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EFFECTS OF MELON SEED OR SOYBEAN MEAL SUPPLEMENTATION ON THE PHYSICOCHEMICAL AND SENSORY PROPERTIES OF INCOMPLETELY PEELED CASSAVA GARRI

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ABSTRACT

In this present study, completely peeled (CP) and Incompletely peeled (IP)cassava roots were used to produce garri, other portions were supplemented with soybean (S) or Melon seed (MS) meals at 10% level and garri were produced, a total of nine which were subjected to physicochemical and sensory analysis using standard procedures and the results presented as mean±SE. The moisture, crude protein, crude fat, total ash, crude fibre and carbohydrate contents varied significantly ($P<0.05$) from 9.75-15.16%, 1.40-9.71%, 0.70-3.35%, 1.60-2.36%, 2.13-3.45% and 68.97-81.03% respectively. Significance increase was observed in ash, fibre, protein and fat contents of IP garri especially the seed meal treated. Calcium (45-87mg/100g), Phosphorous, Iron and Zinc contents were generally low but Calcium, Potassium and Phosphorous were greater in the IP garri than in the Cp garri, and the values of all the mineral elements were enhanced in the treated garri. The bacteria counts, fungi counts, coliform and staphylococcus aureus load were far below the approved permissible safe limits for ready-to-eat foods however, the E.coli observed in two garri samples could be attributed to post-toasting cross contamination. CP garri had the highest water absorption capacity (4.51%), the swelling index of CP (5.78%), IP (5.90%), and CP+IP (5.76%) were relatively high, and decreased on supplementation with seed meal. The P^H of the various garri were slightly acidic especially the untreated garri. The cyanide contents of the various garri (0.11-0.34mg/100g) were low perhaps due to sweet cassava variety used in this study. The sensory properties of the either eba or soaked garri were well appreciated, however the texture of all eba made from IP were softer and stickier. This study has proved that complete removal of the cassava peel for garri production leads to nutrient depletion in a nutrient deficient staple and the waste accumulation constitutes environmental hazard.

Contribution/Originality: The study proved conclusively wasteful peeling away of the cassava root cortex before garri production is unnecessary, increases cost of labour and create environmental pollution and it also depletes the mineral and the dietary fiber contents of the garri; moreover fortification with seed oil meal enhanced the nutrient density of all types of garri however higher oil contents of modified garri reduced water absorption and swelling capacities which are not desired by consumers.

1. INTRODUCTION

Garri is a free flowing, fermented and dehydrated cassava mash, a staple consumed widely across West Africa especially among the urban dwellers. Nigeria and her neighbors are the epicenter of garri production and

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consumption in the world. Garri is either consumed soaked in cold water or liquid milk or made into *eba* (garri dough) and consumed with local soup or stew of varied composition and forms. Nutritional value of garri is enhanced by the food item with which it is consumed, because garri a starchy staple contains with less than 1.5-2.5% protein of poor quality and 1.5-2% fat, the processing method depreciates its mineral and vitamin contents due to leaching during dewatering and fermentation therefore garri is regarded as energy giving food. Cassava (Manihot esculenta Crantz), a perennial drought tolerant herb has its origin in the pre-Columbian tropical forest of South America, now it is grown widely in humid tropical and subtropical countries of Africa, North and South of equator and elevations of not more than 2000 meters above sea level providing calorie for more than 500 million people across Africa, Latin America and Asia (El-Sharkawy, 2003). Nigeria is the leading producer of cassava about 20% or 59 million tons of the world total, 70% of which is consumed internally as garri and fufu wet or dried (IITA, 2019). Within the cassava belt are located, most of the developing countries of the world with 13 % of the world GDP and high level of protein energy malnutrition (Nweke, Spencer, & Lynam, 2002). Soybean (Glycine Max) the wonder crop of the world is prized for its high nutrient density, 38%-45% protein of high biological value, 18-20% fat (Banaszkiewicz, 2011) and as a result it is a legume of choice for fabrication of novel foods, enhancement of the nutritive value of existing foods and its oil is an item of international trade for production of wide range of industrial products. Soybean meal contains (g/100g): Lysine 6.44, methionine 1.50, tryptophan 1.05, cysteine, 1.57(Banaszkiewicz, 2011). Melon seed (Citrillus Lanatus, syn syn colocynthis) on the other hand, is a creeping annual herb locally called egusi in Nigeria, the hairy stems and leaves with forked tendrils produced an oval fruit with oblong seeds immersed in cream coloured pulp. The seeds can be boiled or roasted as snacks or the paste from dehulled seeds is a common soup thickener or when fermented becomes a flavorful condiment called "ogiri" highly prized by the southeastern Nigerians. Melon(egusi) seed kernels contains 45.7-52% oil, 23.4-28.4% protein,2.70-12% fibre, 3.6-4.34% ash, 8.2-10.6% carbohydrate, vitamins and minerals (Jacobs, Efong, & Tijjanni, 2015), the protein is a good source of tryptophan and methionine (Gurudeeban, Satyavani, & Ramanathan, 2010). Cassava roots are transformed into garri through unit operations that lead to nutrient depletion in already nutrient deficient staple; peeling whether manual or mechanical is wasteful, parts of the edible portion is peeled away in the process, dewatering/fermentation of the mash portion leads to leaching of the soluble nutrients (sugar, amino acids, minerals and vitamins etc) in addition to toxic hydrocyanic acid; the toasting that follows removes the remaining heat sensitive vitamins. It is reported that the peel is richer in nutrient than the edible peeled roots, including the toxic cyanogenic glucosides (linamarine and laustralin) which are more in the peel than the starchy flesh Montagnac, Christopher, and Sherry (2009) but reported values of hydrocyanic acid in garri are in most cases below WHO/FAO permissible safe level (10ppm) indicating that mashing, fermentation and toasting are effective means of detoxifying cassava roots. Peeling to remove the outermost brownish layer sparing the inner whitish peel will reduce the laborious work involved, the wastage incurred and reduction of amount waste generated and may encourage lye peeling and consequently the garri produced will be richer in protein, fat, fibre, minerals and vitamins. Therefore the focus of this present study was to fortify garri produced from completely peeled and incompletely roots with melon or soybean seed meal and thereafter evaluate the physicochemical and sensory properties of the resulting garri.

