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Effects of Storage on The Proximate And Beta-Carotene Contents of Cookie-Like Products Formulated From Blends of Wheat Flour And Garri From Biofortified Cassava Varieties.

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Abstract: *Three cassava varieties namely Umucass 36, 37 and 38 were processed into garri and blended with wheat flour for production of cookie-like products. Proximate and beta-carotene contents of the cookies were studied using standard methods before and during storage for twelve weeks. 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% at week zero. 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. Beta carotene values decreased with increase in the proportion of wheat flour added. Generally there were losses in the proximate and beta carotene of the cookie-like products analyzed during the storage period.*

Keywords: *Storage, beta-carotene, proximate, garri, cookie-like products.*

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I. Introduction

Cookies are nutritive snacks produced from unpalatable dough that is transformed into appetizing product through the application of heat in an oven Anozie *et al*. (2014). Cookies contribute valuable quantities of iron, calcium, protein, calorie, fibre and some of the B-vitamins to our diet and daily food requirement. The need for strategic development in the use of inexpensive local resources in the production of staple foods has been promoted by organizations, such as; Food and Agricultural Organization (FAO) and the United Nations Refugee feeding programs (Awogbenja and Ndife, 2012; FAO⁄WHO, 1994). However, this resulted to the initiation of the composite flour program, the aim of which was to seek ways of substituting flours, starches and protein concentrates from indigenous crops, for as much wheat as possible in baked products (FAO⁄WHO⁄UNU Expert Consultation, 1994)

In Nigeria, reliance on wheat flour in the bakery industries has over the years restricted the use of other cereals and tuber crops available for domestic use. In recent years, government has through intensive collaboration with research institutes encouraged the use of composite flours in the production of bread and related food products such as cookies. The adoption of these locally produced flours in the bakery industry increased the utilization of indigenous crops cultivated in Nigeria and also reduces the cost of bakery products (Ayo and Gaffa, 2002).

However, the increasing phenomenon of urbanization coupled with growing number of working mothers, have profoundly contributed to the popularity and increased consumption of snack foods Gernah *et al*. (2010). In addition, the consumption of baked products by human coupled with the escalating cost of wheat importation, difficulty in cultivating wheat in the tropics and the association of wheat consumption with such health problems as celiac disease makes it pertinent to explore the use of alternative local flours as supplements or substitutes for wheat flour in the baking industry. 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). Many researchers have worked extensively on composite flour for the production of biscuits, buns, cakes and bread. Composite flour refers to the mixture of different concentrations of non-wheat flours from cereals, legumes, roots and tubers or mixture of flours other than wheat flour. Composite flours are advantageous, owing to the fact that the inherent deficiencies of essential nutrients in wheat flour are supplemented from other sources.

The aim of this study, therefore, was to produce and assess the effects storage on the proximate composition and bêta carotene contents of the cookie-like products at room temperature.

II. 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.

Gari production

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

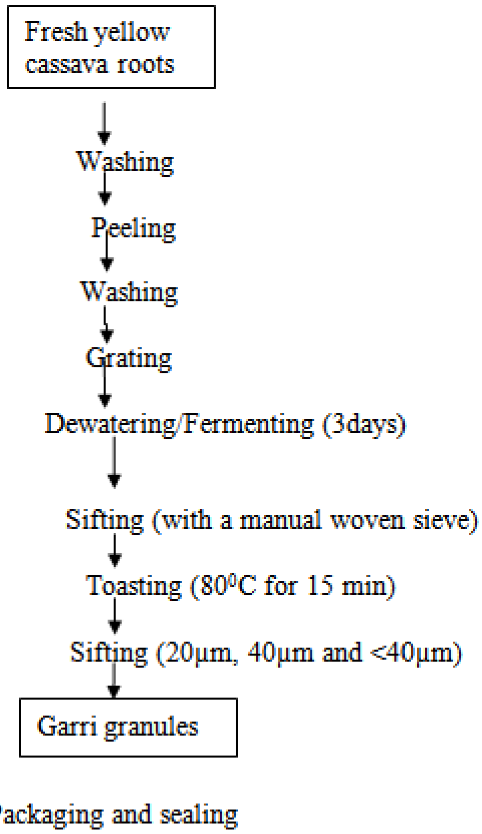

Fig. 1: Flow diagram for processing of cassava tubers into garri

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 2). 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.

