable sack for some time to dewater. There are variations in the time that the mash is pressed. This varies from several hours to a day or two. If pressing is longer the storage before pressing is usually somewhat shorter
- Sieving the mash to remove fibers, or re-grating the mash

- Toasting the mash to obtain *gari*
- Sieving the *gari*

Gari and *eba* are traditionally made in the southern part of Nigeria, already less common in the middle belt of the country and even less common in the north. This follows the general ecological gradient were tuber crops like cassava and yam are most common in the southern belt while grain crops are most common in the north. *Gari* can be found all over Nigeria, however it is mostly consumed by the ethnic groups that are from the southern belt of the country, the region where root and tuber crops are an important tradition (Okoroda, personal communication). Nevertheless, other socio-economic factors also determine the preferences for the kind of *eba* liked. In this respect, e.g. Prof Akoroda (personal communication) mentioned that Yoruba laborers in the South West of the country might prefer an *eba* that is originally more common in the South-South of the country, because they state that such an *eba* "stays longer in the stomach and provides more energy" which facilitates them to work for a longer time before getting hungry again. So this is an important difference between social classes. According to Sanni and Otegbayo (personal communication), Ibo *eba* (referring to the Ibo ethnic groups in the South East and South South), is only fermented very little (so not sour) and has a lower Glycemic index than gari that is not or little fermented. In *eba* made from fermented *gari* (common in the South West), they mentioned that starch is reduced to simpler carbohydrates that are transformed faster into blood sugar than more complex and longer chained starch molecules, resulting in a higher Glycemic index. So this could explains that poor workers would prefer the Ibo *eba* as it keeps them going longer before getting hungry again.

There are variations in the length of the processing procedure as well as in the time involved and the exact tools used at each step.

One of the major processing variations is the level of fermentation that takes place (e.g. Irtwange and Achimba, 2009) The amount of fermentation depends on the particle size of the mash, which is determined by the equipment used (a grater or hammer mill - where hammer mills are more expensive but give a finer mash compared to a grater), along with the temperature/humidity and the duration of the fermentation. The longer the fermentation during processing, the less starchy and more sour the *gari* will be, in addition to the lowering the initial cyanide level (Asegbeloyin & Onyimonyi, 2007). Although George *et al*. (1995) showed that the starch content is not largely affected by fermentation, our key informants Prof Lateef Sanni, Prof Malachy Akoroda as well as Dr Bolanle Otegbayo stated that the enzymes not only consume sugars present in the mash but also a significant part of the starch. This therefore needs further clarification. However, it seems like *eba* made from *gari* that has been fermented for a longer time will result in an *eba* that is:

- More grainy and draws less, this means is less elastic or stretchable and therefore breaks more easily when you want to take a part, to scoop the soup that is eaten along with it.
- Generally softer
- Is sourer (fermentation produces lactic acids that make the *gari* sour).

This can however also be related to the way that *eba* is prepared in the Southwest and Southeast as we shall see later rather than to the extent of fermentation. Recent IITA experience and research (Olaosebikan, 2018) shows that new cassava varieties (containing more pro vitamin A) were rejected by farmers in the South West because they could not be made into a good *eba*: the *eba* did not hold together well as a dough. Indeed these varieties have a lower starch content (Beyene et al. 2017).

There is a general divide between the *eba* liked in the South South and South East versus the *eba* liked in the South West. In the South West people generally like a sour and therefore more fermented *eba*. This can be related to the *gari* drinking (*gari* soaked in cold water) culture by Yoruba South Westerners who demand a *gari with a* strong sour taste that is supposed to refresh.Fermentation might affect the color of the *gari*, and instead of white it becomes more ivory or butter-like in colour (which is most liked) or more greyish which is least liked, however, even such greyish *gari* also has its market however selling at a lower price.

Table 1. Division of *eba* characteristics according to South West and South South/South East (based on a key informant interview with Dr. Adegoke Rasaki Sanusi, University of Ibadan, Human nutrition)

Region	***Mouldability***	***Stretchability/*** *Drawability* ***/Elasticity***	***Taste***	***Color***
South West	Soft	Low	Sour	Off-white, ivory, butter-like, or more greyish
South South and South East	Hard	High	Non-sour	White or yellow because of adding palm oil

The general difference between *eba* in the South South/South East and the *Eba* from the Southwest was expressed by Dr Sanusi (personal communication) as follows: if you would throw a ball of *eba* molded in the hand, to the wall, an *eba* made in the South West with sour *gari* will flatten and stick to the wall, while an *eba* from the South South/ Southeast made from less sour *gari* will bounce back. According to Prof Akoroda, this difference can be explained by two basic different modes of *eba* preparation. Although both modes can be used on both types of *gari* to create all kinds of variations, generally it can be stated with certainty that:

- A South Southern or South Eastern *gari* is prepared by adding *gari* to boiling water. This results in a *gari* more intensely heated as bits of (cold) *gari* go into a large mass of hot water for longer time.
- A South Western *gari* is usually prepared by adding amounts of hot water to a large mass of cold *gari* for a shorter period of time.

