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Development and Quality Evaluation of Carrot Powder and Cowpea Flour Enriched Biscuits

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Abstract: Cowpea (*Vigna unguiculata*) and Carrot (Daucus carota L) were processed into flour and powder respectively and were used to substitute wheat flour as composite flour in the production of biscuits. Biscuits were prepared from different blends of refined wheat flour, cowpea flour and carrot powder in the respective ratios of 100:0:0, 90:5:5, 85:10:5 and 80:10:10 and 75:15:10. The biscuits were analyzed for their physical properties, proximate and carotenoids composition and sensory properties. Results revealed a significant differences ($p < 0.05$) were observed in moisture, crude protein, crude fat, ash and carbohydrate contents of the biscuit samples. The protein content of the samples varied significantly ($p > 0.05$) with increasing levels of cowpea flour. It ranged from 9.27- 10.06% with the control sample (A) having the lowest value, while the sample (E) with 15% cowpea flour inclusion having the highest value (10.05%). Significant differences ($p > 0.05$) existed in the crude fibre content of the enriched and control biscuit samples. The fat content of biscuits varied significantly $p < 0.05$ ranging from 15.45 and 19.81%. A significant reduction ($p < 0.05$) was observed in the carbohydrate content, which ranged from 60.61% to 68.803% with the highest value in the control sample and the lowest value in sample D (80% wheat flour; 10% of cowpea flour and 10% carrot powder). A significant increase ($p > 0.05$) was observed in the carotenoids content of the biscuit samples as the level of carrot powder inclusion increased. It ranged from 1.54- 7.5 mg/kg with the highest value found with the 10% carrot powder inclusion while the lowest value was found in the control sample. The mean sensory scores revealed that there were no significant differences ($p > 0.05$) in all the sensory attributes evaluated. The study showed that value added biscuits can be produced using carrot powder and cowpea flour to enrich biscuits that is capable of increasing the protein and carotenoids contents which can help in ameliorating protein malnutrition and vitamin A deficiency.

Keywords: Cowpea Flour, Carrot Powder, Biscuit, Physical Properties, Proximate, Carotenoids

1. Introduction

The prevalence and ever increasing incidence of protein-energy malnutrition (PEM) among different age groups particularly children with an estimate of 400 million children being malnourished worldwide has been reported (Oosthuizen, 2006; Agiriga and Iwe, 2009). This may be attributed to the ever increasing populace of the developing countries being fed predominantly on their staple food crops (maize, sorghum, cassava, etc) which have been reported to be poor sources of protein (Labadarious *et al.,* 2005) particularly in terms of amino acid balance but are rich sources of carbohydrate particularly starch. Protein deficiency is a major nutritional problem facing the world today, particularly the developing countries. High incidence of protein calorie malnutrition and nutritional diseases in developing countries particularly Nigeria has been reported (UNICEF, 2011).

Snacks are referred to as convenience foods which can be eaten in between meals. Most snacks are generally cereal-based and the most common cereal used in producing snacks is the wheat grain. Reports showed that the use of 100% wheat flour as the major ingredient for preparing snacks generally tends to result into products high in calories and fat but low in proteins, vitamins and other nutrients (Brink and Belay, 2006; Rampersad *et al*., 2003). Studies has shown that combining cereal flour with low-cost protein calorie sources such as legume flours have been recommended to alleviate the perennial problem of protein malnutrition in developing countries in which Nigeria is one,since the amino acid profiles of the two food groups are complemented by their combination (Saxena *et al*., 2010).