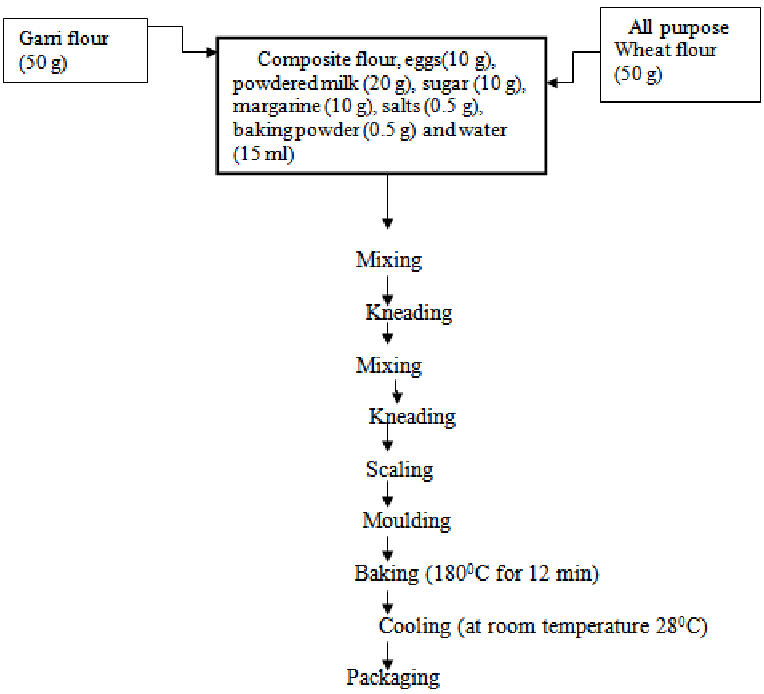

Fig.2: Flow chart for production of cookie-like product

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).

Determination of carotenoids

The method of Harvest-plus for carotenoid analysis described and used Egesi (2011) was employed for the determination of the total β-carotene contents of the samples. Five (5) grams of the sample (garri samples and cookie-products) was ground in 50 ml of cold acetone and filtered with suction through a buchner funnel with filter paper. The filtrate was extracted with 40ml of petroleum ether using separatory funnel. Saturated sodium chloride solution was used to prevent emulsion formation. The lower phase being water was discarded while the upper phase was collected into a 50 ml volumetric flask, making the solution pass through a small funnel containing anhydrous sodium sulfate to remove residual water. Then, the separatory funnel was washed with petroleum ether (P.E) and the standard flask made up to 50 ml mark. The absorbance at 450 nm of the solution was taken using Genway Model 6000 electronic spectrophotometer and the total carotenoid content was calculated as follows;

$$\text{Total Carotenoid } (\mu g/g) = \frac{A \times \text{Volume (ml)} \times 10}{A^{1\%}\,1\text{cm} \times \text{sample weight (g)}} \quad \ldots\ldots(16)$$

Where A = absorbance, Volume = total volume of extract (50 ml), A1% 1 cm = absorption coefficient of β-carotene in petroleum ether (2592).

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.

III. Results And Discussion

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 below shows the proximate composition of the garri samples (Umucass 36, 37 and 38) and wheat flour, while that of cookie-like products are shown in Tables 4.

Table 3: Proximate composition of the raw materials (Three garri samples from Umucass 36, 37, 38 and wheat flour).

Samples	Moisture (%)	Crude Protein (%)	Crude Fat (%)	Crude Fibre (%)	Ash (%)	Carbohydrate (%)
Umucass 36	$11.80^{b} \pm 0.01$	$2.80^{b} \pm 0.01$	$1.56^{a} \pm 0.01$	$0.38^{b} \pm 0.01$	$0.71^{a} \pm 0.01$	$82.51^{a} \pm 0.34$
Umucass 37	$12.42^{a} \pm 0.03$	$2.83^{b} \pm 0.01$	$1.66^{a} \pm 0.01$	$0.34^{b} \pm 0.01$	$0.66^{a} \pm 0.01$	$82.09^{a} \pm 0.22$
Umucass 38	$11.60^{b} \pm 0.01$	$2.59^{b} \pm 0.01$	$1.61^{a} \pm 0.01$	$0.48^{b} \pm 0.01$	$0.71^{a} \pm 0.01$	$82.99^{a} \pm 0.02$
Wheat flour	$11.04^{c} \pm 0.01$	$9.70^{a} \pm 0.14$	$1.34^{b} \pm 0.01$	$1.32^{a} \pm 0.01$	$0.53^{ab} \pm 0.01$	$76.07^{b} \pm 0.18$

Values are means ± SD of duplicate determinations. Mean values with different superscripts in the column are significantly ($p > 0.05$) different.

Table: 4. Effect of storage duration on the moisture content of cookies and cookie-like products from Umucass 36, 37 and 38.

