Production and Quality Evaluation of Cookie-Like Products Formulated From Blends of Wheat Flour and Garri from Biofortified Cassava Varieties.

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Abstract
Yellow cassava roots of three varieties namely Umucass 36, 37 and 38 were processed into garri and blended with wheat flour for production of cookie-like products. Chemical, functional, phytochemicals, β-carotene, microbial and organoleptic attributes of the cookie-like products were also evaluated using standard methods. Cookies produced from 100% wheat flour were used as the control. Moisture content values of the cookie-like products were found to be in the range of 8.07% to 9.67% against the control value of 10.69%. Protein contents of the cookie-like products ranged from 6.05% to 13.05% the control value of 14.64%. The crude fat contents of the cookie-like products ranged from 4.01% to 6.85% against the control value of 3.83%. Crude fibre contents of the cookie-like products ranged from 1.47% to 1.61% against the control value of 1.64%. Ash contents of the products ranged from 1.24% to 1.37% against the control value of 1.23%. The carbohydrate contents of the formulated cookies ranged from 70.26% to 77.09% against the control value of 60.74%. Beta carotene values of the cookie-like products ranged from 0.90µ/g to 6.97µg/g against the control value of 0.15 µg/g. Phytochemical analysis recorded tannins contents of the cookie-like products within the range of 0.81% to 1.05% against the control value of 0.03%, saponin 0.510 mg/100g to 0.865 mg/100g against the control value of 0.425 mg/100g, trypsin inhibitor from 0.45 mg/100g to1.56 mg/100g against the control value of 0.43 mg/100g, alkaloids 0.140% to 0.460% against the control value of 0.055% and hydrogen cyanide 0.13 mg/kg to 0.460 mg/kg against the control value of 0.055 mg/kg. The total microbial load on the nutrient agar ranged from 0.2.10 x 10^3 to 0.25 x 10^3 cfu/g. The total fungi load on the Potatoes Dextrose Agar of samples was 0.10 x 10^3cfu/g. The sensory results showed that the control cookies scored highest (8.00) in terms of appearance, taste (8.00) aroma (6.78) and overall acceptability (8.00) while the cookie-like products scored highest in texture (4.78 - 7.00) and crispness (4.78 to 7.00).

Keywords: *Cookie-like Products, beta-carotene, proximate, anti-nutrients, microbial load, sensory attributes.*

Introduction

Cookies are one of the popular cereal foods apart from bread, consumed in Nigeria. They are baked products that are readily available, cheap, containing digestive and dietary substances of nutritional importance (Olaoye *et al*., 2007). They are usually consumed in most parts of the world and are mostly seen as the largest category of snacks foods (Lorenz, 1983). In

United States and Canada, cookies are small, round and flat cakes commonly called biscuits (Ubbor and Akobundu, 2009). Cookies which are ready-to-eat snacks are popular especially among children in Nigeria and other countries (Addo *et al*., 1987). Report by Anyika and Uwaegbute (2005) indicated that there is increasing tendency among Nigerian children and adolescents to adopt dietary habits of eating snacks like cookies. In Nigeria, ready-to-eat baked products (snacks) consumption is continually growing and there has been increasing reliance on imported wheat (Akpapunam and Darbe, 1994). Staple crops grown in Nigeria include cassava, yam, sweet potatoes and cereals that can be used for bakery foods other than wheat.

Cassava is a woody shrub, which belongs to the genus *Manihot* of the family of *euphorbiacae* (Omah and Okafor, 2015). Cassava (*Manihot* esculenta crantz) root is long and tapered with a firm homogenous flesh encased in a detachable rind, about 1mm thick, rough and brown on the outside. Cassava roots play an important role in the African diet and they are processed using simple traditional methods into products such as *garri*, *fufu*, chips, tapioca (*abacha*), *lafun*, flour, among others (Odunfa, 1985). These processing methods such as peeling, washing, grating, fermenting and toasting reduces the hydrogen cyanide and other anti-nutrients to a safe level (Omah and Okafor, 2015).

Recently biofortified varieties of cassava that contain significant levels of provitamin A carotenoids (pVACs) have been developed by conventional plant breeding methods and introduced for use by the local populations. These biofortified varieties could be used to help tackle vitamin A deficiency (VAD) (Saltzman *et al*., 2013), an important public health problem in sub-Saharan Africa and in the world. These biofortified varieties produce garri that is very similar in colour to garri made with added palm oil (Abu *et al*., 2006).
Carotenoids are yellow to red natural colour pigments found in plants and vegetables (Mortensen, 2006). Alpha carotene, β-carotene, β-cryptoxanthin, lutein, lycopene, and zeaxanthin are the most common dietary carotenoids. Alpha carotene, β-carotene and β-cryptoxanthin are provitamin A carotenoids, they can be converted by the body to retinol (Rasaki and Abimbola, 2009). Lutein, lycopene, and zeaxanthin cannot be converted to retinol because (Ayasan and Karakozak, 2010) because they have no vitamin A activity.

Composite flour can be described as a mixture of several flours either from roots, tubers, and cereals, legumes with or without the addition of wheat flour (Adeyemi and Ogazi, 1985). Traditionally, cookies are produced from wheat flour but could be produced from cassava flour and other composites (Cock, 1985; Oyewole *et al*., 1996). During the preparation of cookie-like product instead of wheat flour in the original formula, garri is blended with the wheat flour, margarine, beaten whole egg, granulated sugar, powdered milk and baking powder. The production of cookie- like products using composite flours of various levels of garri made from different biofortified cassava roots would not only help in tackling vitamin A deficiency but will also increase menu varieties of garri. It would therefore be economically advantageous if imported wheat could be reduced or even eliminated and the demand for baked foods such as cookies could be met by the use of domestically grown products other than wheat. This study focuses on developing pro-vitamin A rich cookie- like products from composite flours of wheat and garri, evaluating their proximate compositions, organoleptic acceptability and evaluating the total carotenoid in the cookie-like products.