Cowpea (*Vignaunguiculata*) is an indigenous tropical legume that produces pods and grain that are highly nutritious and valuable because it contributes to the livelihood of several millions of people in West and Central Africa. It is a rich source of protein up to around ranging 30% (Boukar *et al*, 2010). Unlike soybean, cowpea is well appreciated and used in different food applications such as traditional African meals, soups and homemade weaning foods. (Lambeth, C., 2002)

Carrot (Daucuscarota L) is one of the important nutritious root vegetables grown throughout the world. It is an excellent source of phytonutrients such as phenolics, polyacetylenes and carotenoids (Babic *et al*, 1993; Hansen *et al*, 2003; Block, 1994). The main physiological function of carotenoids is as precursor of vitamin A (Nocolle *et al*, 2003). Carotenoids are potent antioxidants present in carrots which help to neutralize the effect of free radicals. Reports have showed that they have inhibitory mutagenesis activity thus, contributing to decrease risk of some cancers (Dias, 2012)

In recent times, consumption of carrot and its products has gained wide acceptance as a result of its natural antioxidants properties coupled with the anticancer activities of β-carotene in it which is a precursor of vitamin A (Dreosti 1993; Speizer *et al.* 1999). Consequently, consumption of carrot and its products would be very useful in alleviating vitamin A deficiency particularly, among children below six years and adults. Vitamin A deficiency (VAD)has been reported to be one of the major public health problems in developing countries in which Nigeria is one, hence the need to develop enriched baked products such as biscuits which are widely acceptable and consumed as snacks in order to meet the nutritional needs and improve the health of the vulnerable groups. Baked products such as bread, breakfast cereals and particularly biscuits can be considered a convenient vehicle for the addition of micronutrients and protein to meet these consumer health demands.

Biscuit is one of the oldest commonly consumed non fermented baked snacks in Nigeria (Ogunjobi and Ogunwolu, 2010). The fundamental ingredients mostly used in its production include wheat flour, butter, sugar and eggs.

Biscuits are high in carbohydrates, fat and calorie but low in protein, fiber, vitamin, and mineral which make it unhealthy for daily consumption. It is widely acceptable and consumed by all age groups in all geographical locations both in rural community settings and urban settings; and can be eaten at all times as a result of its relatively long shelf-life, more convenience and good eating quality. Due to its wide acceptability by all age groups, it could be considered a good product for protein fortification and other nutritional improvements. (Zaker *et al.,* 2012, Serrem *et al*., 2011). However, several researchers had produced acceptable biscuits from composites of wheat and non-wheat flours or solely from a variety of non-wheat flours (Hussein *et al*., 2011, Olapade *et al* 2011; Zaker *et al*., 2012; Olaoye *et al*., 2007; Hussain *et al.,* 2014).

Biscuits are non-fermented aerated mix variety of flour confectionary products which are eaten as snack.

Therefore, this study is geared towards incorporating cowpea flour and carrot powder as a source of protein and carotenoids respectively which could help in alleviating protein malnutrition and vitamin A deficiency (VAD) amongst the vulnerable groups.

2. Materials and Methods

Refined wheat flour, cowpea, carrots, butter fat, sugar and baking powder used for biscuit making were purchased from local market in Lagos Nigeria. All the chemicals/ reagents used were of analytical grade.

2.1. Preparation of Carrot Powder

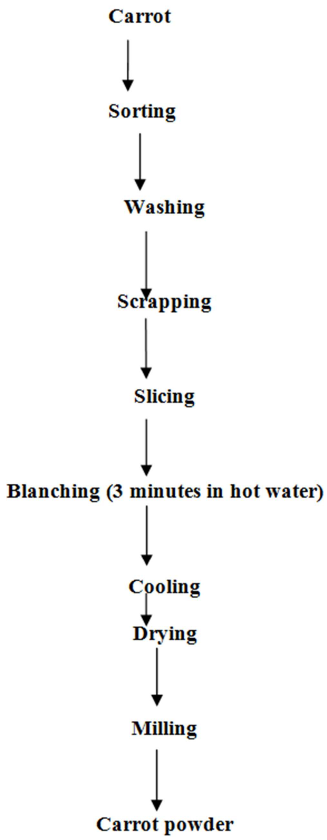
The method described by Marvin (2009) was used in the preparation of carrot powder. The carrot fruits were washed in portable water, peeled, sliced into 56mm thickness; the sliced carrots were blanched for 3 minutes in hot water containing sodium metabisulphite to prevent browning and discoloration. The sulphited carrots were immediately cooled by exposing to air and dried in a cabinet drier at 50°C for 12 hours. The dried fruit was ground to fine powder (model HL 3294/C Phillips) and sieved with a 0.150 µ sieve and was packaged in black polythene bag for further uses.