Variety	Duration of storage (wk)	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	0	8.34^{d}	8.07^{d}	8.34^{d}	9.67^{c}	9.42$^{1-10}$	8.72^{d}	10.68^{b}
	2	8.43^{d}	9.07^{c}	8.59^{d}	9.75^{b}	9.47^{c}	8.78^{d}	10.70^{b}
	4	9.52^{c}	10.03^{b}	9.35^{c}	9.78^{b}	9.47^{c}	8.98^{d}	11.81^{a}
	6	9.52^{c}	10.08^{b}	9.40^{c}	9.83^{b}	9.55^{c}	9.08^{c}	11.87^{a}
	8	9.62^{c}	10.11^{b}	9.45^{c}	9.86^{b}	9.61^{c}	9.11^{c}	11.93^{a}
	10	9.66^{c}	10.17^{b}	9.49^{c}	9.91^{b}	9.65^{c}	9.17^{c}	11.97^{a}
	12	9.72^{c}	10.21^{b}	9.51^{c}	9.99^{b}	9.70^{c}	9.21^{c}	12.01^{a}
Umucass 37								
	0	9.04^{c}	9.03^{c}	9.03^{c}	9.03^{c}	8.97^{d}	8.57^{d}	10.70^{b}
	2	10.13^{b}	9.14^{c}	9.06^{c}	10.02^{b}	9.25^{c}	9.58^{c}	11.81^{a}
	4	10.17^{b}	9.19^{c}	9.04^{c}	10.12^{b}	9.36^{c}	9.60^{c}	11.87^{a}
	6	10.20^{b}	9.23^{c}	9.06^{c}	10.16^{b}	9.39^{c}	9.67^{c}	11.93^{a}
	8	10.25^{b}	9.30^{c}	9.11^{c}	10.18^{b}	9.45^{c}	9.72^{c}	11.97^{a}
	10	10.29^{b}	9.35^{c}	9.16^{c}	10.22^{b}	9.51^{c}	9.76^{c}	12.01^{a}
	12	10.31^{b}	9.39^{c}	10.07^{b}	10.26^{b}	9.58^{c}	9.81^{c}	10.70^{b}
Umucass 38								
	0	9.32^{c}	9.94^{c}	8.57^{d}	8.57^{d}	7.96^{e}	8.49^{d}	10.70^{b}
	2	9.37^{c}	9.96^{c}	9.25^{c}	9.03^{c}	8.15^{d}	8.54^{d}	11.81^{a}
	4	10.21^{b}	10.35^{b}	11.24^{ab}	10.27^{b}	10.16^{b}	11.26^{ab}	11.87^{a}
	6	10.26^{b}	10.43^{b}	11.29^{ab}	10.33^{b}	10.23^{b}	11.29^{ab}	11.93^{a}
	8	10.31^{b}	10.46^{b}	11.32^{ab}	10.35^{b}	10.27^{b}	11.31^{ab}	11.97^{a}
	10	10.30^{b}	10.46^{b}	11.32^{ab}	10.35^{b}	10.27^{b}	11.31^{ab}	12.01^{a}
	12	10.40^{b}	10.55^{b}	11.44^{ab}	10.46^{b}	10.34^{b}	11.40^{ab}	10.70^{b}

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

Moisture content

Table 3 shows the proximate composition of the raw materials used in cookie-like production which were 100% garri samples made from the three cassava varieties (Umucass 36, 37, and 38) and wheat flour. The wheat flour (100%) had the least moisture content of 11.04%, while garri samples made from Umucass 36, 37 and 38 were found in the range of 11.60% to 12.42%. Low moisture content is an indication of a stable shelf life of a product if packaged and stored.

Table 4 shows the moisture content of cookie-like products. This result showed that the control cookies had the highest (12.01 %) moisture content values at week twelve of the storage time while cookies from 20:80 (8.07%) blend from Umucass 36 had the lowest (Table 4). 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% at week zero. The control cookies recorded the highest moisture content values during the storage periods for the three varieties.

Generally the increase observed in the moisture content values of all the cookies maybe due to the added ingredients. Increase in the moisture contents of the stored products could be due to build-up of heat, CO_2 and light (Sudhakar and Maini, 1994). The result of this work also agrees with the work of Chinma and Gernah (2007) who reported increase in moisture content (9.05% -10.32%) of cookies produced from cassava/soybean/mango composite flours. 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.

Table 5: Effect of storage duration on the protein content of cookies and cookie-like products from Umucass 36, 37 and 38.