Materials and Methods

Sample Procurement

Fresh roots of cassava varieties (UMUCASS 36 (TMS 01/1368), UMUCASS 37 (TMS

01/1412) and UMUCASS 38 (TMS 01/1371) were obtained from National Root Crops Research Institute (NRCRI), Umudike in Abia State, Nigeria and were properly identified by Cassava Programme Unit in National Root Crops Research Institute (NRCRI), Umudike.

Garri Production

For the garri production the methods of Sanni (2001) and Onuorah *et al.* (2004) were adopted with slight modifications (Fig. 1).

Fresh yellow cassava roots
↓
Washing
↓
Peeling
↓
Washing
↓
Grating
↓
Dewatering/Fermenting (3days)
↓
Sifting (with a manual woven sieve)
↓
Toasting (80^{0}C for 15 min)
↓
Sifting (20µm, 40µm and <40µm)
↓
Garri granules

Packaging and sealing

Fig. 1: Flow diagram for processing of cassava tubers into garri

Particle Size Analysis: One hundred grammes of each of the garri samples were placed on the topmost sieve of an Endicott sieve shaker and were vibrated for 10 minutes. Siftings of 20, 40 and > 40 µm were collected separately and the finest (20 µm) was used for the production of cookie-like products (Nwancho *et al*., 2014).

Formulation of composites flour: Composite flours of different proportions of garri and wheat were formulated as shown in Table 1. For each of the sieved garri samples a digital weighing balance and a blender (Philip, HR1702) were used for weighing and mixing the composite flours respectively.

Table 1: Composite flour blends

Blends	Gari flour	Wheat flour
Gari flour	100	–
Gari: Wheat 1	80	20
Gari: Wheat 2	60	40
Gari: Wheat 3	50	50
Gari: Wheat 4	40	60
Gari: Wheat 5	20	80
Wheat flour	–	100

Functional properties of the composite flours

The method described by Ukpabi and Ndimele (1990) was used for the determination of swelling capacity, Oil absorption capacity was determined using the methods described by (Eneche, 1999), bulk density and water absorption capacity was determined using standard methods of (AOAC, 1990).

Preparation of cookie-like products from composite flour

The cookie-like products of different blends (garri and wheat at different ratios) were prepared using the method of Nishiber and Kawakishi (1990) with slight modifications (Figure 4). Instead of glucose and butter in the original formula, granulated sugar and margarine were used in this preparation. The cookie-like product formulation (Table 1) include, garri (50 g), wheat flour (50 g), margarine (20 g), whole egg (10 g), powdered milk (20 g), sugar (10 g), salt (0.5 g) and baking powder (0.5 g). These were manually mixed inside a bowl (1000 cm^3) because the quantity of mixture was too small to use a laboratory mixer. Margarine and beaten whole egg were creamed for 60 sec. The batter were shaped and baked in an oven at 180^0C for 12 minutes. Cookies prepared from wheat flour were used as the control. They were allowed to cool, packaged in small transparent plastic bowls.

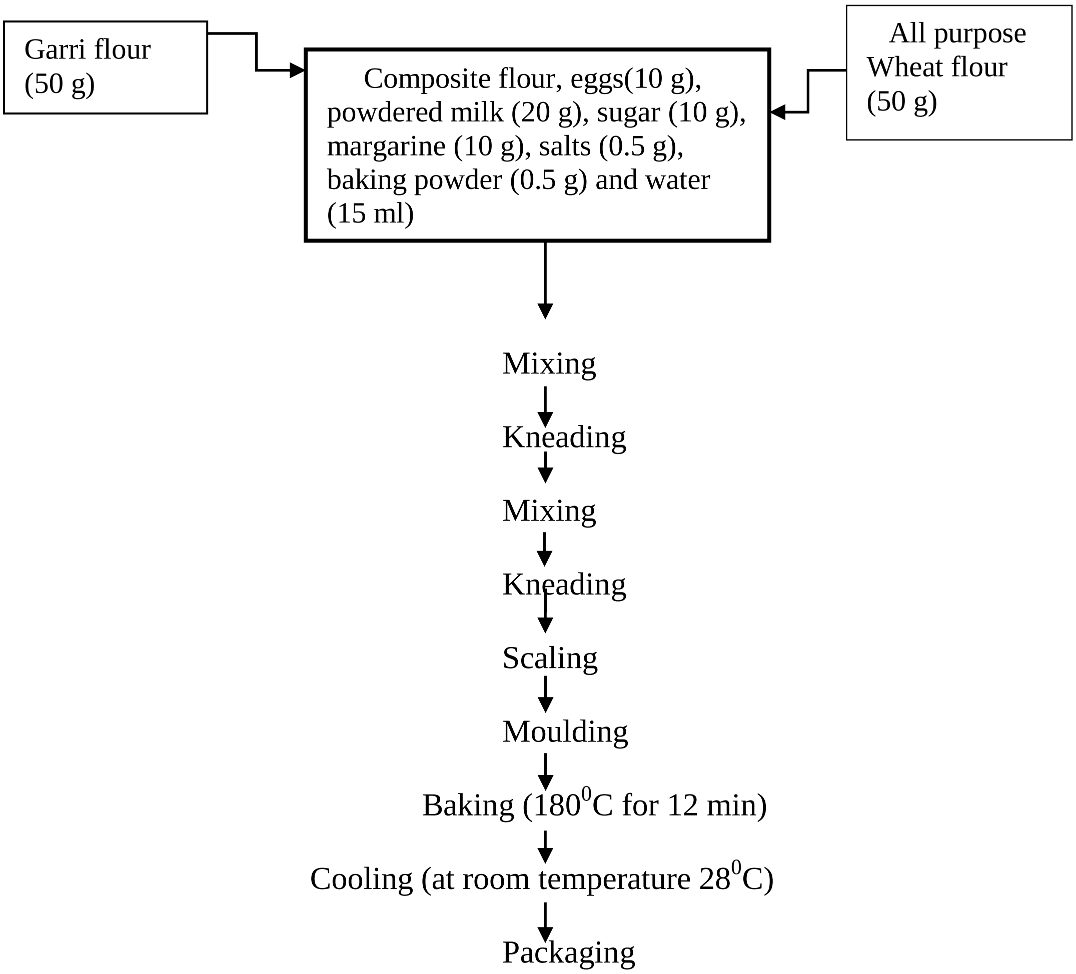

Fig.2: Flow chart for production of cookie-like product.

