

Assessment of Nutritional Contents of Gari Obtained from Different Markets in Southwest Nigeria

*Adeniji, P. O.¹ and Adepoju, O. T.²

1. Department of Hospitality and Tourism Management, Faculty of Management Sciences, Redeemer's University, Ede, Osun State, Nigeria

2. Department of Human Nutrition and Dietetics, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Nigeria

*Corresponding Author: adenijio@run.edu.ng

Phone number: +234 8023009058

ABSTRACT

Background: Gari, a fermented cassava-based staple food, is widely consumed across various socioeconomic groups in Nigeria and West Africa. Its production involves several processing steps, including peeling, grating, fermentation, pressing, and frying.

Objective: This study was designed to comprehensively evaluate the nutritional quality and residual cyanogenic potential of Gari samples.

Methods: The Gari samples were purchased from 3 randomly selected vendors at nine different popular markets in Osun and Oyo States. Proximate Composition of the Gari samples was determined using the Official Methods of Analysis of the Association of Official Analytical Chemists. The data were analyzed using SPSS version 20.0. The level of significance difference was set at $P < 0.05$.

Results: The moisture content of the Gari samples ranged from 6.80g - 7.43g/100g, protein content (0.20g to 0.89g/100g), fat content (0.16g to 0.86g/100g), crude fiber (1.20g to 3.19g/100g), and ash (0.89g - 1.64g/100g). Amylose content ranged from 19.73g to 25.95g/100g, while starch content ranged from 52.26g to 78.87g/100g. Also, cyanide levels varied from 0.48 to 1.29 mg/100g, with most samples falling below the FAO/WHO permissible limit of 10 mg HCN/kg. Lead, copper, nickel, and cadmium levels ranged from 0.009-0.042, 1.28-5.06, 2.42-6.84, and 0.288-0.588 mg/kg, respectively, and were within the recommended safety limits.

Conclusion: All the Gari samples used in this study contained both macronutrients and micronutrients of good significant values. These values are within the Codex Alimentarius Commission's tolerable limits in food samples, making the Gari samples safe for consumption.

Keywords: Gari, Cyanide content, Heavy metals, Local markets

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INTRODUCTION

Gari is a starchy and gritty staple product derived from cassava (*Manihot esculenta* Cranz), [1]. It is regarded as a convenient product as it is stored and marketed in a ready-to-eat form and may be prepared with hot or cold water, depending on the intended form in which it is to be consumed [2, 3]. Oluwole et al. [4] reported that Gari is the most common form in which cassava is sold in Nigeria and other African countries. It contains carbohydrates, an important source of dietary

energy, and dietary fiber, which aids digestion and prevents constipation. Gari is one of the common foods readily available to low-income consumers in many parts of tropical Africa and urban cities. It is regarded as the most important and single traditional product in Nigeria [4]. It is widely consumed by the poor, middle-class, and rich Nigerians as it serves as a source of carbohydrates. Gari can be taken in different forms, such as Eba or soaked in water alongside ground nuts or bean cake.

The occurrence of toxic cyanogenic glycosides in cassava makes the raw roots poisonous and unfit for consumption. However, processing raw roots into products such as *Gari*, *fufu*, *Lafun*, chips, etc. helps to eliminate, to a very large extent, the poisonous compounds and makes them safe for consumption [5]. The poisonous cyanogenic glycosides in cassava are eliminated or reduced to the barest minimum through processing methods, which include peeling, grating, fermentation, pressing, and frying [6, 7].

The processing method adopted will reduce the poisonous substances that can affect the functional characteristics of the final products. Cyanide accumulation in the human body can lead to goiter and some neurological disorders [8]. Cyanide level in *Gari* has been greatly reduced through the unit processing operation, such as peeling, washing, grating, fermentation, dewatering, and roasting.

The traditional method of *Gari* production requires fermentation of the cassava slurry for 72 hours, during which the cyanides (*Linamarin* and *Lotaustralin*) are hydrolyzed by an endogenous enzyme, *linamarase*, to produce hydrocyanic acid, which is volatile and escapes easily during the roasting process, rendering the *Gari* safe for consumption [9]. However, so many cassava processors bypass normal procedure for the sake of profit-making by compromising some unit operations during processing, thereby resulting in *Gari* products with excess cyanide content [9].