2. MATERIAL AND METHODS

2.1. Collection and Preparation of the Raw Materials

Fresh cassava roots, creamed-colored soybean seeds, shelled melon seeds were purchased at Custom Area market, Maiduguri Borno State, Nigeria. The materials were taken to Food Processing laboratory of the Department of Food Science and Technology of the University of Maiduguri. The roots were washed and then portioned into two, one portion was completely peeled (CP) removing both the periderm and the inner cortex, while the other portion was incompletely peeled (IP), only scrapping the outermost brownish periderm. After washing,

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each portion was grated using a locally fabricated grinding machine to produce cassava mash. Soybean seed were soaked overnight (16 h) to loosen the hulls, the dehulled seeds were grounded to produce soybean(S) mash. Washed shelled melon seeds were ground to produce melon seed meal (MS). A blend of seed meal and IP or CP was formed; each formulation was placed in a kitchen mixer and thoroughly mixed before bagging. The traditional method of garri production as previously described by Agbara and Ohaka (2018) involving 72 h fermentation/dewatering of bagged mash and toasting of the fermented mash on a wrought iron pan over a smoldering flame Figure 1. There were nine formulations code-named as follows: CP (100%), IP (100%), CP+IP (50:50), CP+S (90:10), IP+S (90:10), CP+MS (90:10), IP+S (90:10), CP+IP+S (40:50:10), CP+IP+MS (40:50:10).

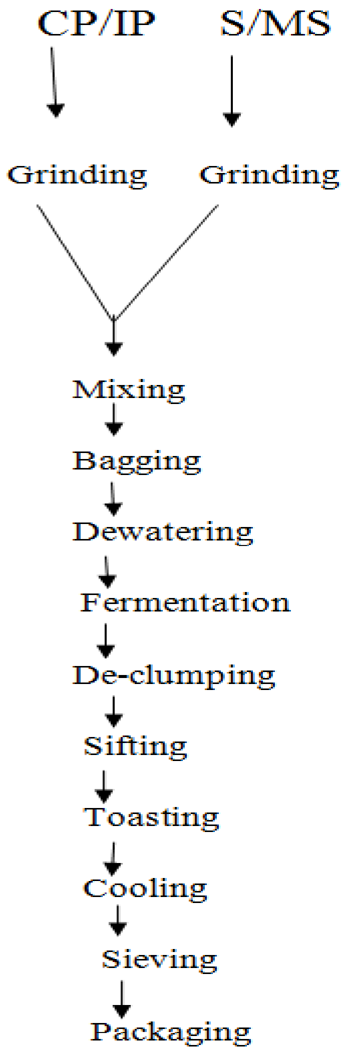

Figure-1. Flowchart for the production of enriched garri from completely peeled (CP), incompletely Peeled(IP) cassava, Soybean(S)/Melon Seed(MS).
Source:: Agbara., Masaya, Igwegbe, Bade, and Mohammed (2018).

2.2. Physicochemical Analysis

2.2.1. Functional Properties of the Garri

Water absorption capacities of the garri samples were determined using the procedure described by Sosulski, Garatha, and Slinkard (1976) and swelling indices were determined using the method of Abbey and Ibeh (1988) at room temperature. P^H of 10% suspension of each garri was determined using a pH meter (PHS-25, Search Tech Instruments, China).