Sensory evaluation of the cookie-like products

The organoleptic evaluation of the cookie samples was carried out for consumer acceptance and preference by a test panel of 20 judges (staff and students of the Department of the Food Science and Technology, Michael Okpara University of Agriculture Umudike Abia State in Nigeria). The cookie-like products were evaluated for quality attributes such as appearance, taste, texture, aroma, crispness and overall acceptability using Hedonic scale as described by Olapade and Adeyemo (2014) where like extremely = 9, like very much = 8, like moderately = 7, like slight = 6, neither like nor dislike = 5, dislike slightly = 4, dislike moderately = 3, dislike very much = 2 and dislike extremely = 1.

Proximate analysis: Moisture, crude protein, fat, fibre and ash contents were determined using the methods of AOAC (1990). Carbohydrate was determined by difference as described Pearson (1976).

Phytochemical analysis

Cyanide determination was carried out using acid titration method (AOAC, 1990),
Tannin content was determined by the Folin-Dennis spectrophotometer method described by Pearson, (1976). Gravimetric method (Harbone, 1973) was adopted for the determination of alkaloid, saponin was determined using the methods described by Hanzah *et al*. (2014) and trypsin inhibitor was determined using the methods described Prokopet and Unlenbruck,

2002.
Microbiological analysis was carried out according to the method described by Jideani (2006).

Statistical analysis

The result (data) obtained were analysed using one way analysis of variance (ANOVA) to test for significant difference between blends at 5% level of significance ($p < 0.05$). Meanwhile, appropriate statistical package minitab version 17 was used to aid the data analysis.

Results and Discussion

Functional properties of flour blends

The functional properties of the flour blends are presented in Table 2. The bulk density of the samples ranged from 0.53 to 0.63 g/cm^3 against the control 0.67 g/cm^3. Although there were variations in the bulk density values of the flour blends but there were not significantly different at ($P > 0.05$). The bulk density of a food material is important in relation to its packaging (Coffmann and Garcia, 1972). Increase in bulk density is desirable, in that it offers greater packaging advantage as greater quantity may be packed within constant volume (Ubbor and Akobundu 2009). The water absorption capacities of the blends were between 133.31% to 145% against the control 138%. The values were generally high. Water absorption capacity is the ability of a product to associate with water under limiting conditions (Akpata and Akubor, 1999). It has been suggested that flours with such high water absorption capacity as seen in this study will be very useful in bakery products, as this could prevent staling by reducing moisture loss. The oil absorption capacities of the flour blends were generally high. The values ranged from 150% to 160% in the composite flour blends against the control 174%. Oil absorption capacity (OAC) is the ability of flour to absorb oil, which is important as oil acts as flavor retainer and improves mouth feel (Onimawo *et al*., 2001). The high OAC suggests the lipophilic nature of the constituents of the flour (Ubbor and Akobundu, 2009), and this suggests that the blends are potentially useful in structural interaction in food especially in flavor retention, improvement of palatability, and extension of shelf life of bakery or meat products, doughnuts, baked goods, pan cakes, and soup mixes where fat absorption is desired (Narayanna and NarsingaRao, 1982).The swelling index of the composite flour blends was found in the range from 48.85 to 52.21% against the control blend 54.65%. There were significant ($p<0.05$) differences between them.

Table 2: Functional properties of the flour blends

Variety	Parameter	100% Garri	80:20 Garri : Wheat	60:40 Garri : Wheat	50:50 Garri : Wheat	40:60 Garri:Wheat	20:80 Garri : Wheat
	Bulk density (g/cm^3)						
Umucass 36	”	0.53[a]	0.55[a]	0.55[a]	0.57[a]	0.57[a]	0.59[a]
" 37	”	0.57[a]	0.55[a]	0.56[a]	0.56[a]	0.58[a]	0.58[a]
" 38	”	0.59[a]	0.61[a]	0.61[a]	0.61[a]	0.63[a]	0.63[a]
wheat	”	0.67[a]	0.67[a]	0.67[a]	0.67[a]	0.67[a]	0.67[a]
	Swelling capacity (%)						
Umucass 36	”	50.04[b]	50.00[b]	48.89[b]	48.85[b]	48.80[b]	48.76[b]
" 37	”	50.09[b]	50.07[b]	50.00[b]	49.00[b]	49.00[b]	48.86[b]
" 38	”	52.21[a]	52.18[a]	52.15[a]	52.10[a]	52.05[a]	52.00[a]
wheat	”	54.65[a]	54.65[a]	54.65[a]	54.65[a]	54.65[a]	54.65[a]
	WAC (%)						
Umucass 36	”	133.1[a]	133.5[b]	134[b]	137[a]	139[a]	141[a]
" 37	”	134[a]	136[a]	136[a]	138[a]	140[a]	143[a]
" 38	”	134.6[a]	136[a]	137[a]	140[a]	140[a]	145[a]
wheat	”	138[a]	138[a]	138[a]	138[a]	138[a]	138[a]
	OAC (%)						
Umucass 36	”	151[b]	154[b]	156[b]	158[b]	158[b]	158[b]
" 37	”	150[b]	153[b]	157[b]	159[b]	160[b]	160[b]
" 38	”	152[b]	154[b]	155[b]	157[b]	160[b]	160[b]
wheat	”	174[a]	174[a]	174[a]	174[a]	174[a]	174[a]
	”						

Mean values with different superscripts within the row are significantly ($p < 0.05$) different.