2.2. Production of Cowpea Flour

The beans were cleaned, sorted to remove stones and shafts. The cleaned seed were soaked in water to soften the hull to ease its removal. The hulls were removed by repeated working between the palms leaving behind dehulled seeds. The seeds were there after dried in a cabinet drier at 60°C for 6 hours. The dried seeds were milled and sieved with mess sieve to obtain fine powder(model HL 3294/C Phillips). This was packaged inside an air fight container for further analysis.

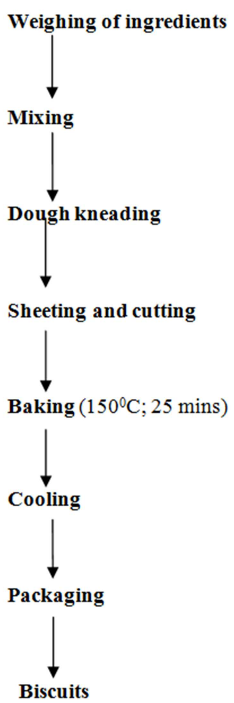
2.3. Product Development

Biscuit samples were prepared, using creamy method for making biscuit dough. The ingredients (g) used in preparation of biscuits were flour blends 100g, fat 40, sugar 40, baking powder 0.8, sodium bicarbonate 0.3, ammonium bicarbonate 0.25 and milk as desired to make dough softer. Biscuits were prepared from different blends of refined wheat flour, cowpea flour and carrot powder in the respective ratios of 100:0:0, 90:5:5, 85:10:5 and 80:10:10 and 75:15:10. Refined wheat flour biscuits were considered as control. Biscuit dough was prepared in a Hobart Mixer and sheeted and rolled out into thin sheet of uniform thickness and cut into desired shape using mould. The cut pieces were placed over a perforated tray and transferred into a baking oven at 190°C for 10 - 15 min. The well baked biscuits were cooled to room temperature and stored in air tight container till further use.



Source: Marvin method (2009)

Figure 1. *Flow chart for production of carrot powder.*



(Ihekoronye, 1999).

Figure 2. *Flow chart for production of biscuits.*

3. Physical Characteristics of Developed Biscuit

Biscuits were analyzed for diameter, thickness, spread ratio following the procedures described by AACC, 2000. The diameter (D) was determined by placing six biscuits horizontally (edge to edge) and rotated at 90° angle for reading. It was measured using the vernier caliper. Thickness (T) of the biscuits was also measured with a vernier caliper in triplicate. Means were recorded. Biscuits spread ratio was calculated as D / T. Weights were determined using a digital top loading balance (CE- 410I, Camry Emperors, China).

3.1. Chemical Composition of Developed Biscuit

3.1.1. Moisture Content

It was determined using procedure described by AOAC, (2010) was used. The moisture content of each sample was determined by weighing 5 g of the sample into a petri dish. The sample was then dried to constant weight at 105±2°C.

Moisture content = Weight of can –weight of empty can ×100/ Weight of sample

3.1.2. Protein Content Determination

Analysis of protein content was done using the Kjeldah method as described by AOAC, 2010.

3.1.3. Fat Content Determination

Extraction of fat was performed by the Soxtec method in automatic fat extraction unit called soxhlet apparatus using diethyl ether.