In the first case *gari* can be added to hot water and stirred until a desired paste is achieved. It can even be left on the fire to create a far less grainy and strongly bound fully rehydrated homogenous dough.

In the second case, boiling water is poured with a beaker over the *gari* in dashes and through stirring the desired paste is achieved resulting in a more grainy and less bound, less rehydrated and less homogenized *eba*. One usually starts however with a small quantity of water to which the *gari* is added after which more water is added in subsequent dashes.

We have to stress however that there are a lot of local variations. Prof Akoroda (personal communication) gave an example of Delta state: in the north, around the city Asaba, people like a grainy *eba* while in the South of Delta state, they like *eba* that is very smooth, starchy, that draws and is very firm because of full rehydration. The 'grainy' *eba* is obtained by a short contact time between hot water and *gari,* similarly to how *eba* is commonly prepared in the South Western by adding dashes of hot water to get the desired *eba* texture.

It seems that this mode of preparing representing different amounts of rehydration and thus binding determine more the texture of the *eba* then the sourness/ degree of fermentation.

From the key informants interviews it seems that a good *gari* can be made from any variety. Only, though varieties with a very low starch content will especially affect a sour *gari*: through the method of preparation in the southwest less starch will rehydrate and bind which will result into the *eba* not holding together well, it will not bind well. There are however differences in garification (the yield of *gari* that can be obtained from a certain amount of fresh cassava roots) between varieties. Varieties with a higher dry matter and starch content (dry matter and starch content are linear related) will provide more *gari* from the same mass of fresh roots. Furthermore, a high insoluble fiber content will result in a longer sieving work of the mash and will make final sieving of the *gari* more necessary. However, during our Nextgen research, farmers and processors in Osun and Imo state, stated that the fiber content does not much depend on the variety but on at what age the cassava is harvested. If cassava is left too long in the ground it will become more fibrous, starting from that part where the root is attached to the plant. Peter Iluebbey (international cassava trial manager at IITA) stated that if you do not cut off the outer end of the root you will have more insoluble fibers in your mash and you will

get a lower yield of *gari* (*gari*fication) after more work. As different cassava varieties have different optimal cycle lengths, fiber content between varieties might differ when harvested at the same date after planting. One way however to deal with these fibers is to regrade the fermented mash by using a grater with fine mesh openings or a hammer mill. Thereby fibers will be cut into small particles, and will likely not much affect the *eba* quality. It will however affect the quality of the drinking *gari*: many fibers will float on the surface of added water, which is not appreciated by the consumers. As a standard, Sanni *et al* (2008) recommend a crude fiber content of about 1 to 2 percent of the dry matter content of the *gari.*

2.1. Different types of gari

A classification of four different types of *gari* has been confirmed by three key informants (Dr Sanusi, Mr. Ileubbey and Dr. Otegbayo) as stated in the following (Table 2):

Table 2. *A classification of four different types of gari from a South Western perspective*

Gari name	Characteristics	Market price rank (1 is highest)
Igbo	Not sour, larger granules, elastic, hard (*eba*), "attractive", white**, clean, dry	1
Egba*	Sour, finer granules, not elastic (*eba*) soft, off white, dry	2
Edjebu*	Very Sour, finer granules, off white, "attractive", dryer than Egba *gari*: more crispy, inviting flavour	2
Oyo	Sour, powderish, fibrous, dirty, off white, greyish colour	3

*Egba and Edjebu *gari* are the most similar

**If palm oil is added which is also common, especially in the South East the *gari* will turn yellow.

It must be noted here that the types of *gari* are strongly linked ethnicity and region. Something that will be dealt with in the gender and social segmentation section below.

The prices in Table 3 are provided from Bodidja market in Ibadan Oyo state (Sanni, 2016). Here Iwo *gari* is *gari* from Iwo in Osun state very close to Ibadan; Igbo *gari* from the South East or South South is however not mentioned .

Table 3. Prices at Bodidja market in September 2016 (Sanni, 2016)

Types of Gari	***Price per congo (Naira)***
Egba	400-450
Ijebu	350
Oyo and Ilora (*Ilora part of Oyo state close to Oyo town*)	200-220
Iwo (*Iwo: town in Osun state close to Ibadan*)	250

2.2. Adding of palm oil to gari

Prof. Akoroda confirmed that in the South East there are markets for both clean white *gari* and yellow *gari*. When preparing yellow *gari*, palm oil is added to the freshly grated roots while mixing oil and mash with hands. So the oil is added before fermentation, while in the South West palm oil is sometimes added during roasting of *gari* to make the *gari* more attractive to hide a greyish or dirty color rather than for the purpose of turning the *gari* into clearly yellow color. Prof. Lafeef Sanni mentioned (personal communication) that the disadvantage of adding palm oil is that storability should be shorter since the *gari* may become rancid. This is also stated by Ezedinma *et al* (2008). What. differs between adding palm oil before fermentation or during roasting is not clear.