WAC (%) = Water absorption capacity, OAC (%) = Oil absorption capacity

Table 3: Phytochemical profile of the raw materials (3 garri samples from Umucass 36, 37, 38 and wheat flour

	Tannins (%)	Saponin (mg/100g)	Trypsin inhibitor (mg/100g)	HCN (mg/kg)	Akaloids (%)
Umucass 36	$6.54^{a} \pm 0.70$	$1.21^{b} \pm 0.02$	$3.77^{a} \pm 0.01$	$9.21^{a} \pm 0.01$	$2.33^{a} \pm 0.01$
Umucass 37	$7.10^{a} \pm 0.01$	$1.57^{a} \pm 0.01$	$3.44^{b} \pm 0.01$	$6.17^{b} \pm 0.02$	$2.11^{a} \pm 0.01$
Umucass 38	$7.14^{a} \pm 0.01$	$1.34^{a} \pm 0.01$	$3.42^{b} \pm 0.01$	$6.14^{b} \pm 0.01$	$2.00^{a} \pm 0.01$
Wheat flour	$5.05^{b} \pm 0.02$	$1.05^{b} \pm 0.01$	$3.42^{b} \pm 0.01$	$1.12^{c} \pm 0.01$	$1.08^{b} \pm 0.01$

Mean values with different superscripts in the column are significantly ($P < 0.05$) different.

Selected anti-nutrients in the flour samples are shown in Table 3. Significant ($p < 0.05$) differences were observed in the entire antinutrients determined. Fermentation and drying processes reduced the antinutrient levels of the flour to safe levels. Hydrogen cyanide levels ranged from 6.14mg/kg to 9.21mg/kg against the wheat flour which recorded 1.12mg/kg. Cassava processing which involves grating, fermentation and toasting have been reported to lower total cyanide in fresh peeled roots (Akindahunsi *et al*., 1999). According to Onuwka (2005) the toxic level of cyanide is an intake above 20 mg per 100 g. Hydrogen cyanide level of garri samples observed in this study were close to the value (9.85%) obtained by Anuonye *et al*. (2012) for pigeon pea and unripe plantain blend.

Tannin levels ranged from 6.54% to 7.14% in garri samples against the wheat flour which recorded 5.05%. These levels were found to be lower than 0.98% reported by Anuonye *et al*. (2012) for pigeon pea and unripe plantain blend. Saponins levels ranged from 1.21mg/100g to 1.54mg/100g in garri samples against the wheat flour of 1.05mg/100g. Trypsin inhibitor contents ranged from 3.42 to 3.77mg/100g. There were no significant ($p>0.05$) differences between the garri sample from Umucass 37 and Umucass 38. Alkaloids content val.ues of the wheat flour was the lowest.

Table 4 shows the proximate composition of the cookie-like products. There were significant ($p<0.05$) differences in all the measured parameters. Moisture content values of the cookie-like products were found in the range of 8.07 to 9.67% against the control 10.69% which recorded the highest moisture content values.

Generally the increase observed in the moisture content values of all the cookies maybe due to the added ingredients. This result compared well with those reported by other researchers (Idowu *et al*., 1996 and Echendu *et al.,* 2004). Cookies are generally low moisture foods. This moisture range would improve the shelf life and acceptability of the products. According to Ezeama (2007), at lower moisture contents, such as in this study, deterioration of baked products would be lowered due to reduced activity of microorganisms and microbial proliferation will be minimal and it confers higher shelf-life stability of the product. Crude protein contents of the cookie-like products ranged from 6.05% to 13.05% against the control 14.64% cookies. The increase found in the protein contents of the cookie samples maybe due to the ingredients such as eggs and milk added to the cookie- like products. Significant ($p < 0.05$) differences were observed among the cookies samples. Among the cookies products, cookie samples produced from 100% (14.64%) of wheat flour recorded the highest protein value, while the lowest was found in the cookie produced from 100% blend of Umucass 38 (6.05%) . These results are close to the result of protein values for biscuits made from 100% millet by (Eneche, 1999) and within the results obtained by of Chinma and Gernah (2007) who reported protein contents (6.83% - 16.60%) of cookies produced from cassava/soybean/mango composite flours. Crude Fat contents of the cookie-like products were observed to be generally high. They ranged from 4.01% to 6.85% against the control 3.83%. These values were in agreement with various composite flour cookies formulated by other researchers. This result is lower than the values 12.96 - 15.21%.

Table 4: Proximate composition and Beta-carotene contents of cookies and cookie-like products from Umucass 36, 37 and 38