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2.2.2. Proximate Composition of the Various Garri

Total ash, crude fat, crude protein and crude fiber were determined using approved methods, numbers 950.46, 920.153, 991.36, 928.08, 993.21 respectively (AOAC, 2000). Carbohydrate was obtained by 'difference'.

2.2.3. Cyanide Determination in Various Garri

The alkaline picrate method described by Williams and Edwards (1980) involved aqueous extract of test samples, establishment of calibration curve using standard solution of potassium cyanide and measurement of absorbance at 510nm using a spectrophotometer (Smart Spectro-2, La Motte USA).

2.2.4. Mineral Composition of the Various Garri

Samples were dry-ashed, then dissolved in 20ml dilute HCl (20%), the filtrate were made up to 100ml in a volumetric flask using de-ionized water. Potassium concentrations were determined using Flame Emission Photometer (Jenway ME 882). Phosphorus was determined colorimetrically using vanado-molybdate method as described by AOAC (2000) absorbance was taken at 450nm and concentrations of Phosphorous was obtained from a standard curve established using anhydrous KH_2PO_4. The concentrations of Iron, Zinc Calcium in the samples were determined using atomic absorption spectrophotometer (Pye Unicam UK, Model SP9).

2.2.5. Microbial Status of the Various Garri

Standard procedures of APHA (1992) were used to evaluate the microbial status of the various garri samples. Serially diluted samples were pour-plated on nutrient agar for total aerobic mesophilic count; on MacConkey for coliform count; on Sabauroud dextrose agar for yeast/mould count incubated at room temperature for 4-5 days; on Violet red broth for E.coli count; on Manitol salt agar for Staphylococcus aureus count. All were incubated at 37-40°C 48 h except agar for yeast/mould count. Colonies were counted using a digital colony counter and counts expressed as colony forming unit per gram (cfu/g).

2.2.6. Sensory Evaluation of the Various Garri

A fifteen- member panel consisting eight females and seven males, staff and students of the Department assessed the sensory attributes (taste, color, texture, aroma) of the raw garri and eba (thick garri dough) using a 9-point hedonic scale, where 1= represents extremely disliked 5= neither liked nor disliked, 9= like extremely. Coded samples were presented to the panelists during the two sessions of evaluation. Description of sensory attributes was provided as a guide to the test panelists. Texture was defined as the degree of softness or hardness/graininess felt on the fingers. Traditional untreated garri is cream-colored, yellow for red oil treated garri more delightful. Good garri has sour taste as a sign of appropriate length of fermentation and the aroma is not offensive. Overall acceptability is the extent of acceptance of the product comparable to others on the basis of the number of desirable attributes.

2.2.7. Statistical Analysis

Generated data were subjected to one way analysis of variance, means were separated using Duncan's multiple range test and significance was accepted at 5% probability. Statistical analysis was carried out using SPSS for Windows Version 16 (SPSS Inc., Chicago, USA) Results were presented as mean ± standard error of the mean.

3. RESULTS AND DISCUSSION

3.1. Proximate Composition of the Various Garri

The significant variations ($p<0.05$) were observed in the proximate compositions of the various garri Table 1. Moisture contents of the garri varied from 9.75 to 15.16%, significantly lower in the melon seed meal treated garri

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and CP+S garri, higher moisture in samples containing soybean meal than in melon seed meal (MS), perhaps due to higher oil contents of the MS. Untreated garri had equivalent moisture contents. Moisture content of fresh garri is a function of length of toasting, length of fermentation and age of the cassava roots used. Moisture contents reported were within the range of 5.59-17.09% reported by Ajifolokun and Adeniran (2018) while MS treated had moisture contents replica of those reported by Komolafe and Arawande (2010) for cassava garri and Agbara et al. (2018) for cassava-sweet potato garri.