Mr. Peter Iluebbey, international cassava trial manager at IITA, mentioned an interesting aspect related to an important characteristic of the *gari*: the color.

A nice clean white- *gari* is obtained by:

- A good peeling: in Edo state people prefer to make an incision over the length of the root and wrap off the outer cortex instead of peeling round the root with a knife. This assures that only the very white center is used, resulting in a whiter and cleaner *gari.*
- Good hygienic conditions: washing the pealed roots, cleaning the machines and tools.
- Limited level of fermentation: fermentation makes the color off-white and sometimes greyish, especially when fermentation continues during sun drying.

Sun drying is often done to save firewood, but this can result in *gari* not being properly roasted. Sun drying goes slower than dry roasting, so fermentation will still continue and this together with dust and smoke may result in an off-white or unattractive greyish color. However, marketers state that *gari* that is too dry and very crunchy can be difficult to cook into *eba* because it will form lumps, so too dry also has its disadvantages. Achinewhu (1998) and Sanni *et al* (2008) indicated that a moisture content of around 10% is a good standard. It seems that sun drying in combination with exposure to dust is indeed explaining the off greyish colour that is often not liked. Irtwange and Achimba (2009) show that the attractiveness (colour in this case) is not decreasing with fermentation time.

2.3. Swelling (volume increase of the gari and eba) and water absorption capacity.

Another important quality characteristic mentioned often by respondents in our current Nextgen and RTB foods work and mentioned by the food vendor in Ikoyi is *swelling*, which represents the increase in volume of *gari* when it is cooked into *eba*. The swelling capacity is a very important attribute for a good quality *gari* as it indicates the degree of gelatinization of the *gari* sample (Oduro et al, 2000 as cited in Teye et al. 2017)

Generally, a higher bulk density of the *gari* results in a higher expansion ratio (volume of *eba* / volume per g of *gari*), while a low density of *gari* will result in the largest water absorption capacity per gram of *gari* and the largest *eba* volume per gram of *gari*. This indicates that water absorption capacity is not a good measurement for the swelling expressed by processors and consumers. This also follows from a recent test that we performed at IITA (unpublished data). We prepared *eba* from *gari* made from seven different varieties (including land races and improved varieties) that were grown in the same field at the IITA station. We determined parameters such as bulk density of *gari*, volume of *eba* obtained per mass unit of *gari*, water absorbed per unit of *gari* as well as volume of *eba* obtained by adding cold water to a cup of dry *gari*. One experienced *eba* cooker- made *eba* from all seven varieties. We had 12 replications per variety. Results showed that the volume of *eba* per gram of *gari* was negatively correlated with the (bulk) density of *eba*, while the expansion ratio (volume *eba*/volume *gari*) was positively correlated to the bulk density (Table 4). So a low density “light *gari*” results in a higher volume of *eba* per gram *gari* and a lower expansion ratio, while a high density, “heavy” *gari* will result in a lower volume of *eba* (per g of *gari*) and a higher expansion ratio per volume unit of *gari*. Another important result is that the swelling test in cold water (Sanni, 2008), did not correlate to volume of *eba* per g of *gari*, nor expansion ratio, nor hot water absorbed per g of *gari*, but correlated to dry matter content of the fresh roots of the cassava. The swelling test of *gari* in cold water therefore seems not to be indicative of swelling of *eba*, but certainly relates to the behavior of *gari* for drinking, for which generally a high swelling in cold water is appreciated.

Irtwange and Achimba 2009 show an important relation to this swelling in cold water: fermentation has a highly significant positive influence of the swelling capacity in cold water. In their experiment the swelling almost doubles after 3 days of fermentation and then stabilizes under higher fermentation lengths. This trend was also observed by Escobar et al. (2018). This indicates that gari fermented for at least 3 days is significantly better for drinking as swelling is a preferred trait, for this type of consumption.

The table below (table 4) shows the Pearson correlations between the different parameters and ratios between parameters.

Table 4. Pearson correlations between *gari* and *eba* characteristics from seven different varieties of cassava (unpublished data of an experiment executed by the authors)

Pearson Correlations N=84	***Vol/g gari [cm3/g]***	***gari density [g/cm3]***	***Volume eba/(weight gari) [cm3/g]***	***expansion ratio [cm3/cm3]***	***Weight eba/(weight gari) [g/g]***	***Weigth hot water absorbed / weight gari [g/g]***	***swelling cold water (Sanni 2008)***	***Cassava roots dry matter content***
Vol/g *gari* [cm3/g]	1	-,999**	,324**	-,293**	.164	.164	-.077	.214
gari density [g/cm3]	-,999**	1	-,322**	,295**	-.161	-.161	.068	-.212
Volume *eba*/(weight *gari*) [cm3/g]	,324**	-,322**	1	,809**	,880**	,880**	-.170	.095
expansion ratio [cm3/cm3]	-,293**	,295**	,809**	1	,790**	,790**	-.117	-.033
swelling cold water (after Sanni 2016)	-.077	.068	-.170	-.117	-.142	-.142	1	-,393**

* Correlation is significant at the 0.05 level (2 tailed) **. Correlation is significant at the 0.01 level (2-tailed).