Variety	Duration of storage (wk)	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	0	6.55^{f}	13.05^{b}	11.40^{c}	10.50^{c}	9.79^{d}	8.16^{e}	14.64^{a}
	2	6.51^{f}	13.02^{b}	11.35^{c}	10.47^{cd}	9.60^{d}	8.13^{e}	14.59^{a}
	4	6.49^{g}	13.00^{b}	11.32^{c}	10.43^{cd}	9.54^{d}	8.11^{e}	14.54^{a}
	6	6.44^{g}	12.82^{b}	11.30^{c}	10.41^{cd}	9.51^{d}	8.09^{e}	14.50^{a}
	8	6.41^{g}	12.80^{b}	11.26^{c}	10.37^{cd}	9.46^{d}	8.05^{e}	14.46^{ab}
	10	6.37^{g}	12.76^{bc}	11.24^{c}	10.35^{cd}	9.42^{d}	8.03^{e}	14.41^{ab}
	12	6.33^{g}	12.73^{bc}	11.22^{c}	10.31^{cd}	9.40^{d}	8.01^{e}	14.40^{ab}
Umucass37								
	0	6.14^{g}	12.95^{b}	11.24^{c}	10.39^{cd}	9.54^{d}	7.84^{e}	14.64^{a}
	2	6.04^{g}	12.93^{b}	11.19^{c}	10.33^{cd}	9.40^{d}	7.82^{e}	14.59^{a}
	4	5.95^{g}	12.90^{b}	11.17^{c}	10.31^{cd}	9.37^{d}	7.79^{e}	14.54^{a}
	6	5.91^{g}	12.87^{b}	11.16^{c}	10.27^{cd}	9.32^{d}	7.75^{e}	14.50^{a}
	8	5.87^{g}	12.84^{b}	11.13^{c}	10.23^{cd}	9.30^{d}	7.71^{e}	14.46^{ab}
	10	5.84^{g}	12.80^{b}	10.87^{c}	10.21^{cd}	9.24^{d}	7.66^{e}	14.41^{ab}
	12	5.65^{g}	12.78^{bc}	10.81^{c}	10.16^{cd}	9.22^{d}	7.61^{e}	14.40^{ab}
Umucass38								
	0	6.05^{g}	12.93^{b}	11.21^{c}	10.35^{cd}	9.49^{d}	7.77^{e}	14.64^{a}
	2	5.99^{g}	12.90^{b}	11.18^{c}	10.24^{cd}	9.36^{d}	7.23^{f}	14.59^{a}
	4	5.96^{g}	12.86^{b}	11.16^{c}	10.21^{cd}	9.34^{d}	7.20^{f}	14.54^{a}
	6	5.92^{g}	12.81^{b}	11.14^{c}	10.17^{cd}	9.28^{d}	7.16^{f}	14.50^{a}
	8	5.89^{g}	12.79^{b}	11.13^{c}	10.15^{cd}	9.26^{d}	7.13^{f}	14.46^{ab}
	10	5.89^{g}	12.75^{bc}	11.11^{c}	10.15^{cd}	9.24^{d}	7.13^{f}	14.41^{ab}
	12	5.81^{g}	12.72^{bc}	11.08^{c}	10.04^{cd}	9.18^{d}	7.01^{f}	14.40^{ab}

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

Crude protein

The protein contents of the cookie-like products ranged from 6.05% to 13.05% against the control 14.64% cookies (Table 5) at week zero. 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. Variations in these results can be attributed to their original raw materials and effect of blend ratio. 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 (5.81%) at week twelve of storage time. The protein contents decreased progressively in all the blends but were not significantly different ($p>0.05$) except in the control cookies which showed significant difference at week eight of storage time and remained stable throughout the storage periods. These results are higher than 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.

Table 6: Effect of storage duration on the fat content of cookies and cookie-like products from Umucass 36, 37 and 38.