The ash contents of incompletely peeled (IP) garri treated or not were enhanced, higher than those obtained from completely peeled (CP) roots. The same trend was observed for the crude fibre contents of the garri. This could only have originated from higher ash and fibre present in the cortex layer of the cassava roots that were not removed. The ash and crude fibre contents significantly varied from 1.88-2.51% and 2.28-3.45% respectively. The ash and crude fibre of the treated CP+IP garri were greater than others and CP garri had the least value. Olaoye, Lawrence, Cornelius, and Ihenetu (2015) reported ash content of 1.61-1.99% and crude fibre of 0.38-0.65% for garri produced from bitter and sweet cassava varieties, values smaller than ash and fibre contents reported in this study, however similar to the findings reported by Agbara and Ohaka (2018) for enriched garri from three different roots. The importance of dietary fibre intake has been emphasized elsewhere especially for regular bowel movement. Ash represents the mineral elements which are needed for electrolyte balance, proper functioning of enzymes involved in metabolic reactions and strengthening growth and maintenance of tissue. Surprisingly, the protein contents of IP garri (1.40%) was less than 1.70% for CP and 1.49% for CP+IP garri. The higher protein (5.94-9.71) and fat (1.79-3.53%) in treated garri could be traceable to the effect of oil seed meal supplementation because the untreated CP or IP had the least value of both protein and fat contents. A similar enhancement was reported by Bankole, Tanimola, Odunukan, and Samuel (2013) for cassava-bambara groundnut garri and Agbara et al. (2018) for sweet-potato soybean garri. The untreated garri CP or IP or CP+IP had greater carbohydrate contents, highest value was observed in the untreated CP garri (81.03%). The carbohydrate contents dropped significantly from 81.03% (CP) to 68.97% (CP+S), the latter had the highest amount of protein. The dietary energy (kcal) of various garri (329.42-359.37) were higher in garri fortified with oil seed meal, higher values were observed in those treated with MS containing equal amounts of CP and IP; the untreated CP and IP garri had the least value of dietary energy especially IP garri because of the smaller amounts of protein and fat and higher contents of dietary fibre. Bankole et al. (2013) similarly reported a drop in carbohydrate contents in cassava-bambara groundnut garri. The composition of garri like that of raw cassava roots depends on several factors including geographic location, age and variety and environmental conditions (Montagnac et al., 2009).

Table-1. Proximate composition of the differently processed garri samples.

Garri	Moisture	Ash	Protein	Fat	Fibre	CHO	Energy/ Kcal
CP (100%)	12.41±12.27b	1.88±0.05b	1.70±0.07^{e}	0.70±0.01^{e}	2.28±1.07^{c}	81.03±3.5a	337.852
IP (100%)	12.49±1.32^{b}	2.10±0.05^{ab}	1.40±0.09^{f}	1.34±0.00^{de}	3.41±0.19^{a}	77.94±4.4^{b}	329.42
CP+IP (50:50)	13.63±1.15^{b}	1.96±0.7^{b}	1.49±0.06^{f}	1.53±0.01^{d}	2.98±0.11^{b}	78.41±4.7^{b}	333.37
CP+S (90:10)	15.16±1.09^{a}	2.20±0.09^{ab}	9.71±0.02^{a}	1.79±0.00^{c}	2.17±0.06^{cd}	68.97±5.4^{f}	330.83
IP+S (90:10)	13.25±1.33^{b}	2.51±0.86^{a}	6.31±0.09^{c}	2.05±0.02^{bc}	3.45±0.010^{a}	72.43±4.6^{e}	333.41
CP+MS (90:10)	10.50±11.41^{c}	1.60±0.96^{c}	7.18±0.03^{bc}	2±.410.00^{b}	2.13±0.13^{cd}	76.18±3.8^{d}	359.37
IP+MS (90:10)	9.75±1.43^{d}	2.40±0.65^{a}	7.61±0.02^{b}	2.69±0.01^{b}	3.22±0.15^{ab}	74.33±4.6^{d}	351.97
CP+IP+S (50:40:10)	10.13±1.29^{c}	2.14±0.79^{ab}	6.48±0.04^{c}	3.01±0.01^{ab}	2.31±0.09^{c}	75.19±3.6^{d}	356.73
CP+IP+MS (40:50:10)	11.09±1.19^{c}	2.36±0.85^{a}	5.94±0.07^{d}	3.35±0.01^{a}	2.37±0.09^{c}	74.89±5.6^{d}	353.47

Note: Values are means of triplicate determination.
Mean within the same column with similar superscripts are not significantly different ($P<0.05$).
CP=100% completely peeled cassava.
IP= 100% incompletely peeled cassava.
CP+IP= Completely peeled and incompletely peeled cassava (50:50).
CP+S= Completely peeled cassava and soybeans (90:10).
IP+S = Incompletely peeled cassava and soybeans (90:10).
CP+MS= Completely peeled cassava and melon seed (90:10).
IP+MS= Incompletely peeled cassava and melon seed (90:10).
IP+CP+S= Incompletely peeled and completely peeled cassava and soybeans (40:50:10).
CP+IP+MS= Completely peeled and Incompletely peeled cassava and melon seed (40:50:10).

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3.2. Mineral Profile of the Various Garri