Although the *gari* samples with the lowest density resulted into the largest volume of *eba* per gram *gari* when turned into *eba*, the expansion of volume per gram *gari* was the largest for the *gari* samples with the highest density.

According to respondents in the Nextgen research and our two *gari* marketers at Ifon market, the different quality aspects of *gari* to be used to drink with cold water and *gari* to be turned into *eba should be the followings*:

- For drinking *gari* as well as for sprinkling *gari* on food, generally a very dry, more light (less dense) *gari* is accepted as it absorbs more cold water per gram of *gari* and therefore forms soft grains in the water.
- *Gari* with a high density, usually with less airy pore space has more starch and will swell better in hot water as more rehydration can take place, while it will take more time to swell in cold water.

Leaving out the difference in starch content and the density of *gari*, more precise investigations on cassava starch also suggest that the kind of starch also determines the swelling power when rehydrated. Charles *et al*. (2005) suggested that swelling is not so much related to amylose/amylopectin ratios but more to the ratio of short and long amylopectin chains. However, Dr. Bruce Hamacker from Purdue University USA (personal communication) suggested that such ratios highly fluctuate between samples and differences between varieties are hardly obtained.

Another important quality characteristic of *gari* is the granule size. Although many things were found to influence the granule size (equipment used such as a grater and sieves) respondents within the Nextgen research indicated that the largest determinant of the granule size seems to be the temperature of the roaster, or better the contact temperature between the mash and the roaster. A high temperature will increase immediate gelatinization at the peripheral part of the particles, forming lumps which provide big granules. This high temperature of the roaster may be corrected by decreasing the intensity of wood fire or stirring more quickly. A temperature that is high and a cooker that stirs too often and fast will result in powderish *gari*: a very small granule size and a *gari* that is not

well toasted, not well done. However, coarse *gari* can be sieved to finer *gari*. And the skill of the cooker determines how fine she or he can make a *gari* on basis of the mash. Ezedinma *et al*, 2008 state that coarse *gari* usually has sweet taste (i.e. more unfermented) while fine *gari* has a sour taste. The reasoning behind this is rather unclear and needs clarification. Their study also shows something very interesting and confirms the importance of color. They studied what kind of factors determined the price of *gari* that a wholesaler pays for *gari*. Here color was highly important, followed by texture (coarse or fine) but also by the ethnicity of the wholesaler. This shows that certain types of *gari* (with their specific quality criteria) are probably sold, represented by the different ethnic groups traditionally related to each type of *gari*. In general, larger granule size *gari* is cheaper and less appreciated but how this exactly relates to the different types of *gari* and preferences of consumers is still something to be inquired into, as some respondents in our Nextgen study and also one of our key informants Mr Williams, cassava processing operator (personal communication) have articulated a preference for larger or smaller granule size depending on their age and physical wellbeing. Mr Williams said, he prefers fine *gari* particles to coarse or bigger particles because of his age (above 40years) for easy digestion. He emphasizes that the taste of the fine particle *gari* is like taking wheat to him. He indicates that it are mostly older people that prefer a smaller granule size.

2.4. Color as part of "attractiveness"- a key characteristic

From participatory processing demonstrations we learnt that attractiveness is one of the most important descriptors and is evaluated by consumers according to color and granule size. Usually a light, clean white or butter color (light yellow) is preferred, with granules that are fine but not that fine that it becomes like powder or starts to resemble wheat or maize flour. Some respondents within the Nextgen participatory processing exercise have even indicated that they would prefer a *gari* that has less weight (density, starch) over one that has more weight if the attractiveness is better. Color seems the most important aspect of this attractiveness. Clean operation during processing is key to have a good color, but also the variety determines the color of the *gari* and *eba.* Preliminary results show that some varieties turn into an unattractive color while others do not. Any color that can be related to grey or brown as you see on the floor (like sand, stones etc) is not liked. The color should distinguish itself clearly from the environment by portraying a clean white, off white, butter-like color and somehow transparent color. Figures 1 and 2 show *gari* and *eba* from five different varieties grown in the same field and processed by the same processor.

Figure 1. *Gari: Varieties A and B are liked while C, D and E are disliked because of brownish and somehow unclean unattractive appearance (not very clear on photo as nuances are quite 'physical experiences': facing the products material surface)*

