PRODUCTION AND QUALITY EVALUATION OF ENRICHED COOKIES FROM WHEAT, AFRICAN YAM BEAN AND CARROT COMPOSITE FLOURS

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Abstract
This work was done to investigate the performance of composite flour in the production of cookies. The composite flour was formulated from the blends of wheat, African yam bean and carrot in the ratios of 100:0:0, 60:20:20, 60:30:10 and 60:10:30 designated as WA_oC_0, $WA_{20}C_{20}$, $WA_{30}C_{10}$ and $WA_{10}C_{30}$ respectively used to produce the cookies. Sample WA_oC_0 served as control. The functional properties of flour samples were determined while the proximate composition, pro-vitamin A and sensory evaluation of the cookies were also determined. The bulk density of the flour samples ranged from 0.70 to 0.71 g/ml, swelling index from 1.02 to 1.72 ml/g and water absorption capacity from 180 to 230 %. Addition of African yam bean and carrot flours as partial substitution of wheat flour in cookies production increased the protein content of the cookies samples from 8.24 to 13.82 %,fat from 9.97 to 11.83 %, ash from 1.81 to 1.92 % and fiber from 2.45 to 3.45 %. Pro-vitamin A ranged from 301.94 in sample WA_oC_0 to 317.86 mg/kg in sample $WA_{1o}C_{30}$. Sample WA_oC_0 had the highest values in terms of colour (7.90), taste (8.50), mouth feel (7.00), flavour (7.60) and crispness (7.20). In terms of the general acceptability, WA_oC_0 which had the highest value (8.70) was also the most acceptable by the panelists of all the samples.

Keywords: Cookies, African yam bean, carrot, composite flour, quality evaluation

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1. INTRODUCTION

Cookies are nutritive snacks obtained from unpalatable dough which is transformed into light porous easily digestible and more appetizing products through the action of heat in the oven (Ndife*et al.*, 2013). Bakery products (bread, buns, cookies, noodles among others) are produced from wheat flour which are mainly consumed by school children that need adequate protein for growth which is limited in wheat. The use of composite flour from local available crops has been encouraged since it reduces the importation of off wheat.
In 1987, Nigeria obtained loan on the importation of wheat flour and other baked products resulted in the adoption of alternative solution by the baking industries and out rightly closed down. One of the solutions developed was the mixing of flour from other sources with wheat flour (Osuntogun, 1987). Composite flour is the mixture of wheat and other non- wheat flours such as cassava, sweet potatoes, soybeans, maize and yam flour among others. Bakery industries in Nigerian have adopted this method of composite as a substitute for whole wheat cookies thereby reducing the cost of production of cookies and other baked products. Cookies made from African yam bean flour provide extra protein while carrot provides β- carotene.
African yam bean (*Sphenostylisstenocarpa*) is one of the lesser known legumes. It is known as "Azuma" or "odudu" in the Eastern state of Nigeria "SeSe" in the western state and "Kashinkaji" in the Northern states.
Nutritionally, African yam Bean (AYB) contains 21.0 % protein, 5.70% crude fibre, 12% ether extract, 74.10% carbohydrate and 3.20% Ash (Ezueh,1984). Edem*et al.* (1990) reported that AYB is rich in minerals such as potassium, phosphorus, magnesium, calcium, iron and zinc but low in sodium and copper. The protein is made up of over 32% essential amino acids with lysine and leucine being predominant (Onyenekwe *et al.*, 2000). African

Yam bean is a cheaper protein source than animal products such as meat, fish and poultry.

Carrot (*Daucescarota L*) belongs to the umbellifer family Apiaceae. It provides β-carotene and orange yellow which metabolizes into vitamin A in human and is helpful for health and sight improvement (Strobe *et al.*, 1997).

β – carotene may prevent cancer and certain chronic diseases (Sies and Krinsky, 1995). β-Carotene is an important precursor of vitamin A which gives attractive colour to food products. It contains appreciable quantities of nutrient such as protein and is also high in sugar (Hassan *et al.*, 2005). Partial replacement of wheat flour with African yam bean and carrot flour will increase overall nutrient, encourage utilization of underutilize crop like African yam bean, increase the cookies variety and reduce dependence on wheat flour.