There were significant variations in the concentration of the elements present in the various garri Table 2. The most abundant element was calcium (43-87mg/100g) and CP or IP garri had the least concentration and the S or MS supplemented garri the highest calcium levels especially IP+ MS and CP+S garri. The next element with higher concentration after calcium was potassium (14.8-34mg/100g), IP garri had the highest concentration of K and CP+MS the least; there were enhancement of K in all garri containing IP cassava root, however soybean or melon seed supplemented IP or CP or CP+IP garri had enhanced levels of Potassium (K) which were not significantly different among them. Phosphorous content varied from 3.45mg/100g in IP+S to 0.72mg/100g in IP+MS levels in the various garri were greater in IP garri or S supplemented IP garri than in CP. The Iron contents of CP (0.36mg/100g) or IP (0.38mg/100g), treated with soybean meals was the smallest, smaller than the quantity of Iron in CP garri(0.7mg/100g) or IP garri(0.91mg/100g) treated with Melon seed meal. The increasing order of Iron and Zinc concentrations in various garri was CP+S< IP+S<IP<CP+IP+MS<CP+MS<CP+MS+S<IP+MS<CP+IP<CP. The iron and zinc contents were greater in the completely peeled garri while calcium, phosphorous were observed to be greater in the incompletely peeled (IP) garri. The concentrations of mineral elements observed in this study were smaller than those reported by Olaoye et al. (2015) for garri from bitter and sweet cassava varieties but greater than those reported by Bamidele, Ogundele, Ojubanire, Fasogbon, and Bello (2014) for cassava-cocoyam garri analogue indicating the influence of cassava root age, variety, geographic location on the mineral composition in addition to leaching that occurred during the dewatering, fermentation process. However, the two seed meals (MS and S) enhanced the mineral contents of the garri in different degrees. Ajifolokun and Adeniran (2018) similarly observed the same trend in cassava-breadfruit garri.

Table-2. Mineral contents (mg/100g) of the different types of processed garri.

Garri	Ca	P	Fe	Zn	K
CP (100%)	45±7.13^{f}	2.03±.03^{cd}	1.40±0.01^{a}	1.82±0.17^{a}	17±7.94^{c}
IP (100%)	48±7.05^{e}	2.72±.03^{b}	0.60±0.04^{c}	0.84±0.10^{c}	34±3.54^{a}
CP+IP (50:50)	43±7.24^{f}	1.54±.03^{d}	0.94±0.04^{b}	1.22±0.21^{b}	15±8.44^{cd}
CP+S (90:10)	36±8.25^{g}	0.82±0.09^{g}	0.36±0.07^{d}	0.47±0.09^{d}	23±6.24^{bc}
IP+S (90+10)	57±6.05^{c}	3.45±.01^{a}	0.38±0.07^{d}	0.55±0.05^{d}	22±7.54^{bc}
CP+MS (90:10)	55±6.08^{d}	2.65±.03^{bc}	0.17±0.09^{e}	0.93±0.10^{c}	14.8±8.54^{cd}
IP+MS (90:10)	87±3.36^{a}	0.72±.08^{g}	0.91±0.04^{b}	1.21±0.13^{b}	22±7.54^{bc}
IP+CP+S (40:50:10)	66±4.56^{b}	2.18±.03^{c}	0.72±0.04^{c}	0.97±0.15^{c}	25±6.54^{b}
CP+IP+MS (40:50:10)	58±5.98^{c}	0.85±0.06^{g}	0.18±0.09^{e}	0.88±0.11^{c}	26±6.44^{b}

Note: Values are means of triplicate determinations.
Mean within the same column with similar superscripts are not significantly different ($P<0.05$).
CP=100% completely peeled cassava.
IP= 100% incompletely peeled cassava.
CP+IP= Completely peeled and incompletely peeled cassava (50:50).
CP+S= Completely peeled cassava and soybeans (90:10).
IP+S = Incompletely peeled cassava and soybeans (90:10).
CP+MS= Completely peeled cassava and melon seed (90:10).
IP+MS= Incompletely peeled cassava and melon seed (90:10).
IP+CP+S= Incompletely peeled and completely peeled cassava and soybeans (40:50:10).
CP+IP+MS= Completely peeled and Incompletely peeled cassava and melon seed (40:50:10).

3.3. Microbiological Status of the Various Garri

The microbiological quality of the various garri packaged in low density polythene bags and left at room temperature are given in Table 3. The aerobic mesophilic bacteria counts (39-83cfu/g), yeast mould counts (9-65cfu/g), coliform counts (03-31cfu/g), staphylococcus aureus counts (10-42cfu/g) on the various alga did not indicate any health hazard because the microbial load observed were far below the recommended standards for ready-to-eat foods. E coli were not detected in seven of garri types. The negligible quantities of microbes observed could only have risen from post-toasting contamination from contact surfaces. Although total aerobic counts were far below the permissible limit of (10^{4}cfu/g) ICMSF (1996) however bacteria can only be involved in the spoilage of

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food stuff only when higher moisture condition exists and to prevent spoilage by storage fungi, the moisture content of garri or any starchy food should be stored at moisture content below 14%. E. coli were observed in two garri samples IC+CP+S and CP+S both soybean meal treated their presence were undesirable and indicate poor hygienic conditions or inadequate heat treatment; levels exceeding 10^2cfu/g are unacceptable and is a pointer to possible presence of pathogens ICMSF (1996) Coliform may include virulent thermostable and enterotoxigenic strains of E.coli (Anigo, Ameh, Ibrahim, & Danbauchi, 2007) and their presence indicate fecal contamination of domestic water supply. Staphylococcus aureus presence could only have arisen from handling since this bacteria is a natural flora of humans, however the near absence of E.coli in the garri samples except two indicates proper hygienic conditions were maintained in all the unit operations involved in garri production as well as adequate heating temperature during toasting which ensured the near-zero absence of staphylococcus aureus, E.coli and coliform. This is important in view of the fact that most Nigerians prefer to soak garri with cold water and other food items as a popular beverage during dry hot season.