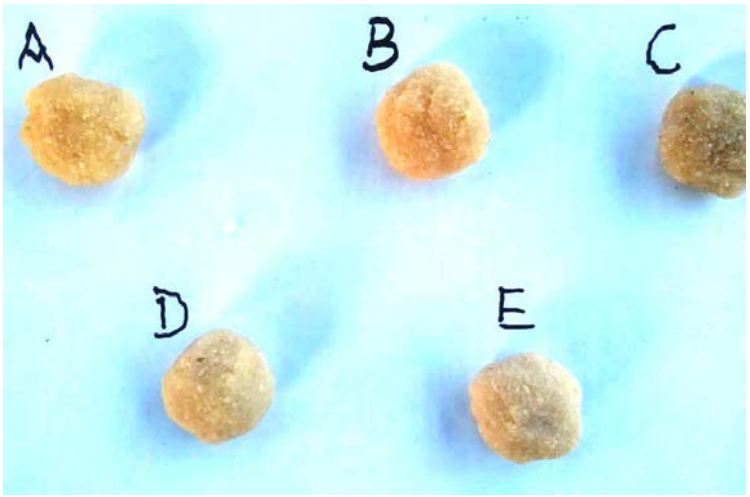

***Figure 2**. Eba: the same varieties as in Figure 1 cooked into eba. A and B are liked while C, D and E are disliked because of brownish and somehow unclean unattractive appearance (much clearer here, the eba making brought out the contrast)*

It also seems to occur that people like a certain *gari* but then do not like the appearance of the *eba* made from it. This finding will be further substantiated after full analysis of the Nextgen data as well as from the ongoing activity 3 and upcoming activity 4 and 5 RTB foods work.

It seems that most of descriptors of *gari* are determined by the processing factors while dry matter/starch content of the variety has effect on the quality of the *gari* and *eba* obtained especially when the *gari* is prepared with less cooking time (Like is common in the Southwest) which greatly affects the cohesiveness: how good the *eba* will hold together when you break off a piece to scoop the sauce. Furthermore, there seems to be a relation between the color of the *gari* and *eba* and the variety.

Although there is little evidence that the starch content of *gari* decreases as result of fermentation (George et al 1995) such reasoning is however still prevalent among several of the key informants. The way *eba* is prepared in the regions where *gari* is mostly fermented for longer (Southwest) probably better explains the differences observed. Preliminary results from RTB foods activity 3 in Benue (North Central) that show that people also “cook” their *eba* longer (because just like in the SouthEast they prefer a harder product) than in the Southwest while fermentation time is similar to the Southwest supports this as longer cooking of fermented *gari* simply results into a better binding and rehydration irrespective of the *gari* being fermented or not.

In a personal communication with Food Scientist Thierry Tran at CIRAD he explained it as follows: “A comment on the preparation of *eba* in Benue vs southwest: Normally the starch contained in *gari* is already fully gelatinized during the toasting operation of the *gari* process. (……..) The longer “cooking” of *eba* in Benue may result in more rehydration of the *gari* particles, which will give more freedom to starch molecules to interact with each other and stick together, resulting in better cohesiveness of the *eba* mass. In contrast, a shorter cooking may limit the rehydration of the particles, and their ability to form a cohesive, elastic mass.”

We can conclude that the following aspects/descriptors are important (Table 5):

Table 5. *Descriptors for gari-eba*

Gari	- Attractiveness/Color (in relation to the variety and the color that a sour *gari* takes as influence of the fermentation process/sundrying) -Heterogeneity / granule size (also part of the visual attractiveness) -Dryness (hand feel) -Density (weight) -Amount of chaffy/crude fibres -Flavor (sourness) -Crunchiness (often mentioned, but to what extent is it related to dryness is not yet clear) -Swelling in cold water (highly preferred when gari is drunk with cold water)
Eba	-Grainyness (to what extent can *gari* particles still be distinguished) -Cohesiveness (hard or soft, and holding together or falling apart more easily) -Stretchability, Drawabilty -Swelling

The main descriptor for gari for drinking is the swelling in cold water. This swelling is however not related to the swelling of gari when making eba. Literature however shows a positive correlation between fermentation and swelling in cold water. Fermented gari swells significantly more and is therefore more suitable for drinking gari as swelling is a preferred trait. Fermented gari is also most common in the Southwest where drinking gari is highly encultured. Secondly for drinking *gari* the amount of fibers “sticks/woody”, chaff in the *gari* is more crucial as these fiber filaments will float on the surface. This characteristic is preferred to a certain extent (one respondent in the Nextgen work compared it with beer that needs a certain amount of foam on top) but should not be excessive. This is a little less critical for *eba*. Furthermore, as stated for drinking and especially for sprinkling on food a more light (lower bulk density) crunchy *gari* is accepted, while lightness (i.e. low density) is always a disadvantage for *eba*.

3. GENDER ASPECTS OF SOCIAL SEGMENTATION & DEMAND

Important gender aspects can be explained by the history of cassava in Nigeria. Formally it was men who led yam cultivation and women’s tuber crop was cocoyam. Around the end of the 19th century cassava was taken up by women as a way to emancipate themselves and built up a lucrative value chain of cassava and *gari* gaining a formal and economically independent position and also (just like their male counterparts) create a liaison with the colonial economy to such an extent that they were even able to hand in petitions that influenced colonial laws (Korieh, 2007 and 2010). Like this Oyewumi (1997; 2010) would state that they were somehow able to regain the power they had before the colonial rulers created the imbalance between women and men as colonial rule and operations was mainly a men’s operation. So, cassava became important and was especially cultivated and processed by women in the South after which its importance spread to other parts of the country. This explains that in the south many men prefer to eat *amala* (from cassava) and *akpu* rather than *eba* as it resembles the structure of pounded yam. This was also expressed by Mr. Iluebbey, International

Cassava trial manager at IITA, who himself is from Edo state (South). Also a key informant restaurant owner in Ikoyi (South West) indicated that more men than women are customers of her restaurant because they eat out more often, and that the *eba* they prefer, and which she makes, appears like pounded yam.