Besides, it is common practice within the Southwest, Nigeria, to display *gari* at marketplaces or road sides, which exposes the product to various contaminants such as heavy metals from vehicular emissions. Therefore, this study focuses on the nutritional evaluation of *Gari* purchased from different markets and road sides within Southwest Nigeria to ascertain the variation in quality of *gari* products from different processors and market outlets.

MATERIALS AND METHODS

Sample collection and preparation

Gari samples were collected from 9 different markets, namely: *Oja lfe* and *Oja titun* from Ile-Ife, *Bodija*, *Oje*, and *Eleyele* markets in Ibadan, *Orita Moro* market, *Ede*, *Ita Ikogun*, and *Sekona* markets, all within Southwest, Nigeria. Samples were purchased from three randomly selected vendors in each market, pooled together, transferred into cellophane bags, neatly sealed, and transferred immediately to the laboratory for analysis.

Proximate composition determination

The proximate compositions of the *Gari* samples were determined using the official methods of analysis of the Association of Official Analytical Chemists [9]. The moisture content of *Gari* samples was determined using an air oven set at 105 °C for 4 hrs (Plus 11 Sanyo Gallenkamp PLC UK). The crude protein of the samples was determined using the micro-Kjeldahl method (Method No. 978.04), while crude lipid content was determined through the Soxhlet extraction method (Method No. 930.09). The Ash content of the *Gari* samples was determined using a VULCAN™ furnace (Model 3-1750, Cole-Parmer, IL 60061, United States) set at 550 °C for 4 hrs (Method No. 930.05). The crude fibre of the samples was determined using the AOAC method 958.06.

Starch and sugar content determination

The method of AOAC (9) was used in determining starch and sugar in this study.

Starch and sugar content were determined by weighing 0.02 g of the sample into a centrifuge tube with 1 ml of ethanol, 2 ml of distilled water, and 10 ml of hot ethanol. The mixture was vortexed and centrifuged at 2000 rpm for 10 min. The supernatant was decanted and used for determining sugar content, while the sediment was hydrolyzed with perchloric acid and used to estimate starch content. Phenol sulfuric acid reagent was used for colour development, and glucose standards were used for the estimation of sugar. The absorbance was read with a *Genesys G10S (USA)* spectrophotometer at 490 nm.

Data analysis

The data were analyzed using SPSS version 20.0. Triplicate determination of the cyanide content of *gari* and mean with standard deviation (SD) {22}. Analysis of variance (ANOVA) was used to determine the significant differences.

RESULTS

The result of the proximate composition of *Gari* samples from selected markets in Southwest Nigeria is presented in Table 1. *Gari* samples from *Bodija* market had the least moisture content, while samples from *Oja lfe* had the highest moisture content, which corresponds to a range between 3.80g and 7.43 g/100 g. This is consistent with the moisture content of *Gari* samples reported by [10]. The fat and protein content of the *gari* samples were relatively low, ranging from 0.12% to 4.58% and 0.20% to 0.89% respectively. Ash content was observed to be highest in samples from *Oja lfe* and lowest in

samples from Sekona. On the other hand, crude fibre ranged from 1.20% (Bodija) to 2.86% (Oja lfe).

Table 2 presents the carbohydrate and cyanogenic potential (CNP) of the gari samples from different markets. Sugar and starch were highest in samples from Bodija, with respective mean values of 8.36% and 78.87% while they were lowest at Oja lfe, with mean values of 2.34% and 68.67% respectively. On the other hand, samples from Oja lfe had the highest amylose content (24.29%). The cyanogenic potential was highest and lowest at Eleyele (1.29%) and Oja Titun (0.13%), respectively. In

general, a significant difference ($p < 0.05$) was observed for the quality parameters across all markets. However, a non-significant difference ($p > 0.05$) was observed between Orita Moro and Oje for amylose, Bodija and Eleyele for sugar, Oje and Ede market for starch, and Orita Moro, Oja Titun, and Sekona for CNP.

Table 3 shows the level of heavy metals in the Gari samples from the nine markets. Chromium and Cadmium were not detected in any of the samples at the mg/100 g detection level. However, lead, copper, and nickel were present at low concentrations.