Variety	Duration of storage (wk)	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	0	5.57^{b}	4.18^{c}	4.52^{bc}	6.22^{b}	6.08^{b}	6.03^{b}	3.83^{c}
	2	5.53^{b}	4.16^{c}	4.50^{bc}	6.20^{b}	6.00^{b}	6.00^{b}	3.80^{c}
	4	5.49^{b}	4.13^{c}	4.47^{c}	6.17^{b}	5.74^{b}	5.90^{b}	3.79^{c}
	6	5.48^{b}	4.10^{c}	4.43^{c}	6.15^{b}	5.71^{b}	5.85^{b}	3.75^{c}
	8	5.41^{b}	4.07^{c}	4.40^{c}	6.11^{b}	5.66^{b}	5.81^{b}	3.74^{c}
	10	5.37^{b}	4.06^{c}	4.37^{c}	6.05^{b}	5.64^{b}	5.77^{b}	3.71^{c}
	12	5.37^{b}	4.03^{c}	4.31^{c}	6.00^{b}	5.62^{b}	5.73^{b}	3.69^{c}
Umucass 37								
	0	6.85^{a}	4.44^{c}	5.04^{bc}	5.34^{bc}	5.64^{b}	6.25^{b}	3.83^{c}
	2	6.79^{a}	4.41^{c}	5.00^{bc}	5.27^{bc}	5.60^{b}	6.14^{b}	3.80^{c}
	4	6.72^{a}	4.38^{c}	4.89^{bc}	5.21^{bc}	5.58^{b}	6.10^{b}	3.79^{c}
	6	6.65^{a}	4.36^{c}	4.62^{bc}	5.20^{bc}	5.50^{b}	5.77^{b}	3.75^{c}
	8	6.62^{a}	4.32^{c}	4.59^{bc}	5.18^{bc}	5.47^{bc}	5.72^{b}	3.74^{c}
	10	6.60^{a}	4.28^{c}	4.55^{bc}	5.14^{bc}	5.43^{bc}	5.72^{b}	3.71^{c}
	12	6.57^{a}	4.22^{c}	4.51^{bc}	5.07^{bc}	5.40^{bc}	5.65^{b}	3.69^{c}
Umucass 38								
	0	4.69^{bc}	4.01^{c}	4.18^{c}	4.27^{c}	4.34^{c}	4.52^{bc}	3.83^{c}
	2	4.91^{bc}	3.88^{c}	4.16^{c}	4.24^{c}	4.31^{c}	4.46^{c}	3.80^{c}
	4	4.88^{bc}	3.85^{c}	4.12^{c}	4.20^{c}	4.29^{c}	4.43^{c}	3.79^{c}
	6	4.85^{bc}	3.76^{c}	4.10^{c}	4.18^{c}	4.25^{c}	4.41^{c}	3.75^{c}
	8	4.82^{bc}	3.71^{c}	3.06^{d}	4.14^{c}	4.21^{c}	4.36^{c}	3.74^{c}
	10	4.79^{bc}	3.68^{c}	3.04^{d}	4.09^{c}	4.16^{c}	4.34^{c}	3.71^{c}
	12	4.63^{bc}	3.63^{c}	3.03^{d}	4.04^{c}	4.12^{c}	4.31^{c}	3.69^{c}

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

Crude Fat

The 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% (Table 6) at week zero. 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% reported by Giwa and Ikujenlola (2010) for biscuits produced from composite flours of wheat and quality protein maize. These fat values compared favourably 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 cookie-like product made from 40:60 blends (3.03%) of Umucass 38 at week twelve of the storage time. Among the cookie samples losses was observed throughout the storage periods but were not significantly different at (P > 0.05). The decrease in the crude fat noticed during storage could be due to rancidity reaction which may have taken place during the storage period as a result of light, high temperature, local oxygen and water concentration in the stored product (Chopa and Panesar, 2013). Despite the decrease observed during storage in the cookie-like products, their crude fat contents were still high. 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).

Table 7: Effect of storage duration on the crude fibre content of cookies and cookie-like products from Umucass 36, 37 and 38.