Within cassava production, gendered roles exist and in the South still reflect the historical perspective outlined by Korieh. In general men are responsible for land clearing and land preparation (making heaps). Especially in the South, seed sourcing, planting and maintenance of the crop is women's work as cassava is considered a women's crop but men participate in the maintenance and harvesting work. However, the notion that cassava is a women's crop is being challenged in some areas, specifically where demand for fresh roots is high or growing (Forsythe et al., 2015, 2016). It seems that especially where land is very scarce and opportunities outside agriculture predominate, production activities are mainly done by women (like in Imo and Abia state).

Almost all the processing work is done by women (with exceptions in some migrant communities – Forsythe et al., 2015, 2016), although often tools for processing, such as motorized grater and presses, are owned by men and women pay a fee to use them at processing centers outside the home (Southwest) or inside the household were mobile grater services are used (e.g. Imo state in the Southwest). Women in many cases make an income from processing activities as it adds significant value to the crop (Afolabi, 2009; Onya, 2016). Afolabi (2009) showed for South Western Nigeria that 69% of the *gari* marketers were women, which was also reiterated in Forsythe et al. (2015, 2016). In some cases, women are known to lend money to their husbands although this money is often not returned, and some considerable differences exist in the profitability of different products e.g. *abacha* involves less processing and therefore gives higher returns (Butterworth *et al*., 2008). However, the *gari* product is probably more versatile and its demand on a large scale is higher. This is significant as *gari* is often regionally collected and then bulked and sold in the cities (Ezedinma *et al*., 2005).

As land heritage in Nigeria is mostly patrilineal (Butterworth, 2008; Korieh 2010 and 2007; Forsythe et al., 2015 and 2016) women are often disadvantaged when it comes to accessing to land and therefore the resources of production. In the South-West region, men typically allocate a separate plot for women to cultivate independently (Forsythe et al., 2015, 2016). However, individual lands of women are many times smaller than those of men, and women are dependent on men for access to land. Also divorced women are especially vulnerable as they can entirely loose access to land (Butterworth, 2008). As women do almost all the processing, the product preparation and marketing is entirely in their hands while they also sell fresh roots on the market. This often gives them the possibility to specialize in processing and gives them the capacity to buy fresh roots for processing as so to "compensate" for the limited land resources. Men mostly sell fresh roots and often do so in higher quantities, as their role in production can be larger because of more access to land and other resources.

An important difference between the South South and South West is that especially among smallholder men and women work on individual farms together, while in the South- South it is more common that only women are involved in the maintenance and production of cassava as well as in the processing.

Our key informants Dr Otegbayo and Mr. Ileubbey stress that women are most determinative in what products are made from fresh cassava and are therefore much more critical in the judgement of the *gari* and *eba* qualities. If we want to know the specific preferences of *gari* and *eba* in relation to the production and especially the processing steps it is mostly experienced women that we have to consult.

As men will not quickly acquire this knowledge and the patience to carry out tasks like sieving, peeling and roasting, and marketing (Dr Otegbayo personal communication), tasks of which the expertise highly determines the product quality, men will probably not easily take over the control over this business. Interviews with women processors within our Nextgen work indicated that they will profit from mechanization services, even if they are controlled by men, because they will come to pay a small fee for using them while they keep on controlling and enlarging their business, as mechanization increases the turnover as well as the time that can be spent to optimize marketing

aspects such as packing and other important non drudgery activities. Men might pay women to process their crop but as soon as women built up some capital they can also buy roots and process and sell them. The interaction between technology development (mechanization) and society with its gender roles and gendered task ask for a more action oriented comparative research.

Prof Akoroda (personal communication) also mentioned an important aspect: there are many smaller regional differences within States: e.g. where pure starch consumption is common (South South, delta and river states), people prefer a very stretchable *eba* that is hard and homogenous (less grainy), and resembles the products made from pure starch. Here the example from Prof Akoroda: laborers in Ibadan prefer an *eba* that is normally associated with the South South states and South East is relevant as it indicates that considerable attention has to be given to markets that exist within the whole country for certain types of *eba* that are originally tied to ethnic groups, not only because those ethnic groups are nowadays dispersed all over the country, but also because certain socio economic and professional conditions connect well to the nutritive and physical-chemical properties of a certain *gari* type, traditionally produced by a certain ethnic group. The case of the Tiv in the following table (Table 6, as sketched during the interview with Prof Akoroda) illustrates this; they produce any type of *gari* depending on the market they are targeting, as *gari* is not a food that they traditionally produce. In this respect, it is also interesting to see that in the South West the Igbo *gari* is known to be the most expensive, not only because it involves more careful work and hygiene, but also because the demand is high in a region where it does not originate. Figure 3 shows the traditional regions of the ethnic groups in Nigeria. Again here, the notion that fermented (sour) *gari* is usually fine and non-fermented *gari* is coarse comes back.