Table 1: Proximate composition of Gari samples from markets in Southwest Nigeria (g/100g) *

Market samples	Moisture	Ash	Fat	Protein	Crude fibre
Oja lfe	7.43±0.37 ^a	1.64±0.03 ^a	0.90±0.01 ^e	0.20±0.01 ^e	2.86±0.04 ^b
Bodija, Ibadan	3.80±0.11 ^f	1.39±0.02 ^c	0.60±0.01 ^e	0.89±0.07 ^a	1.20±0.16 ^g
Orita Moro	5.40±0.14 ^d	1.42±0.04 ^c	1.72±0.04 ^c	0.35±0.07 ^d	2.28±0.08 ^d
Oje, Ibadan	6.13±0.34 ^{bc}	1.31±0.02 ^d	2.07±0.18 ^b	0.44±0.01 ^{cd}	2.58±0.08 ^c
Oja Titun, Ile lfe	6.48±0.28 ^b	1.49±0.03 ^b	0.56±0.01 ^d	0.45±0.01 ^{cd}	3.19±0.07 ^a
Eleyele, Ibadan	4.50±0.47 ^e	1.37±0.06 ^{cd}	4.58±0.03 ^a	0.86±0.01 ^a	2.34±0.03 ^d
Ede Market	5.67±0.06 ^d	1.40±0.00 ^c	1.71±0.20 ^c	0.49±0.09 ^c	1.88±0.02 ^e
Ita Kogun	5.32±0.03 ^d	1.30±0.12 ^{bc}	1.86±0.12 ^{bc}	0.71±0.07 ^b	2.56±0.01 ^c
Sekona, Ede	6.12±0.02 ^{bc}	0.89±0.02 ^e	0.12±0.05 ^e	0.39±0.00 ^{cd}	1.54±0.08 ^f

*Values are mean of duplicate determinations.

Means with the same in a column are not significantly ($P>0.05$) different.

Table 2: Carbohydrate (g/100g) and cyanide (mg/100g) content of Gari Samples from markets in southwest Nigeria.

Market samples	Amylose	Sugar	Starch	CNP (mg/100g)
Oja lfe	24.29±0.06 ^b	2.34±0.03 ^g	68.67±0.29 ^f	0.48±0.004 ^a
Bodija, Ibadan	19.84±0.11 ^f	8.36±0.13 ^a	78.87±0.02 ^a	1.23±0.006 ^b
Orita Moro	21.10±0.11 ^d	6.79±0.06 ^e	70.25±0.14 ^e	0.34±0.007 ^c
Oje, Ibadan	21.14±0.17 ^d	7.03±0.06 ^d	75.40±0.43 ^b	1.03±0.001
Oja Titun, Ile lfe	22.21±0.11 ^c	2.61±0.06 ^f	69.39±0.39 ^f	0.13±0.006 ^c
Eleyele, Ibadan	19.73±0.05 ^f	8.31±0.04 ^a	74.21±0.54 ^c	1.29±0.001 ^{ab}
Ede Market	20.83±0.16 ^e	8.11±0.00 ^b	75.12±0.54 ^b	1.14±0.005 ^d
Ita Kogun	21.06±0.17 ^{de}	7.81±0.06 ^c	71.25±0.14 ^d	0.13±0.004 ^b
Sekona, Ede	25.95±0.05 ^a	1.26±0.07 ^h	52.26±0.25 ^g	1.26±0.001 ^c

Table 3: Trace metal content of Gari samples from markets in Southwest Nigeria (mg/100g)

Market samples	Copper	Iron	Lead ($\mu\text{g/l}$)	Nickel ($\mu\text{g/l}$)	Cadmium ($\mu\text{g/l}$)	Chromium ($\mu\text{g/l}$)
Oja lfe	0.20±0.06	0.60±0.04	0.003±0.000	0.03±0.01	ND	ND
Bodija, Ibadan	0.37±0.03	0.34±0.15	0.004±0.000	0.05±0.00	ND	ND
Orita Moro	0.14±0.42	0.18±0.02	0.001±0.000	0.06±0.01	ND	ND
Oje, Ibadan	0.27±0.04	1.08±0.03	0.001±0.000	0.04±0.01	ND	ND
Oja Titun, Ile lfe	0.35±0.04	0.69±0.03	0.002±0.000	0.06±0.01	ND	ND
Eleyele, Ibadan	0.13±0.01	0.58±0.04	0.004±0.000	0.05±0.02	ND	ND
Ede Market	0.42±0.08	0.64±0.04	0.002±0.000	0.04±0.01	ND	ND
Ita Kogun	0.51±0.02	0.55±0.02	0.035±0.002	0.05±0.01	ND	ND
Sekona, Ede	0.40±0.04	0.44±0.03	0.043±0.000	0.64±0.44	ND	ND

Values are means of duplicate determinations.