		Composition (%)						
Variety	Duration of storage (wk)	100 % Garri	20:80 Garir:Wheat	40:60 Garri:Wheat	50:50 Garri:Wheat	60:40 Garri:Wheat	80:20 Garri:Wheat	100% Wheat
Umucass 36	0	1.41^{b}	1.59^{a}	1.46^{b}	1.53^{ab}	1.51^{ab}	1.46^{b}	1.64^{a}
	2	1.41^{b}	1.59^{a}	1.46^{b}	1.53^{ab}	1.51^{ab}	1.46^{b}	1.66^{a}
	4	1.41^{b}	1.59^{a}	1.46^{b}	1.53^{ab}	1.51^{ab}	1.46^{b}	1.66^{a}
	6	1.41^{b}	1.59^{a}	1.46^{b}	1.53^{ab}	1.51^{ab}	1.46^{b}	1.66^{a}
	8	1.41^{b}	1.55^{a}	1.46^{b}	1.53^{ab}	1.51^{ab}	1.46^{b}	1.66^{a}
	10	1.41^{b}	1.55^{a}	1.44^{b}	1.53^{ab}	1.51^{ab}	1.46^{b}	1.66^{a}
	12	1.41^{b}	1.55^{a}	1.44^{b}	1.53^{ab}	1.51^{ab}	1.46^{b}	1.66^{a}
Umucass 37								
	0	1.47^{b}	1.60^{a}	1.49^{b}	1.56^{ab}	1.55^{ab}	1.51^{ab}	1.64^{a}
	2	1.47^{b}	1.60^{a}	1.49^{b}	1.56^{ab}	1.55^{ab}	1.51^{ab}	1.66^{a}
	4	1.47^{b}	1.60^{a}	1.49^{b}	1.56^{ab}	1.55^{ab}	1.51^{ab}	1.66^{a}
	6	1.47^{b}	1.60^{a}	1.49^{b}	1.56^{ab}	1.55^{ab}	1.51^{ab}	1.66^{a}
	8	1.47^{b}	1.60^{a}	1.49^{b}	1.56^{ab}	1.55^{ab}	1.51^{ab}	1.66^{a}
	10	1.47^{b}	1.60^{a}	1.49^{b}	1.56^{ab}	1.55^{ab}	1.51^{ab}	1.66^{a}
	12	1.47^{b}	1.60^{a}	1.49^{b}	1.56^{ab}	1.55^{ab}	1.51^{ab}	1.66^{a}
Umucass 38								
	0	1.50^{ab}	1.61^{a}	1.50^{ab}	1.57^{ab}	1.56^{ab}	1.53^{ab}	1.64^{a}
	2	1.50^{ab}	1.61^{a}	1.50^{ab}	1.57^{ab}	1.56^{ab}	1.53^{ab}	1.66^{a}
	4	1.50^{ab}	1.61^{a}	1.50^{ab}	1.57^{ab}	1.56^{ab}	1.53^{ab}	1.66^{a}
	6	1.50^{ab}	1.61^{a}	1.50^{ab}	1.57^{ab}	1.56^{ab}	1.53^{ab}	1.66^{a}
	8	1.50^{ab}	1.61^{a}	1.50^{ab}	1.57^{ab}	1.56^{ab}	1.53^{ab}	1.66^{a}
	10	1.50^{ab}	1.61^{a}	1.50^{ab}	1.57^{ab}	1.56^{ab}	1.53^{ab}	1.66^{a}
	12	1.50^{ab}	1.61^{a}	1.50^{ab}	1.57^{ab}	1.56^{ab}	1.53^{ab}	1.66^{a}

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

Crude fibre

The crude fibre contents of the cookie-like products ranged 1.471% to 1.61% against the control 1.64% (Table 7) at week zero. 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%, Table 7) at week two of the storage time while the lowest was found in product made from 100% garri (1.41%) of Umucass 36 at week zero. They were no significant difference at p > 0.05 in the cookie products made from 20:80 blends of the three garri samples throughout the storage periods. 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).

Table 8: Effect of storage duration on the ash content of cookies and cookie-like products from Umucass 36, 37 and 38.

Variety	Duration of storage (wk)	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	0	1.32^a	1.24^b	1.27^a	1.28^a	1.28^a	1.33^a	1.23^b
	2	1.32^a	1.24^b	1.27^a	1.28^a	1.28^a	1.33^a	1.23^b
	4	1.32^a	1.24^b	1.27^a	1.28^a	1.28^a	1.33^a	1.23^b
	6	1.32^a	1.24^b	1.27^a	1.28^a	1.28^a	1.33^a	1.23^b
	8	1.32^a	1.24^b	1.27^a	1.28^a	1.28^a	1.33^a	1.23^b
	10	1.32^a	1.24^b	1.27^a	1.28^a	1.28^a	1.33^a	1.23^b
	12	1.32^a	1.24^b	1.27^a	1.28^a	1.28^a	1.33^a	1.23^b
Umucass 37								
	0	1.37^a	1.25^a	1.29^a	1.31^a	1.31^a	1.34^a	1.23^b
	2	1.37^a	1.25^a	1.29^a	1.31^a	1.31^a	1.34^a	1.23^b
	4	1.37^a	1.25^a	1.29^a	1.31^a	1.31^a	1.34^a	1.23^b
	6	1.37^a	1.25^a	1.29^a	1.31^a	1.31^a	1.34^a	1.23^b
	8	1.37^a	1.25^a	1.29^a	1.31^a	1.31^a	1.34^a	1.23^b
	10	1.37^a	1.25^a	1.29^a	1.31^a	1.31^a	1.34^a	1.23^b
	12	1.37^a	1.25^a	1.29^a	1.31^a	1.31^a	1.34^a	1.23^b
Umucass 38								
	0	1.35^a	1.25^a	1.25^a	1.30^a	1.30^a	1.33^a	1.23^b
	2	1.35^a	1.25^a	1.25^a	1.30^a	1.30^a	1.33^a	1.23^b
	4	1.35^a	1.25^a	1.25^a	1.30^a	1.30^a	1.33^a	1.23^b
	6	1.35^a	1.25^a	1.25^a	1.30^a	1.30^a	1.33^a	1.23^b
	8	1.35^a	1.25^a	1.25^a	1.30^a	1.30^a	1.33^a	1.23^b
	10	1.35^a	1.25^a	1.25^a	1.30^a	1.30^a	1.33^a	1.23^b
	12	1.35^a	1.25^a	1.25^a	1.30^a	1.30^a	1.33^a	1.23^b