Table 6. *Table Sketched during key informant interview with Prof Akoroda, Seed production and plant breeding, University of Ibadan)*

Sour (more fermented)		***Non-Sour (less fermented)***		***Processing Ethnic group***	***Processing characteristics***
Fine	***Coarse***	***Fine***	***Coarse***		
X				Yoruba	Not fully roasted dry, *gari* is sun dryed after roasting: fermentation continues while drying in the sun. This often causes the *gari* to become greyish. Drinking *gari* is very common and *eba* is not major food so that is why sour *eba* has also become preferred.
			X	Ibo	Fully dried through roasting, no sun drying.
		X		Urhobo	Fully dried through roasting, no sun drying.
X	X	X	X	Tiv	Produce the *gari* for whom they are selling, it is not their own food.
		X	X	Ishekiri	Used to consume pure starch so they like non-fermented high starch *gari* that is very fine.
		X	X	Ijaw	Fine and Coarse *gari* but always starchy and non-fermented.
		X	X	Ika/Asaba	Fine and Coarse *gari* but always starchy and non-fermented.

Figure 3. *Ethnic groups in Nigeria*

With reference to the demand and supply markets, Sanni *et al* (2016) mention that the market for *gari* is characterized by perfect competition: there are many buyers and sellers who are not in a position to influence marketing transactions by refusing to either sell or buy. This illustrates the high demand for *gari* in the country. It is interesting to see is that the wholesale prices for *gari* from the South West are higher than those from the South East (Ezedinma *et al*. 2008). Ezedinma *et al* (2008) suggest that there is difference in the efficiency of the value chain because rural markets in the South West are closer to city markets than in the South East. This could however also be related to fermentation time as *gari* in the South West is fermented longer, which increases the whole processing time and thus the turnover. Most of the *gari* traded is white *gari* but a substantial part is yellow *gari*, because of adding palm oil, and its market price is higher; not only because of the palm oil added but also because of the more limited shelf life. Almost all of this yellow *gari* comes from the South South or South East. About one third to one fourth of the *gari* traded in Lagos is yellow *gari* according to data from Bernard Olusegun Siwoku (an agribusiness specialist working with the CAVA phase 1 and 2 project) and mostly comes from the South South and South Eastern region (Sanni, 2016). Figure 4, shows the partition of rural *gari* supply markets that enter Mile 12 in Lagos, one of the biggest food markets in Nigeria.

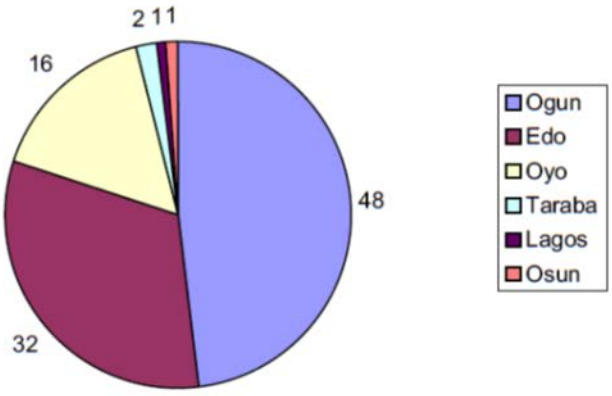

Figure 4 Distribution of rural *gari* supply markets to Mile 12 market, Lagos, by state (after Ezedinma *et al*. 2005)

The figure above shows that the largest supply of *gari* comes from the South West (Ogun, Oyo, Osun, Lagos) with almost a third coming from Edo state in the South South. Interestingly there is *gari* supply from Taraba state in the North East geographical zone. It would be interesting to see if this is a particular type of *gari* or just represents the share of *gari* coming from this state that borders with Cameroon. The large potential for increased growth and benefit that the *gari* market can bring to Nigeria has already been illustrated by Nweke *et al.* (1994). Sanni (2016) also mentions that Kano in the North of Nigeria is a great hub for export of *gari* from the Southern belt to the North: North Cameroon, Chad, Niger, Burkina Faso and Mali. This shows the large role of *gari* in Nigeria, as a dry (transportable) and storable food product (in that respect comparable to rice).