Variety	Parameter (%)	Composition (%) 100 % Garri	20:80 Garri:Wheat	40:60 Garri:Wheat	50:50 Garri:Wheat	60:40 Garri:Wheat	80:20 Garri:Wheat	100% Wheat
Umucass 36	Moisture content (%)	8.34^{c}	9.67^{b}	9.42^{b}	8.34^{c}	8.07^{d}	8.72^{c}	10.68^{a}
	Protein (%)	6.55^{f}	13.05^{b}	11.40^{c}	10.50^{c}	9.79^{d}	8.16^{e}	14.64^{a}
	Crude fat (%)	5.57^{b}	4.18^{c}	4.52^{bc}	6.22^{b}	6.08^{b}	6.03^{b}	3.83^{c}
	Crude fibre (%)	1.41^{b}	1.59^{a}	1.46^{b}	1.53^{a}	1.51^{a}	1.46^{b}	1.64^{a}
	Ash (%)	1.24^{b}	1.33^{a}	1.27^{a}	1.28^{a}	1.28^{a}	1.24^{b}	1.35^{a}
	Carbohydrate (%)	76.81^{a}	71.53^{b}	72.01^{b}	70.81^{b}	73.21^{b}	70.67^{b}	67.98^{c}
	Beta –carotene (µg/g)	3.91^{d}	0.90^{h}	1.65^{f}	2.04^{f}	2.40^{f}	3.16^{d}	0.15^{i}
Umucass 37								
	Moisture content (%)	9.04^{b}	9.03^{c}	9.03^{c}	9.03^{c}	8.97^{c}	8.57^{c}	10.68^{a}
	Protein (%)	6.14^{g}	12.95^{b}	11.24^{c}	10.39^{cd}	9.54^{d}	7.84^{e}	14.64^{a}
	Crude fat (%)	6.72^{a}	4.38^{c}	4.89^{bc}	5.21^{b}	5.58^{b}	6.10^{b}	3.83^{c}
	Crude fibre (%)	1.47^{b}	1.60^{a}	1.49^{b}	1.56^{a}	1.55^{a}	1.51^{a}	1.64^{a}
	Ash (%)	1.25^{a}	1.37^{a}	1.29^{a}	1.27^{a}	1.25^{a}	1.22^{a}	1.35^{a}
	Carbohydrate (%)	75.18^{a}	70.73^{b}	71.91^{b}	72.37^{b}	72.99^{b}	74.52^{b}	67.98^{c}
	Beta –carotene (µg/g)	4.93^{c}	1.11^{g}	2.06^{f}	2.55^{d}	3.03^{d}	3.97^{d}	0.15^{i}
Umucass 38								
	Moisture content (%)	9.32^{b}	9.94^{b}	8.57^{c}	8.57^{c}	7.96^{d}	8.49^{c}	10.68^{a}
	Protein (%)	6.05^{g}	12.93^{b}	11.21^{c}	10.35^{cd}	9.49^{d}	7.77^{e}	14.64^{a}
	Crude fat (%)	4.88^{bc}	3.85^{c}	4.12^{c}	4.20^{c}	4.29^{c}	4.43^{c}	3.83^{c}
	Crude fibre (%)	1.50^{a}	1.61^{a}	1.50^{a}	1.57^{a}	1.56^{a}	1.53^{a}	1.64^{a}
	Ash (%)	1.22^{b}	1.32^{a}	1.25^{a}	1.23^{b}	1.24^{a}	1.23^{b}	1.35^{a}
	Carbohydrate (%)	77.09^{a}	70.26^{b}	73.29^{b}	73.94^{b}	75.35^{a}	76.37^{a}	67.98^{c}
	Beta –carotene (µg/g)	6.97^{a}	1.51^{f}	2.88^{d}	3.57^{d}	4.24^{c}	5.61^{b}	0.15^{i}

Means with the same superscript are not significantly ($p>0.05$) different

Reported by Giwa and Ikujenlola (2010) for biscuits produced from composite flours of wheat and quality protein maize. These fat values compared favorably with Eneche‟s results of 4.8% and 1.4% respectively for biscuits made from 100% millet (Eneche, 1999). The Significant (P<0.05) differences were observed among them. This could be as a result of the garri samples, since the same amount of fat was used for all the recipes. The fat value was highest (6.85%) in the cookie-like product from Umucass 37 of 100% garri while the lowest was seen in the control cookies (3.83%). Crude Fat contents of the cookies were within the standard value for soft dough biscuits (Okpala, 2010). Fats are an integral part of cookies being the third largest component after flour and sugar (Manley, 2000). Cookies are in fact a rich source of fat and carbohydrates hence, are energy giving food (Kure *et al*., 1998). Crude fibre contents of the cookie-like products ranged 1.471% to 1.61% against the control 1.64%. It was observed that the fibre contents decreased with decrease in the proportion of garri added to the products. Meanwhile, the crude fibre contents of cookie products was highest in the control cookies made from 100% wheat flour (1.66%) while the lowest was found in product made from 100% garri (1.41%) of Umucass 36. This result is close to the work of Ukapbi and Ndimela (1990), who recorded crude fibre of garri (0.5 to 3.6%) and 1.7% - 2.9% reported by Eneche (1999). Fibre aids in lowering blood cholesterol level and slows down the process of absorption of glucose, thereby helping in keeping blood glucose level in control (Anderson *et al*., 2009). It also ensures smooth bowel movements and thus helps in easy flushing out of waste products from the body, increase satiety and hence impacts some degree of weight management (Mickelson *et al*., 1979). Ash content of the cookie-like products ranged from 1.24% to1.27% against the control cookies 1.35% with products made from 100% wheat flour (1.35%) significantly (p<0.05) the highest and cookies made from 100% garri from Umucass had the lowest (1.23%) . There were significant difference at p <0.05 amongst the blends. In general the increased value of ash in the cookie products indicates high amounts of minerals in the developed cookies. This increase maybe due to the variety of cassava used since the same quantity of ingredients was used. This work is close the work of Chinma and Gernah (2007) who reported ash content (1.90 to 2.40%) of cookies produced from cassava/soyabean/mango composite flours. Comparable values of 1.5-2.0% were also observed by Eneche (1999) for biscuits made from 100% millet. Carbohydrate content of the formulated cookies were generally high and aged from 70.26% to 77.09% against the control 60.74% .The highest value was seen in cookie products made from 100% (77.09%) blend of Umucass 37 and the lowest was found in the product from 20:80 (60.74%) of the control cookies . This result compared favourably with 61.0 to 66.5% and 68.29 to 74.34% ranges from previous works by Eneche (1999) and Magda *et al*. (2008) respectively. The result is also in line with the value 64.4% reported by reported by Oyenuga (1968). Carbohydrate content of all the products decreased during the storage time. The high carbohydrate contents of the products were expected as ingredients composed of mainly carbohydrate rich materials, which are garri and wheat flours which were not so much affected by processing. The high level of carbohydrate in the samples may be due to also the added baking fat. The high carbohydrate contents of the cookie-like products favors better production of energy in meeting the daily activities.