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

Ash content

Ash contents of the cookie-like products ranged from 1.24% to1.37% against the control cookies 1.23% (Table 8) with products made from 100% (1.37%) garri of Umucass 37 significantly ($p<0.05$) the highest at week zero and control cookies had the lowest (1.23%) at week twelve of the storage period. There were significant difference at $p <0.05$ amongst the blends. Ash values of cookies were stable during the storage periods. 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.

Table 9. Effect of storage duration on the carbohydrate content of cookies and cookie-like products from Umucass 36, 37 and 38.

Variety	Duration of storage (wk)	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	0	76.81^a	71.53^b	72.01^b	70.81^b	73.21^b	70.67^b	67.98^c
	2	76.78^a	61.30^d	70.37^b	68.85^c	70.94^b	72.60^b	67.74^c
	4	76.78^a	60.97^d	70.14^b	68.72^c	70.84^b	72.63^b	67.16^c
	6	76.76^a	60.86^d	70.98^b	68.60^c	70.72^b	72.62^b	67.09^c
	8	76.73^a	60.78^d	70.86^b	68.53^c	70.27^b	72.56^b	66.98^c
	10	76.68^a	60.67^d	68.80^c	68.20^c	70.07^b	72.57^b	66.96^c
	12	76.66^a	60.57^d	68.70^c	68.17^c	70.16^b	72.51^b	66.89^c
Umucass 37								
	0	75.18^a	70.73^b	71.91^b	72.37^b	72.99^b	74.52^b	67.98^c
	2	74.41^b	68.53^c	72.09^b	71.57^b	72.02^b	72.58^b	67.74^c
	4	74.34^b	68.46^c	71.63^b	71.48^b	71.95^b	72.54^b	67.16^c
	6	74.25^b	68.40^c	71.41^b	71.39^b	71.89^b	72.5^b	67.09^c
	8	74.18^b	68.37^c	71.22^b	71.31^b	71.84^b	72.47^b	66.98^c
	10	74.07^b	68.34^c	70.98^b	71.23^b	71.78^b	72.45^b	66.96^c
	12	74.01^b	68.30^c	70.84^b	70.15^b	71.72^b	72.42^b	66.89^c
Umucass 38								
	0	77.09^a	70.26^b	73.29^b	73.94^b	75.35^a	76.37^a	67.98^c
	2	75.48^a	69.90^c	71.11^b	71.74^b	73.88^b	76.17^a	67.74^c
	4	75.43^a	69.86^c	71.07^b	71.64^b	73.85^b	76.13^a	67.16^c
	6	75.40^a	69.86^c	71.01^b	71.58^b	73.76^b	74.84^b	67.09^c
	8	75.35^a	69.81^c	70.84^b	71.48^b	73.66^b	74.74^b	66.98^c
	10	75.28^a	69.73^c	70.81^b	71.46^b	73.49^b	74.65^b	66.96^c
	12	75.21^a	69.70^c	70.68^b	71.43^b	73.40^b	74.57^b	66.89^c

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

Carbohydrate content

The carbohydrate contents of the formulated cookies were generally high and ranged from 70.26% to 77.09% against the control 60.74% (Table 9) at week zero. 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 (60.57%) blend of Umucass 36 at week twelve. There were no significantly difference at (p>0.05) between the cookie-like products made from 100% garri of Umucass 36 and 37 throughout the storage periods. 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.

Table 10: Effect of storage duration on the beta carotene content of cookies and cookie-like products from Umucass 36, 37 and 38