Table-3. Microbial status (cfu/g) of the differently processed garri samples.

Garri	Aerobic Mesophilic Bacteria	Fungi/ Mould	E.coli	Coliform	Staphylococcus aureus
CP (100%)	60±6.32^{a}	19±1.50^{bcd}	NG	3±0.00c^{d}	10±1.54^{a}
IP (100%)	80±4.28^{a}	9±2.45^{cd}	NG	4±0.00^{bcd}	30±3.43^{a}
CP+IP (50:50)	74±4.56^{a}	2±1.00^{d}	NG	NG	32±3.54^{a}
CP +S (90:10)	54±3.41^{a}	34±1.80^{abcd}	21±0.55^{a}	28±2.25^{ab}	42±6.52^{a}
IP+S (90+10)	48±3.27^{a}	16±1.7^{abcd}	NG	24±2.55^{abc}	25±3.35^{a}
CP+MS (90+10)	39±4.29^{a}	39±4.9^{abcd}	NG	22±2.33^{abcd}	31±4.10^{a}
IP+MS (90+10)	83±2.19^{a}	57±8.3^{ab}	NG	30±2.47^{a}	42±5.20^{a}
IP+CP+S(40:50:10)	75±3.46^{a}	52±7.45^{abc}	3±0.00^{b}	26±2.45^{ab}	38±4.25^{a}
CP+IP+MS (40+50+10)	53±3.79^{a}	65±9.75^{a}	NG	31±1.33^{a}	16±2.50^{a}

Note: Values are means of triplicate determinations; NG=No growth.
Mean values within the same column with similar superscripts are not significantly different(p>0.05).
CP=100% completely peeled cassava.
IP= 100% incompletely peeled cassava.
CP+IP= Completely peeled and incompletely peeled cassava (50:50).
CP+S= Completely peeled cassava and soybeans (90:10).
IP+S = Incompletely peeled cassava and soybeans (90:10).
CP+MS= Completely peeled cassava and melon seed (90:10).
IP+MS= Incompletely peeled cassava and melon seed (90:10).
IP+CP+S= Incompletely peeled and completely peeled cassava and soybeans (40:50:10).
CP+IP+MS= Completely peeled and Incompletely peeled cassava and melon seed (40:50:10).

3.4. Functional Properties of the Differently Processed Garri Samples

Significant variations (P<0.05) were observed in the water absorption capacity and swelling power of the various garri, Table 4. The control (CP) had the highest water absorption capacity (WAC) (451%) followed by 50:50 CP+IP (403.97%). Those treated with seed meal had the least WAC especially those treated with MS, because of its higher fat content which restricts either water absorption, although it was expected that higher fibrous material content in IP would lead to higher water absorptions since higher WAC is a desirable index of good quality garri for consumers and WAC is said to correlates positively with extent of hydrophilic groups present on protein and carbohydrate molecules. Agbara et al. (2018) reported depressing effect of soybean supplementation on the water absorption and swelling power of sweet potato-soybean. Bankole et al. (2013) similarly reported for cassava-bambara groundnut. There were no significant variation (P<0.05) in the swelling indices(S I) of the various garri (5.18-6.20ml/g) but numerically the untreated garri had higher SI than the treated ones. Generally the S I of the various were high (4.00-5.90ml/g); swelling power is a measure of the cohesive force within the starch granules as they imbibe water, the presence of fat restricts swelling as observed in the lower swelling indices of the garri treated with S or MS seed meal. Komolafe and Arawande (2010) reported S I of 2.15-4.15ml/g for garri made from three cassava varieties; Achinewhu, Barber, and Ijeoma (1998) reported S I of 223.5-364.0% smaller than S I of 4.00-5.90 obtained in this study. Extent of starch gelatinization is a function of toasting