Beta carotene values of the cookie-like products ranged 0.90µg/g to 6.97µg/g against the control 0.15 µg/g. Beta carotene values decreased with increase in the proportion of wheat flour added. Among the garri samples Umucass 38 had the highest beta carotene contents while Umucass 36 had the least. There were significant (p < 0.05) differences among the samples. However, the control samples had the lowest value while the highest value was seen in cookies made from 100% garri from Umucass 38 (6.97µg/g). Higher values in all the other samples can be attributed to the garri samples used in formulating the cookies. The difference in the beta carotene values obtained for the cookie-like products maybe due to different ratio of the blends. The consumption of these composite flour cookies under study from yellow garri and wheat blends could reduce VAD in children and pregnant/lactating women and other consumers in some amounts. β-carotene is a major source and precursor of dietary vitamin A to human health. The β-carotene from plant sources converted to vitamin A in human body to improve the diet of population in food based approach. Consumption of vitamin A rich cookie-like products can provide households with direct access to foods rich in β-carotene and the alleviation of VAD (Faber *et al.*, 2002).

Anti-nutrients are substances that reduce the nutritional values of food by reducing the bioavailability, digestibility, and utilization of nutrients. The phytochemical profiles of the cookies products are shown in Table 5. There were significant ($p<0.05$) differences among the cookie samples. Tannins level decreased with decrease in garri flour added during formulation. The highest tannins content was seen in products made from 100% garri blend from Umucass 38 and the lowest was seen in control cookies (0.03%) Slight variations observed may be due to difference in the raw materials. The presence of tannins in the formulated snacks could have some health benefits (Adeyeye, 1998). Tannins are water soluble polyphenols and have been reported to have anticarcinogenic and antimutagenic potentials which protect cellular oxidative damage, including lipid perioxidation in man (Chung *et al.*, 1998). Saponin content of the products ranged from 0.510 mg/100g to 0.865 mg/100g against the control 0.425 mg/100g. Saponin value was highest in cookie-like products made from 100% garri blend from Umucass 36, while the lowest was seen in the control cookies (0. 0.425 mg/100g). Saponins are known to inhibit growth of cancer cells, lower cholesterol levels, boosts immunity and energy and acts as a natural antibiotic (Onwuka, 2005).

Trypsin inhibitor contents of the cookie-like products ranged from 0.45 mg/100g to1.56 mg/100g against the control 0.43 mg/100g. There were significant ($p<0.05$) differences among the cookie samples. Trypsin inhibitor was observed to decrease with decrease in the proportion of garri added to composite flour. Among the different garri samples used, products from 100% garri blends of Umucass 36 recorded significantly ($p<0.05$) the highest trypsin inhibitor value (Table 5) and the lowest value was seen in the control cookies. The values obtained agreed reasonably well with the work of Olapade and Adeyemo (2014) who recorded (2.50±0.05 mg/100g) of 100% cassava cookies. Previous workers have reported a similar trend in trypsin inhibition activity for potato flour supplemented with soy- bean flour (Iwe and Ngoddy, 1998).

The alkaloids content values of the cookie-like products ranged from 0.140% to 0.460% against the control 0.055%. From Table 5 the highest alkaloid content (0.460%) was found in cookie products made from 100% garri of Umucass 36. The control (100% wheat flour) recorded the lowest level of alkaloid content with the least value 0.05 %. This result is lower than the result (5.57%) obtained by Anshula Bhat and Rajinder (2015) on cookies formulated from *Amaranthus hypochondriacus* L. grains. The presence of alkaloids this study may lead to healing of wounds, varicose ulcers, hemorrhoids, frostbite and burn in herbal medicines

Hydrogen cyanide contents of the cookie-like products ranged from 0.130 mg/kg to 0.460 mg/kg against the control cookie 0.05 mg/kg (Table 4.16). There were significant ($p<0.05$) differences between them. The hydrogen cyanide contents values in the cookie-like products increased with increase in the proportion of garri added the cookies during formulation. Hydrogen cyanide values were highest in the cookie-like product made from100% garri blend of Umucass 36 while the lowest was found in the product made the control cookies. Baking reduced the hydrogen cyanide contents of the formulated samples, since these values were lower than the cyanide values of the raw materials used for the product formulations (Table 5). These relatively low cyanide levels could be attributed to cassava processing which involves grating, fermentation and toasting that have been reported to lowering total cyanide in fresh peeled roots (Akindahunsi *et al*., 1999). The values obtained are lower than the recommended safe level of 20 mg/kg (NIS, 2004, Oluwamukomi and Adeyemi, 2013). Since the values obtained for all the cookie-like samples are below the safe level, the products can therefore be considered adequate and safe for human consumption as regards cyanide poisoning. It was generally observed in this study that the antinutritional content of the products was low and within the tolerable levels

Table 5: Phytochemical profile of cookies and cookie-like products from Umucass 36, 37 and 38