This research work evaluates the quality of cookies produced from the blends of wheat, African yam bean and carrot flours.

2. MATERIALS AND METHODS

Procurement of raw materials

African yam bean was purchased from Ogige market, Nsukka in Enugu state while carrot, wheat and other bakery materials were purchased from Eke Ekwulobia market in Anambra state.

African yam bean flour preparation

The methods described by Enwere (1998) were used to prepare African yam bean flour. The AYB were cleaned to remove all contaminants such as stones, pods, fragments, immature beans soaked in water for 12 hours and allowed to boil for 20 min to reduce the anti-nutritional factors and beany flavour that might be present. The boiled AYB were dehulled and dried in cabinet dryer. The boiled dehulled and dried African Yam bean were ground to fine flour and then sieved. The AYB flour was packaged in air tight polythene bag and stored for further use.

Carrot flour preparation

Carrot fruits were peeled, sliced or grated and dried to an almost brittle consistency at temperature of 50°Cin a cabinet dryer. The dried carrot was then milled into powder, sieved through 250µm sieve, packaged in air tight polythene bag and stored for further use.

Formulation of composite flour

Wheat, African yam bean and carrot flours were blended in the following ratios as shown in Table 1.

Table 1: Formulation of flour from the blends of wheat, African yam bean and carrot

Samples	Wheat flour	African yam bean	Carrot flour
WA_oC_o	100	0	0
$WA_{20}C_{20}$	60	20	20
$WA_{30}C_{10}$	60	30	10
$WA_{10}C_{30}$	60	10	30

Key WA_oC_o = 100% wheat, $WA_{20}C_{20}$ = 60% wheat, 20% AYB and 20% carrot flour, $WA_{30}C_{10}$ = 60% wheat, 30% AYB and 10% carrot flour and $WA_{10}C_{30}$ = 60% wheat, 10% AYB and 30% carrot flour

Production of Cookies

The method used for the preparation of dough was the creaming method where fat and sugar were creamed together using the Kenwood mixer (United Kingdom) at medium speed for two (2) min. After creaming, such ingredients as flour, baking powder and milk were added and mixed to form dough and properly mixed. The dough was manually kneaded to ensure uniformity. The dough was then transferred to a clean tray and gently rolled using a roller. The dough sheath was cut into round shapes using a cutter. Shaped dough pieces were placed into a greased pan and baked in the oven at 180^{0}C for 40min. The baked biscuits were placed on a cooling rack for 30 min to cool before packaging.

Determination of Functional Properties

The bulk density was determined by the method of Nwanekezi *et al.* (2001). Water absorption capacity was determined by the method of Sosulski (1962). Swelling Capacity/ Index was determined by the method of Leach *et al.* (1959).

Determination of Chemical Composition

The moisture, protein, fat, ash and crude fibre content of the cookies was carried out according to the methods of AOAC (2010), while carbohydrate was calculated by differences. Vitamin C content of the sample was determined by titrimetric method of AOAC (2010). Pro-vitamin A was determined by the method of the Association of Vitamin Chemists (Kirk and Sawyer, 1998).

Sensory evaluation

A ten members panel was trained on sensory attributes for the evaluation of cookies on a 9-points Hedonic scale (where 9= extremely like and 1= dislike extremely). The samples were scored for colour, flavor, taste, crispiness and overall acceptability.

Statistical analysis

The experiment adopted was complete randomization design (CRD). The data generated from all analyses and sensory evaluation were subjected to statistical analysis of variance (ANOVA) using the Statistical Package for Social Statistics (SPSS) version 20. Means were separated using the Duncan's Multiple Range Test and significance was accepted at $p < 0.05$ (Steel and Torres, 1980).