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time. A good garri according to IITA. (1989) and Sanni, Odukogbe, and Faborode (2016) should swell three times its original weight. No significant variation (P<0.05) existed in the cyanide content of the various garri (0.11-0.35mg/100g), however numerically IP garri treated or not had marginally higher levels of cyanide. The variety of cassava roots used for this study were the chewable type among the locals therefore assumed to be sweet type ; moreover three-day fermentation and the rigorous thermal dehydration that followed were enough to detoxify the garri of cyanide. Higher levels of cyanide was reported by Achinewhu et al. (1998) 1.1 -1.5mg/100g cyanide in garri produced from selected cassava cultivars in River State Nigeria; Komolafe and Arawande (2010) reported 1.36-2.15mg/100g for garri from three cassava cultivars, still higher than 0.016-0.073mg/kg reported by Tope, Oseni, and Taiwo (2017). IITA. (1989) recommends 2-3mg of cyanide as per 100g of garri as acceptable; recommended safe level of cyanide is 100mg/kg FAO. WHO (1999). The P^H range of the various garri was 4.84-5.90 Table 2, the P^H levels of CP, IP and CP+IP were significantly not different, and more acidic (sour) and the P^H of the treated garri were higher i.e. less acidic especially soybean meal treated garri. Fermentation of the cassava mash leads to production of organic acids which are responsible for the sour nature of a good garri, therefore regarded as a quality indicator. P^H values obtained in this study were higher than 3.4-4.0 reported by Achinewhu et al. (1998) but similar to 4.65-5.69 reported by Koubala, Kansci, Enome, Ndjidda, and Essame (2014) for sweet potato garri.

Table-4. Functional properties of the differently processed garri samples.

Garri	Water Absorption Capacity (%)	Swelling Index (ml/g)	P^H	Cyanide(HCN) mg/100g
CP (100%)	451.09 ± 19.5^a	5.78 ± 1.12^a	4.76 ± 1.40^a	0.25^a
IP (100%)	388.27 ± 14.5^c	5.90 ± 1.13^a	4.78 ± 1.40^a	0.33^a
CP+IP (50:50)	403.97 ± 11.0^b	5.76 ± 1.14^a	4.85 ± 1.42^a	0.34^a
CP+S (90:10)	223.20 ± 12.5^g	4.57 ± 1.09^b	5.15 ± 1.94^a	0.15^a
IP+S (90:10)	346.84 ± 16.7^d	4.26 ± 1.06^{ab}	5.15 ± 1.68^a	0.22^a
CP+MS (90:10)	331.93 ± 12.3^e	4.21 ± 1.05^{ab}	4.98 ± 1.45^a	0.31^a
IP+MS (90:10)	303.76 ± 14.2^f	4.18 ± 1.04^{ab}	5.02 ± 1.52^a	0.20^a
IP+CP+S (40:50:10)	329.09 ± 13.4^e	4.20 ± 1.03^{ab}	4.84 ± 1.41^a	0.17^a
CP+IP+MS (40:50:10)	330.06 ± 14.5^e	4.00 ± 1.04^{ab}	4.94 ± 1.40^a	0.11^a

Note: Values are means of triplicate determinations.
Mean within the same column with similar superscripts are not significantly different (P<0.05).
CP=100% completely peeled cassava.
IP= 100% incompletely peeled cassava.
CP+IP= Completely peeled and incompletely peeled cassava (50:50).
CP+S= Completely peeled cassava and soybeans (90:10).
IP+S = Incompletely peeled cassava and soybeans (90:10).
CP+MS= Completely peeled cassava and melon seed (90:10).
IP+MS= Incompletely peeled cassava and melon seed (90:10).
IP+CP+S= Incompletely peeled and completely peeled cassava and soybeans (40:50:10).
CP+IP+MS=Completely peeled and Incompletely peeled cassava and melon seed (40:50:10).

3.5. Sensory Attributes of Eba (Stiff Dough)

Sensory attributes of *eba* as presented in Table 5 shows no clear cut difference in the Color (6.30-7.90), Aroma (5.50-7.30), Taste (5.70-7.30), Texture (5.20-6.60) and acceptance level (6.10-7.90) of the differently processed eba on a 9-point hedonic scale. The color, aroma, taste, overall acceptability were equally liked with CP and CP+S garri having the highest scores. The IP eba or treated IP eba had poorer texture expectedly because of higher fibre content which made them to have softer textures which stick to the fingers during molding, therefore smaller amount of hot water will be required for preparing IP or IP treated eba. Also, the taste of IP or IP treated eba received lower scores, still were accepted. Overall acceptability sores of all the eba were high especially CP and CP+S eba. Some individuals prefer consuming soaked garri especially during the hot season of the year as a refreshing beverage, the sensory scores of sugar sweeten cold water soaked garri is presented in Table 6. The color, taste, texture, aroma of soaked garri were equally appreciated by the test panellists, the texture (mouthfeel) of all the soaked garri equally received poor rating for unknown reason and the overall acceptability scores were equally high. Generally all the differently processed garri were accepted either as eba or soaked garri.

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Table-5. Scores of the sensory evaluation of differently processed eba (garri dough).