Variety	Parameter s	Composition (%) 100 % Garri	20:80 Garri:Wheat	40:60 Garri:Wheat	50:50 Garri:Wheat	60:40 Garri:Wheat	80:20 Garri:Wheat	100% Wheat
Umucass 36	Tannins (%)	1.035^{a}	0.040^{d}	0.555^{c}	0.570^{cr}	0.705^{b}	0.915^{b}	0.030^{d}
	Saponin (mg/100g)	0.865^{a}	0.565^{bc}	0.630^{b}	$0.745a^{b}$	0.820^{a}	0.855^{a}	0.425^{c}
	Trypsin inhibitor (mg/100g)	1.561^{a}	0.65^{c}	0.880^{b}	1.001^{b}	1.112^{b}	1.321^{b}	0.431^{d}
	Akaloids (%)	0.460^{a}	0.140^{d}	0.200^{c}	0.260^{bc}	0.300^{bc}	0.380^{ab}	0.050^{f}
	HCN (mg/kg)	0.460^{a}	0.140^{f}	0.200^{e}	0.260^{c}	0.300^{c}	0.380^{c}	0.055^{g}
Umucass 37	Tannins (%)	1.015^{a}	0.050^{d}	0.570^{c}	0.585^{c}	0.805^{b}	0.900^{b}	0.030^{d}
	Saponin (mg/100g)	0.790^{a}	0.510^{c}	0.560^{b}	0.720^{ab}	0.750^{ab}	0.805^{a}	0.425^{21}
	Trypsin inhibitor (mg/100g)	0.521^{c}	0.453^{d}	0.471^{d}	0.481^{d}	0.480^{d}	0.482^{d}	0.431^{d}
	Akaloids (%)	0.432^{a}	0.140^{d}	0.210^{c}	0.251^{c}	0.280^{c}	0.360^{ab}	0.055^{f}
	HCN (mg/kg)	0.432^{b}	0.140^{f}	0.210^{e}	0.250^{c}	0.280^{c}	0.36^{c}	0.055^{g}
Umucass 38	Tannins (%)	1.050^{a}	0.040^{d}	0.445^{c}	0.560^{c}	0.705^{b}	0.925^{b}	0.030^{d}
	Saponin (mg/100g)	0.765^{a}	0.565^{bc}	0.630^{b}	0.715^{ab}	0.720^{ab}	0.755^{ab}	0.425^{21}
	Trypsin inhibitor (mg/100g)	1.060^{b}	0.550^{c}	0.681^{c}	0.750^{c}	0.810^{b}	0.942^{b}	0.431^{i}
	Akaloids (%)	0.402^{ab}	0.140^{d}	0.203^{c}	0.231^{c}	0.260^{bc}	0.331^{b}	0.055^{f}
	HCN (mg/kg)	0.402^{b}	0.130^{f}	0.20^{e}	0.230^{d}	0.260^{c}	0.330^{c}	0.055^{g}

Mean values with different superscripts are significantly (P < 0.05) different.

Table 6: Sensory profile of cookies and cookie-like products

Variety	Parameter	Blends						
		100 % Garri	20:80 Garri:Wheat	40:60 Garri:Wheat	50:50 Garri:Wheat	60:40 Garri:Wheat	80:20 Garri:Wheat	100% Wheat
Umucass36	Taste	4.45^{e}	7.60^{a}	6.00^{c}	6.75^{b}	6.87^{b}	6.00^{c}	8.00^{a}
	Appearance	6.86^{b}	7.26^{a}	7.02^{a}	7.00^{ab}	6.00^{c}	6.00^{c}	7.32^{a}
	Crispness	4.78^{f}	6.91^{a}	6.22^{c}	6.10^{d}	6.08^{d}	5.75^{e}	6.96^{a}
	Aroma	6.42^{c}	6.54^{b}	6.45^{c}	6.26^{e}	6.14^{d}	5.54^{b}	6.78^{a}
	Overall acceptability	4.05^{e}	7.00^{b}	6.79^{b}	6.12^{c}	6.00^{c}	5.25^{d}	8.00^{a}
	Texture	6.65^{a}	6.00^{e}	6.06^{c}	6.25^{c}	6.40^{b}	6.70^{a}	6.00^{c}
Umucass37								
	Taste	6.53^{c}	7.75^{a}	6.00^{c}	6.99^{b}	5.45^{d}	6.93^{b}	8.00^{a}
	Appearance	6.96^{b}	7.00^{b}	6.92^{b}	6.84^{b}	6.00^{c}	5.60^{c}	7.32^{a}
	Crispness	7.00^{a}	6.83^{a}	6.83^{ab}	6.67^{b}	6.56^{b}	6.37^{b}	6.91^{a}
	Aroma	6.31^{b}	6.55^{a}	6.28^{b}	6.20^{b}	5.90^{c}	5.88^{c}	6.78^{a}
	Overall acceptability	4.00^{f}	7.00^{b}	6.40^{b}	6.00^{c}	5.15^{d}	5.00^{e}	8.00^{a}
	Texture	7.00^{a}	5.50^{d}	5.55^{e}	6.00^{c}	6.00^{c}	6.05^{c}	6.00^{c}
Umucass38								
	Taste	5.50^{d}	7.00^{b}	5.70^{cd}	6.30^{b}	6.00^{c}	6.30^{b}	8.00^{a}
	Appearance	6.00^{c}	7.00^{b}	6.88^{b}	6.00^{c}	5.35^{d}	5.00^{e}	7.32^{a}
	Crispness	7.00^{a}	6.35^{b}	6.20^{a}	6.00^{d}	5.00^{e}	5.00^{e}	6.91^{a}
	Aroma	5.00^{c}	6.00^{b}	6.00^{b}	5.75^{b}	5.00^{c}	5.00^{c}	6.78^{a}
	Overall acceptability	5.00^{e}	7.00^{b}	6.00^{c}	6.00^{c}	5.30^{d}	5.00^{e}	8.00^{a}
	Texture	7.00^{a}	5.00^{e}	6.00^{c}	6.00^{c}	6.50^{ab}	7.00^{a}	6.00^{c}

Means with the same superscript among rows are not significantly at ($p > 0.05$) different.

Sensory attributes of cookies and cookie-like products.