3. RESULTS AND DISCUSSION

Table 2: Functional properties of composite flour from blends of wheat, African yam bean and carrot

Samples	Bulk density(g/ml)	Swelling index (ml/g)	Water absorption capacity (WAC) (%)
WA_oC_o	$0.71^a \pm 0.01$	$1.02^b \pm 0.03$	$180^c \pm 0.10$
$WA_{20}C_{20}$	$0.70^a \pm 0.10$	$1.61^a \pm 0.10$	$210^b \pm 1.10$
$WA_{30}C_{10}$	$0.71^a \pm 0.20$	$1.61^a \pm 0.01$	$230^b \pm 1.02$
$WA_{10}C_{30}$	$0.70^a \pm 0.01$	$1.77^a \pm 0.12$	$220^{ab} \pm 0.10$

Means with the same superscripts within the column are not significantly different ($p<0.05$).
Key WA_oC_o = 100% wheat, $WA_{20}C_{20}$ = 60% wheat, 20% AYB and 20% carrot flour, $WA_{30}C_{10}$ = 60% wheat, 30% AYB and 10% carrot flour, $WA_{10}C_{30}$ = 60% wheat, 10% AYB and 30% carrot flour.

The result of the functional properties of flour samples is shown in Table 2. There was no significant ($p > 0.05$) difference in bulk density of flour samples. The result shows that samples WA_oC_o and $WA_{30}C_{10}$ had the highest value (0.71g/ml) of bulk density while samples $WA_{20}C_{20}$ and $WA_{10}C_{30}$ had the lowest value (0.70g/ml) of bulk density. Bulk density is a measure of heaviness of flour and is generally affected by the particle size. The low value of bulk density observed in this study is important in transportation, packaging requirement, material handling and cost-efficient of bakery products (Karuna*et al.*, 1996; Ajanaku*et al.*, 2012).

The swelling index ranged from 1.02 to 1.77 ml/g. There was a significant ($p < 0.05$) difference between WA_oC_o (the control) and the blended samples. The highest value (1.77 g/ml) of the swelling power of blended sample ($WA_{10}C_{30}$) was slightly higher than the value obtained in composite flour from the blends of wheat, acha and soybean (Omeire*et al.*, 2014). According to Achinewhu*et al.* (1988), high swelling index has been a part of criteria for a good quality product.

The blended samples had higher value of water absorption capacity than the control sample. The water absorption capacity ranged from 180 to 220 %. There was a significant ($p < 0.05$) difference between WA_oC_o (the control sample) and the fortified or blended samples. This implies that all the samples will respond in different levels of water absorption. WAC describes flour – water association ability under limited water supply. It refers to ability of protein matrix such as protein particle, protein gels or muscle to absorbed water against gravity. Water absorption capacity is a desirable character in foods such as custards, sausages and dough because these are supposed to imbibe water without dissolution of protein thereby attending body thickening and viscosity (Seena and Sridhair, 2005)

Table 3: Proximate composition of cookies from blends of wheat, African yam bean and carrot flours

Samples	Moisture (%)	Crude protein (%)	Fat (%)	Ash (%)	Fibre (%)	Carbohydrate (%)
WA_oC_o	$10.18^a \pm 0.10$	$7.70^c \pm 0.10$	$9.76^c \pm 0.01$	$1.10^c \pm 0.10$	$0.93^c \pm 0.10$	$70.33^a \pm 0.10$
$WA_{20}C_{20}$	$9.77^b \pm 0.10$	$8.54^b \pm 0.10$	$9.77^c \pm 0.01$	$1.92^a \pm 0.01$	$2.50^b \pm 0.10$	$67.50^b \pm 0.10$
$WA_{30}C_{10}$	$11.83^a \pm 1.00$	$13.82^a \pm 0.12$	$11.83^a \pm 1.00$	$1.92^a \pm 0.10$	$2.45^b \pm 0.01$	$58.15^c \pm 1.00$
$WA_{10}C_{30}$	$9.76^b \pm 0.02$	$8.24^b \pm 0.01$	$10.18^b \pm 0.10$	$1.81^b \pm 0.01$	$3.45^a \pm 0.10$	$66.56^b \pm 0.01$

Means with the same superscripts within the column are not significantly ($p > 0.05$) different. Key WA_oC_o = 100% wheat, $WA_{20}C_{20}$ = 60% wheat, 20% AYB and 20% carrot flour, $WA_{30}C_{10}$ = 60% wheat, 30% AYB and 10% carrot flour, $WA_{10}C_{30}$ = 60% wheat, 10% AYB and 30% carrot flour.