Table 4: Heavy metals tolerable limits in foods (Codex Alimentarius Commission 2011)

Heavy metal	Tolerable limits	Reference
Pb	0.1 - 1.5	Codex Alimentarius Commission (2011)
Cd	0.05 - 1.0	Codex Alimentarius Commission (2011)
Cr	-	-
Cu	0.1 - 1.0	Codex Alimentarius Commission (2011)
Ni	-	-
Hg	0.001 -1.0	Codex Alimentarius Commission (2011)

DISCUSSION

The moisture content of samples represents the amount of water molecules in the sample. The lower the moisture content of gari, the longer the storageability because the moisture content determines the extent of mould infestation on the sample, which in turn affects the shelf life of the gari [13]. The moisture content of the gari samples evaluated in this study is consistent with 10.3 to 12.4% reported by Makanjuola et. al. [12] and is below the 12.0% (12 g) moisture level recommended by Codex Alimentarius Commission [11]; this indicates that the gari samples evaluated in this study could have a reasonable shelf life. Furthermore, no significant ($P>0.05$) difference was observed for the moisture contents of Gari obtained from Orita Moro, Ita Kogun, and Ede markets, and this could be attributed to the processing methods, which may likely be different. The Gari samples were very low in protein content. The low protein content value of the samples is in line with the fact that cassava root is a poor source of protein [10, 14]. The protein values obtained in this study are lower than the values reported for Gari products by [10]. This observed difference in protein content might be due to processing methods and varietal differences [10]. A very low-fat content was also observed for the analyzed samples, with the highest value being recorded for the sample from the Ita-Ikogun market. The very low-fat content of the samples is an indication that minimal or no palm oil was added to the Gari during the production process. The samples contained a substantial amount of crude fibre, and the values obtained are within the maximum of 3% reported by [15].

The ash contents of gari samples were lower than the ash content for gari samples reported by [10], but higher than the range of 0.69 to 0.78 % reported by Olakunle et al. [16]. Gari from Oja Ife had the highest ash content. All the gari samples had lower ash content compared with the stipulated 2.8 % by the Codex Alimentarius

Commission [11]. The values of ash obtained in this study are an indication that the samples may contain substantial amounts of macro-minerals. There was no significant ($P>0.05$) difference between the ash values of gari obtained from Bodija, Orita Moro, and Ede markets.

The amylose contents of gari samples (Table 2) agreed with the values reported by Akingbala et. al. [17]. Higher Amylose fraction of starchy foods enhances their degree of gelatinization [18] and improves the swelling capacity and enzymatic susceptibility of the starch. The amylopectin content of the gari samples ranged from 52.26 g to 78.87 g/100 g sample. The cyanide level of the 9 gari samples ranged from 0.48 (Oja Ife) to 1.29 mg/100g (Eleyele Market). However, concentrations were within the 10 mg HCN/kg permissible limit of FAO/WHO [19]; except for a few locations that are marginally above the limit, which could be due to the effect of processing, especially steeping after fermentation.

The heavy metal contents in this present study agree with values reported by Ogbonna et al. [20], and the levels of the trace elements fall within the FAO/WHO Codex Alimentarius Commission [21] tolerable limits in food samples (Table 4), hence, they cannot pose any threat to the healthy living of consumers (23).

CONCLUSIONS

This study has shown that the Gari samples sold in the selected markets in the Southwest have similar nutritional values as previously reported. The cyanide content is within the regulated limits for the Gari purchased from most locations, and their heavy metal concentrations are within the permissible limits. Hence, they are safe for human consumption without any attached health hazards; a few locations with slightly high levels of cyanide above regulatory limits require attention for adequate processing to avert any health complications.

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CONFLICT OF INTEREST

The authors declare no conflict of interest

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