The results of the sensory evaluation of the cookie samples are presented in Table 6 above. The result shows that all the samples had very high sensory ratings in all the attributes considered such as appearance, aroma, taste, texture and overall acceptability. The control sample made with 100% wheat flour had significantly ($p<0.05$) higher ratings than all the other samples in all the attributes evaluated except texture and crispness. Appearance is an important sensory attribute of any food because of its influence on acceptability. The old adage that the eye accepts the food before the mouth is very true. The brown colour resulting from Maillard reaction is always associated with baked goods (Ubbor and Akobundu, 2009). The results showed that the control cookies scored highest (8.00) in terms of appearance against the cookie-like products which ranged 5.95 to 7.26 with cookies made from 80:20 (5.00) of Umucass 38 significantly ($p < 0.05$) the lowest. These variations could be due to the raw materials used in the cookie formulation since the same ingredients were used. The cookies scored within 5.95 to 7.26 on the 9 point-Hedonic scale indicating that the cookies were liked and agrees with the observations of Iwe (2007). The appearance of the control cookies was superior to the all cookie-like samples. As the level of garri supplementation increased in the wheat flour, the appearance score values of the cookies decreased. This result is close to work of Mebpa *et al.* (2007) who reported that supplementing bakery products with cassava flour increased the deterioration in appearance as a result of maillard reaction.

Cookies prepared from wheat flour had texture score value of 6.00 against the cookie-like products which ranged from 5.00 – 7.00 with cookies made from 100% garri (7. 00) of Umucass 37 the highest followed by products made from 100% of Umucass 38 and 80:20 from Umucass 36, there were no significant ($p > 0.05$) difference between them while the cookies made from 20:80 of Umucass 38 scored the lowest (Table 4.26). Texture score values of cookie-like products decreased as garri inclusion decreased. It was observed that up to 40% garri inclusion in the cookie formulation scored higher that the control cookies. This is due to the creation of roughness which gave a fibre-like texture, evenness and dullness of the surface texture in the composite flour cookies. This result of texture score is in line with the texture score value of cookies (7.05 - 7.43) developed from wheat and vitamin A fortified reported by Shahid *et al.* (2008).

Crispness is a desirable quality of cookies. Crispness scores of the cookie-like products ranged 4.78 to 7.00 against the control 6.91. Cookie-like products from 100% (7.00) garri blends of Umucass 37 scored the highest followed by products from 100% of Umucass 38 (7.00 Table 4.26). The lowest crispness score value was seen in the products made from 80:20 (5.00) blends of Umucass 38 (Table 4.26). There were significant differences ($p<0.05$) in the crispness values of the cookie samples but all the cookies were at least liked slightly.

Aroma is another attribute that influences the acceptance of baked goods even before they are tasted. The aroma score values ranged from 5.00 to 7.00 against the control (8.00). The control cookies scored highest while products produced from 100% garri of Umucass 38 was the lowest (5.00). The attribute aroma score values of cookies were significantly ($p < 0.05$) different. The aroma score values of cookie-like products decreased as the amount of garri increased in the composite flours. This may be due to consumer-oriented panelists were not familiar with such newly developed products like the cookie-like products.

The control cookies tasted better than the cookie-like products, its score (8.00) was significantly the highest while cookies made from 100% garri (4.45) of Umucass 36 was the lowest. The difference could be due to the raw materials used. It cloud be also that the panelists were only familiar with cookies made from wheat flour.

The overall acceptability score values was maximum the control cookies and was found in the range of 8.00 while minimum values (4.00 - 7.00) was seen in cookie-like products with the least score (4.00) seen in products made from 100% garri of Umucass 37. There were significant ($p < 0.05$) differences between them. The overall acceptability score value of the composite flour cookies decreased when more garri was added to the wheat flour. This may be due to the results of appearance, texture, aroma and taste of the composite flour cookies. Changing the staple foods of a population in a certain society can influence the overall acceptability of new products. It was interesting to notice that up to 50% incorporation of garri to develop a cookie- like product did not make negative impact concerning the overall acceptability of the new product by consumer-oriented panelists. The results show that all the samples had very good sensory ratings for appearance, flavor, taste, texture and overall acceptability

Table 7: Microbiological profile of cookies and cookie-like products

	Composition (cfu/g)													
Variety	100% Garri		20:80 Garri:Wheat		40:60 Garri:Wheat		50:50 Garri:Wheat		60:40 Garri:Wheat		80:20 Garri:Wheat		100% Wheat flour	
	TVC	FC	TVC	FC	TVC	FC	FC	TVC	FC	TVC	FC	TVC	FC	TVC
Umucass 36	0.2×10	x	x	x	x	x	x	x	x	x	0.1×10	x	x	x
Umucass 37	0.25×10	x	x	x	x	x	x	x	x	x	x	x	x	x
Umucass 38	x	x	x	x	x	x	x	x	x	x	x	x	x	x

KEY: FC = Fungi count (cfu/g), TVC= Total Viable count (cfu/g), X = No visible growth.

Microbiological studies conducted for yeast, mold, total plate count and coliform revealed that no microbial growth was detected in the cookie-like products and in the control cookies except cookies produced from 100% Umucass 36, 100% Umucass 37 and 80:20 blends from Umucass 37. These samples had very low levels of bacteria and mold growth. The total microbial load on the nutrient agar ranged from 0.2.10 x 10^3 to 0.25 x 10^3 cfu/g. The total fungi load on the Potatoes Dextrose Agar of samples was 0.10 x 10^3cfu/g. These maybe be attributed to the fact the analysis was not done on day zero. There may have been contamination in the cause of keeping as the samples were kept for some days before the microbial analysis. However these counts were within acceptable limits (Fawole and Oso, 1988).

Conclusion

The study attempted to investigate the possibility of using home-made garri from yellow cassava roots for the production of cookie-like products by blending with wheat flour. These cookies were found to be good nutritional products. Cookie-like products developed up to 50% garri supplementation with wheat flour was superior in β-carotene and proximate compositions than the wheat flour (control). It was interesting to notice that up to 50% incorporation of garri to develop a cookie- like product did not make negative impact concerning the overall acceptability of the new product by consumer-oriented panelists.

In view of the results of the present study, the use of garri-wheat flour blends in cookies formulation appeared to be promising from nutritional quality, acceptability and economical point of view.

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