The proximate composition of cookies samples is presented in Table 3. The moisture content ranged from 9.76-11.83 %. Sample $WA_{30}C_{10}$ (60% wheat, 30 %AYB, 10% carrot) had the highest value (11.83 %) moisture content while sample $WA_{10}C_{30}$ (60% wheat, 10 % AYB, 30 % carrot) had the lowest value (9.76 %). It was observed that there was no significant ($p > 0.05$) difference between samples WA_oC_o and $WA_{30}C_{10}$ but there was a significant ($p < 0.05$) difference between sample WA_oC_o and samples $WA_{20}C_{20}$ and $WA_{10}C_{30}$. The moisture content of samples $WA_{20}C_{20}$ and $WA_{10}C_{30}$ were below the 10% moisture level recommended for storage stability of flours (SON, 2007). In general, the lower the moisture contents of a product, the longer the storage life.

The protein content ranged from 7.70-13.82 %. There was a significant ($p<0.05$) difference between sample WA_oC_o and other blended samples. Sample $WA_{30}C_{10}$ had the highest value (13.82%) of protein content while the control sample had the lowest value (7.70%) of protein content. The samples that contain African yam bean and carrot flours had higher protein and carotene contents than the control sample. The increase in protein content of cookies substituted with African yam bean may be due to the effect of the African yam bean flour added. African yam bean is a good source of protein, several researchers have also reported increase in protein contents of food supplemented with African yam bean (Uguru and Madukaife, 2001; Okoye and Obi, 2017; Okoye*et al*., 2015).

The fat content of the samples ranged from 9.76- 10.18 %. There was a significant ($p < 0.05$) difference between sample WA_oC_o and samples $WA_{30}C_{10}$ and $WA_{10}C_{30}$ but there was no significant ($p < 0.05$) difference between samples WA_oC_o and $WA_{20}C_{20}$. Samples incorporated with AYB had higher value of fat content when compared with the control sample. This observation may be as a result of high fat content of African yam bean (Nwosu, 2013).

The ash content of the samples ranged from 1.10-1.81 %. Samples $WA_{20}C_{20}$ and $WA_{30}C_{10}$ had the highest value (1.92%) while sample WA_0C_0 had the least value (1.10 %). There was a significant ($p < 0.05$) difference between sample WA_oC_o and other blended samples. This shows that samples substituted with African yam bean and carrot had higher value of ash content than the control sample, this might be due to that AYB are rich in ash content (Ojukwu*et al*., 2012; Adegunwa *et al.*, 2012).

The total carbohydrate content of cookies was within the range of 62.22 to 70.33%. There was a significant ($p < 0.05$) difference between sample WA_oC_o and other blended samples. The carbohydrate content of the cookies samples incorporated with African yam bean and carrot were lower than the control sample. This may be as a result of the substitution which led to the reduction or changes in the carbohydrate content of the blended sample. Elochukwu and Onyekwelu (2015) and Okoye and Obi (2017) reported that decrease in carbohydrate content of cookies produced from blends of wheat and African yam bean and wheat and bambara groundnut respectively.

Table 4: Pro-vitamin A of cookies

Samples	Pro-vitamin A (mg/kg)
WA_oC_o	301.94[b] ± 1.00
$WA_{20}C_{20}$	307.14[b] ± 1.00
$WA_{30}C_{10}$	305.94[b] ± 1.02
$WA_{10}C_{30}$	317.86[a] ± 0.01

Means with the same superscripts within the column are not significantly ($p > 0.05$) different. Key WA_oC_o = 100% wheat, $WA_{20}C_{20}$ = 60% wheat, 20% AYB and 20% carrot flour, $WA_{30}C_{10}$ = 60% wheat, 30% AYB and 10% carrot flour, $WA_{10}C_{30}$ = 60% wheat, 10% AYB and 30% carrot flour.