4. GAPS AND FURTHER REQUIREMENTS

We can conclude that most of the quality of *gari* and *eba* lies in the expertise with which it is processed, although a low dry matter (low density roots and thus lower starch) associated with some varieties can contribute to a lower quality product and to a lower *gari* yield. Our preliminary results from the Nextgen study also suggest that a main important characteristic of *gari* "attractiveness" is highly determined by the color and even very small nuances in color seem crucial. We do not yet know to what extent this is determined by the variety in combination with a longer or shorter fermentation time, a good cleaning, sieving. Furthermore, we do not yet have a good understanding if an attractive color in *gari* will also result in an attractive color within the wet product (*eba*) made from it. Adding water to *gari* makes the color obviously darker and glassier, more transparent. This transparency together with the nuance in color seems to be a crucial descriptor determining how the appearance of the *gari* triggers "attractiveness". Within Nextgen we are to compile a large dataset from in-depth participatory processing done in Imo state (South East), where in line with this review *gari* is made with little fermentation and Osun state (South West) where fermentation takes place over a longer period (up to five days). We hope that this comparative participatory evaluation at all the stages of *gari* and *eba* making will provide us clearer insight on what an attractive *gari* and *eba* entails as well as how this relates to the variety and chemical composition of the roots. The farmer/processors we worked with in Imo add palm oil to the freshly grated roots which turns the product yellow while in the South East and even in parts of Imo, also a very white *gari* is preferred by some consumers. We will need to do additional experiments there, which would also represent some of the other areas in the South East where white *gari* is also preferred. The RTB foods work by NRCRI will be crucial here. More clarity on the relation between *gari*'s bulk density, dry matter and granule size is needed to better specify how bulk density relates to dry matter and starch content, swelling capacity as well as the different uses of *gari*: mostly drinking and *eba* making. The perceived wisdom that unfermented *gari* is associated with large granule size and fermented *gari* with a finer texture also needs investigation. Furthermore, the diverging preferences of consumers for larger or smaller granule size also needs clarification. Also the relative advantage (no sieving of mash) and disadvantages of re-grating the cassava mash after pressing (more work for *gari* processing) have to

be studied further, especially related to the smallest pieces of fibers that end up in the final *gari* and might affect especially the drinking *gari* since many fibers might float on top of the water.

There is a clear understanding among food scientist key informants that fermentation reduces the starch content of the *gari* and therefore results in a less starchy product in which part of the starch is also reduced into shorter easier to digest chains. This needs clarification because the difference might be rather explained by the difference in the preparation of the *eba*, involving longer cooking time in the South South and Southeast and shorter cooking time (contact time between boiling water and *gari*) in the Southwest.

Literature shows that fermented gari has a higher swelling capacity in cold water, a trait preferred by people who drink gari with cold water and additives (groundnuts etc). This is an important phenomenon that demands physiochemical explanation.

Furthermore, there is some but limited qualitative information about how and what kind of *gari* from the rural areas is assembled in hubs in towns or suburbs of cities before it is bulked and sold as wholesale in cities. There is also little information on the specific quantities of each type of *gari,* and how they relate to different traditions . Divisions between coarse/sweet *gari* at the one hand and fine/sour *gari* on the other hand and *gari* where palm oil is added (mostly to the coarse/sweet type) are informative but do probably not do full justice to general trends and insights in the relation between *gari* product quality and cassava varieties. Quality aspects can be related to types of cassava and this is important to know with regards to breeding, but also for identifying ideal existing cassava varieties for different types of cassava products. As we have seen, ethnicity is connected to specific traditions (types) of *gari*. From an equity perspective, it is important to better understand such differences, to be able to support and promote specific types of *gari* in order to do justice to the quality inscribed in each tradition. Such specific qualities can be marketed and can become appreciated by many consumers. This might provide new opportunities to (minority) communities practicing specific cassava food traditions that are entering a modern market economy. This requires an inquiry into the different quality standards as used in different rural and city hubs in the country but also an eye for specific minority qualities and practices that might become the base of new re-invented products and value chains.

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6. KEY INFORMANT INTERVIEWS

- Prof. Lateef Sanni, Food scientist, FUNAAB Abeakuta University, 27 February 2018.
- Dr Otegbayo, Food Scientist, Bowen University Iwo, Osun state, 23 March 2018
- Prof. Malachy Akoroda, Breeder/Seed specialist and food marketing, University of Ibadan, Seed production and Plant Breeding, 19 March 2018
- Mr. Peter Ileubbey, International cassava trial manager at IITA, IITA, Ibadan, 12th April 2018
- Prof. Sanusi Adegoke Rasaki, Nutritionist, University of Ibadan, Human nutrition, 22 March 2018
- Mrs Rose at Jerusalem *Gari* Processing Centre, Processor, Ojo Ibadan, Oyo state, 12th April 2018
- Anonymous two *gari* marketers at Ifon market in Iwo, Osun State, Nigeria, 23 March 2018
- Anonymous Food vendor at Ikoyi, Osun state restaurant, 24 March 2018
- Mr. Williams, IITA utilization processing unit manager, 28 July 2017
- Dr Bruce Hamaker, Food scientis, Purdue University, USA. Conversation with him at Buea, Cameroon, 24 January 2018, RTBfoods kick-off meeting.

7. PERSONAL EMAIL CORRESPONDENCE:

- E-mail communication with Thierry Tran, food scientist at CIRAD Monday, 3 December 2018.

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