Garri	Color	Aroma	Taste	Texture	Overall Acceptability
CP (100%)	7.70±0.78a	7.20±0.68a	7.30±10.89a	6.60±0.69a	7.70±0.56a
IP (100%)	6.10±0.87a	6.40±0.58a	6.10±10.56a	5.90±0.47a	6.10±0.53a
CP+IP (50:50)	6.60±0.68a	6.40±0.65a	5.70±10.45a	4.30±0.79a	6.60±0.57a
CP+S (90:10)	7.90±0.78a	7.30±0.78a	7.10±10.88a	5.40±0.32a	7.90±0.68a
IP+S (90:10)	6.30±0.86a	6.30±0.56a	6.70±10.86a	5.50±0.54a	6.30±0.67a
CP+MS (90:10)	6.80±0.84a	6.60±0.67a	6.60±10.89a	6.30±0.65a	6.60±0.65a
IP+MS (90:10)	6.50±0.83a	6.40±0.66a	6.10±10.83a	5.20±0.79a	6.50±0.67a
IP+CP+S (40:50:10)	6.67±0.81a	7.10±0.78a	7.30±10.88a	6.40±0.69a	6.60±0.67a
CP+IP+MS (40:50:10)	6.82±0.88a	5.50±0.45a	6.80±10.80a	5.60±0.49a	6.90±0.72a

Note: Values are means of triplicate determinations.
Mean within the same column with similar superscripts are not significantly different (P<0.05).
CP=100% completely peeled cassava.
IP= 100% incompletely peeled cassava.
CP+IP= Completely peeled and incompletely peeled cassava (50:50).
CP+S= Completely peeled cassava and soybeans (90:10).
IP+S = Incompletely peeled cassava and soybeans (90:10).
CP+MS= Completely peeled cassava and melon seed (90:10).
IP+MS= Incompletely peeled cassava and melon seed (90:10).
IP+CP+S= Incompletely peeled and completely peeled cassava and soybeans (40:50:10).
CP+IP+MS= Completely peeled and Incompletely peeled cassava and melon seed (40:50:10).

Table-6. Scores evaluation of sweeten cold water soaked garri differently processed.

Garri	Color	Aroma	Taste	Texture	Overall Acceptability
CP (100%)	7.60±0.78a	7.20±a0.76a	6.70±0.77a	5.60±0.48a	7.00±0.80a
IP (100%)	6.60±0.68a	5.60±0.45a	5.60±0.47a	5.30±0.47a	6.40±0.74a
CP+IP (50:50)	7.30±0.78a	6.50±0.56a	6.60±0.63a	6.30±0.57a	6.60±0.78a
CP+S (90+10)	7.60±0.78a	6.60±0.77a	7.00±0.84a	5.80±0.67a	7.30±0.84a
IP+S (90+10)	6.40±0.67a	5.60±0.46a	6.40±0.65a	6.60±0.77a	610±0.71a
CP+MS (90+10)	6.60±0.68a	6.00±0.56a	6.40±0.56a	5.50±0.57a	7.10±0.82a
IP+MS (90+10)	6.30±0.58a	6.40±0.56a	6.60±0.67a	5.50±0.65a	6.10±0.70a
IP+CP+S (40:50:10)	6.50±0.48a	6.20±0.66a	6.40±0.77a	5.50±0.68a	6.60±0.73a
CP+IP+MS (40:50:10)	6.30±0.68a	6.60±0.76a	5.70±0.87a	5.70±0.57a	6.30±0.72a

Note: Values are means of triplicate determinations.
Mean within the same column with similar superscripts are not significantly different (P<0.05).
CP=100% completely peeled cassava.
IP= 100% incompletely peeled cassava.
CP+IP= Completely peeled and incompletely peeled cassava (50:50).
CP+S= Completely peeled cassava and soybeans (90:10).
IP+S = Incompletely peeled cassava and soybeans (90:10).
CP+MS= Completely peeled cassava and melon seed (90:10).
IP+MS= Incompletely peeled cassava and melon seed (90:10).
IP+CP+S= Incompletely peeled and completely peeled cassava and soybeans (40:50:10).
CP+IP+MS= Completely peeled and Incompletely peeled cassava and melon seed (40:50:10).

4. CONCLUSION

Soybean and melon seed meals (100%) were used to fortify completely or incompletely peeled cassava roots and garri were produced from the mashes. The ash, fibre, fat and protein contents of the treated garri were improved especially in incompletely peeled garri, 10% level of fortification with seed meal did not affect either the traditionally appreciated sensory attributes of eba (garri dough) and instead the water absorption and swelling capacities were improved. The slightly acidic garri had cyanide levels that were lower than previous studies, although cyanide levels of IP garri treated or not were insignificantly higher. The dominant mineral elements in the various garri in increasing order were Ca>K>P>Zn>Fe with IP garri treated or not having higher concentrations of the elements. Microbiological quality although insignificantly low yet E.coli were detected in two samples.

The take home message is garri produced from incompletely peeled cassava roots had improved proximate composition and mineral contents, yet the functional and sensory properties were not negatively affected. Environmental pollution caused by cassava peels which yet have not found alternative use would be reduced if this study is commercially applied.

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