Table 4 shows the values obtained for pro-vitamin A of the cookies from the blends of wheat, African yam bean and carrot flours. Pro-vitamin A content of the samples ranged from 301.94 to 317.86 mg/kg. Sample $WA_{10}C_{30}$ (cookies samples substituted with 10% African yam bean and 30% carrot) had the highest value (317.86 mg/kg) of pro-vitamin A while sample WA_oC_o (the control sample) had the lowest value (301.94mg/kg). There was a significant ($p < 0.05$) difference between samples WA_oC_o and $WA_{10}C_{30}$ but there was no significant ($p > 0.05$) difference between sample WA_oC_o and samples $WA_{20}C_{20}$ and $WA_{30}C_{10}$. It was observed that increase in the level of addition of carrot flour in the production of cookies increased the pro-vitamin A content of the cookies. This result might be due to the fact that carrot is rich in β-carotene which is a precursor of vitamin A (Adegunwa*et al.*, 2012*).* Vitamin A is known for maintenance of vision and fetus development.

Table 5: Sensory scores of cookies

Samples	Colour	Taste	Mouth feel	Flavour	Crispness	General Acceptability
WA_oC_o	7.90[a] ± 0.02	8.50[a] ± 0.10	7.00[a] ±1.02	7.60[a] ± 0.02	7.20[a] ± 0.10	8.70[a] ± 0.10
$WA_{20}C_{20}$	6.80[c] ± 0.10	7.00[b] ± 1.20	6.80[b] ±0.10	6.50[b] ± 0.10	6.50[b] ± 0.10	7.60[b] ± 0.01
$WA_{30}C_{10}$	7.30[b] ± 0.30	6.40[c] ± 0.12	6.00[c] ±1.00	6.50[b] ± 0.13	6.50[b] ± 0.01	6.60[c] ± 1.00
$WA_{10}C_{30}$	7.30[b] ± 0.11	7.20[b] ± 0.01	5.90[c] ±1.00	6.00[b] ± 0.01	6.00[c] ± 0.10	7.10[bc] ± 0.01

Means with the same superscripts within the column are not significantly ($p > 0.05$) different. Key WA_oC_o = 100% wheat, $WA_{20}C_{20}$ = 60% wheat, 20% AYB and 20% carrot flour, $WA_{30}C_{10}$ = 60% wheat, 30% AYB and 10% carrot flour, $WA_{10}C_{30}$ = 60% wheat, 10% AYB and 30% carrot flour.

The result of sensory scores of cookies is shown in Table 5. Sample WA_oC_o had the highest scores incolour (7.90), taste (8.50), mouthfeel (7.00), flavour (7.60) and crispness (7.20). Thus, there was a significant ($p < 0.05$) difference between sample WA_oC_o (control) and other fortified samples. In terms of the general acceptability, sample WA_oC_o had the highest score (8.70) and was the most acceptable by the panelists followed by. sample was most accepted in all the sensory attributes. Among the blended samples, sample$WA_{20}C_{20}$ (cookies substituted with 20% African yam bean and 20% carrot) was the most acceptable in terms of general acceptability. Cookies enriched with protein and β-carotene (pro-vitamin A) can be produced from the addition of African yam bean and carrot flour in the production of cookies.

4. CONCLUSION

Cookies were produced from substituting part of wheat with African yam bean and carrot flour. The samples with African yam bean and carrot substitution had higher values of protein, β-carotene, fat and oil, ash and fibre contents than the control sample (100% wheat).Sample $WA_{10}C_{30}$ (cookies substituted with 10% African yam bean and 30% carrot flour) had thehighest value of pro-vitamin A. The control

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