		Composition (µg/g)						
Variety	Duration of storage (wk)	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	0	3.91^{d}	0.90^{h}	1.65^{f}	2.04^{f}	2.40^{f}	3.16^{d}	0.15^{i}
	2	3.82^{d}	0.87^{h}	1.61^{f}	2.00^{f}	2.38^{f}	3.14^{d}	0.13^{i}
	4	3.75^{d}	0.84^{h}	1.55^{f}	1.95^{f}	2.35^{f}	3.10^{d}	0.11^{i}
	6	3.71^{d}	0.80^{h}	1.52^{f}	1.91^{f}	2.30^{f}	3.05^{d}	0.11^{i}
	8	2.89^{d}	0.78^{h}	1.52^{f}	1.85^{f}	2.28^{f}	2.97^{e}	0.09^{j}
	10	2.43^{e}	0.75^{h}	1.48^{f}	1.82^{f}	2.25^{f}	2.95^{e}	0.08^{j}
	12	2.19^{e}	0.72^{h}	1.42^{f}	1.80^{f}	2.23^{f}	2.92^{e}	0.08^{j}
Umucass 37								
	0	4.93^{c}	1.11^{g}	2.06^{f}	2.55^{d}	3.03^{d}	3.97^{d}	0.15^{i}
	2	4.82^{c}	1.09^{g}	2.02^{f}	2.45^{e}	3.01^{d}	3.930^{d}	0.13^{i}
	4	4.62^{c}	1.05^{g}	1.95^{f}	2.40^{e}	2.97e	3.91^{d}	0.11^{i}
	6	4.71^{c}	1.02^{g}	$1.93^{f/}$	2.38^{e}	2.94^{e}	3.87^{d}	0.11^{i}
	8	3.88^{d}	0.95^{h}	1.90^{f}	2.36^{e}	2.92^{e}	3.84^{d}	0.09^{j}
	10	3.82^{d}	0.93^{h}	1.85^{f}	2.32^{e}	2.87^{e}	3.82^{d}	0.08^{j}
	12	3.78^{d}	0.90^{h}	1.82^{f}	2.30^{e}	2.82^{e}	3.80^{d}	0.08^{j}
Umucass 38								
	0	6.97^{a}	1.51^{f}	2.88^{d}	3.57^{d}	4.24^{c}	5.61^{b}	0.15^{i}
	2	6.83^{a}	1.45^{g}	2.84^{d}	3.55^{d}	4.20^{c}	5.57^{b}	0.13^{i}
	4	6.81^{a}	1.35^{g}	2.80^{d}	3.50^{d}	3.85^{d}	5.53^{b}	0.11^{i}
	6	6.75^{a}	1.05^{h}	2.76^{d}	$3. 45^{d}$	3.75^{d}	5.49^{b}	0.11^{i}
	8	5.74^{b}	0.89^{h}	2.74^{d}	3.43^{d}	3.74^{d}	5.47^{b}	0.09^{j}
	10	5.48^{b}	0.80^{h}	1.72^{f}	3.40^{d}	3.68^{d}	5.43^{b}	0.08^{j}
	12	5.28^{b}	0.80^{h}	1.705^{f}	3.38^{d}	3.64^{d}	4.84^{c}	0.08^{j}

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

Beta carotene contents of the cookie-like products from Umucass 36, 37 and 38) and wheat flour).

Beta carotene values of the cookie-like products ranged 0.90µg/g to 6.97µg/g against the control 0.15 µg/g (Table 10) at week zero. 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 (Table 4.8) 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. Beta carotene values of the cookie-like products and that of the control cookies decreased throughout the storage periods. The decrease in the beta carotene values of the products observed during storage may be due to instability of carotene, it easily undergo isomerization, photo-degradation, photo oxidation, auto-oxidation, singlet oxidation and thermal degradation (Stratton *et al*., 1993). All- trans-carotenoids, the most common form of carotenoids present in foods, can be isomerized to the cis -isomer by exposure to direct sunlight. The twisting of the molecule during the isomerization process may lead to an unpaired spin state, which can react easily with oxygen to form carbon-peroxyl triplet di-radicals unavailable for conversion to retinol (Mordi *et al*., 1993). Isomerization is the main reaction that occurs during heating at atmospheric pressure and at temperatures lower than 100°C, the 13- cis-isomer is formed at higher rates than 9- cis –isomer, formation of oxidation products from β-carotene, such as epoxides and apo-carotenals, as well as di- cis isomers occur under higher temperature, longer time, and higher pressure (Mercadante, 2008).

However the values obtained were still high, this result agrees with the work of Tee and Lim (1991a) who recorded reduction of beta carotene values in cookies enriched with beta carotene by blending with orange flesh sweet potatoes and wheat flour during processing. This work is also close to the work of Uzomah *et al*. (2016) who recorded decrease in vitamin A activity in stored red garri flour at ambient temperature. 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).

IV. 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. The proximate composition of the cookie-like products made from the composite flours recorded more ash, crude fat, crude fibre and beta carotene values as the addition of garri flour increased in the blends. Generally there were losses in the proximate and beta carotene profile analyzed during the storage period. 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) and it was more preferable to vulnerable groups who need pro-vitamin A to combat vitamin A deficiency.

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