3.1.4. Ash Content Determination

10g of the samples was weighed and placed inside muffle furnace with temperature adjusted to between 575+15°C and was heated for 6hours or more to burn off all the nutrients and fibre present to obtain a white ash in hot plate. Ash Content in percentage was calculated thus (AOAC, 2010)

% Ash = Ash weight x 100/ Weight of sample

3.1.5. Crude Fibre Content Determination

Analysis of crude fibre content was done by digesting samples with trichloroacetic acid, nitric acid, water and acetic acid using the Fibretec system as described by AOAC, 2010. Crude fibre content in percentage was calculated as

Crude Fibre = Final Weight of Crucible – Initial weight of crucible ×100/ Weight of Sample

The carbohydrate content was calculated by difference between 100 and total sum of the percentage of moisture, protein, fat, fibre and ash while the energy values were calculated using Atwater formula.

3.2. Carotenoid Analysis

The total amount of carotenoids was determined using a Ultra Violet Spectrophotometer at 450 nm. Approximately 15 g of the samples, plus 3 g of celite, a filtration acid (Tedia, Ohio, USA) were weighed in a mortar on a digital balance (CE- 410I, Camry Emperors, China). For the carotenoid extraction, successive additions of 25 mL of acetone were made to obtain a paste, which was transferred into a sintered funnel (5 μm) coupled to a 250 mL Buchner flask and filtered under vacuum. This procedure was repeated three times or until the sample became colorless. The extract obtained was transferred to a 500 mL separatory funnel containing 40 mL of petroleum ether. The acetone was removed through the slow addition of ultrapure water (Milli-Q - Millipore) to prevent emulsion formation. The aqueous phase was discarded. This procedure was repeated four times until no residual solvent remained. Then, the extract was transferred through a funnel to a 50 mL volumetric flask containing 15 g of anhydrous sodium sulfate. The volume was made up by petroleum ether, and the samples were read at 450 nm. The total carotenoid content was calculated using the following formula:

Carotenoids content (μg/ g) = $A \times V\,(mL) \times 10^4 / A^{1\%}_{1cm} \times P(g)$

where A = Absorbance; V = Total extract volume; P = sample weight; A1cm 1% = 2592 (β-carotene Extinction Coefficient in petroleum ether).

3.3. Organoleptic Characteristics of Developed Biscuits

This was determined in all the different biscuits samples produced using semi-trained panelist of at least 50 people from the Institute using a 9-point hedonic scale ranging from 1 (extremely disliked) to 9 (extremely liked). The parameters evaluated are such as colour, crispiness, taste, texture, flavor and overall acceptability were determined.

3.4. Statistical Analysis

The data obtained were subjected to analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS) software. Duncan Multiple Range Test was used to detect significant differences (α=0.05)

The data obtained were statistically analyzed using the analysis of variance (ANOVA) and the Duncan Multiple range test with significance level at $p < 0.05$ (Ihekoronye and Ngoddy).

4. Result and Discussion

The physical characteristics of biscuits prepared from different blends of flours are presented in Table 1. The weight of biscuits decreased with increased concentration of cowpea flour and carrot powder in the blends. The diameter showed a significant reduction ($p > 0.05$) with increasing levels of cowpea flour and carrot powder. It ranged between 4.65 and 4.90 cm with the highest value in the control sample and lowest value in the sample (E) with the 15% cowpea flour and 10% carrot powder. Spread ratio ranged between 6.5 and 7.5 with the highest value in the biscuit with 15% cowpea flour and 10% carrot powder and the lowest value in the control sample. The low spread ratio of the control sample showed that the starch polymer molecules are highly bound with the granules when heated and when dough or batter become less viscous with the inclusion of non wheat flour, it tends to spread more thereby increasing in diameter and consequently the spread ratio.

Table 1. *Physical Parameters of Developed Biscuits.*

Sample Codes	Weight (g)	Diameter (cm)	Thickness(cm)	Spread ratio
A	8.0^a	4.90^a	0.75^b	6.5^c
B	7.7^b	4.85^a	0.72^b	6.7^c
C	7.6^b	4.71^b	0.65^a	7.2^a
D	7.5^b	4.68^b	0.64^a	7.3^b
E	7.2^c	4.65^b	0.62^a	7.5^b

Means values in the same column with the same superscript are not significantly different ($p<0.05$).

Key: A=100% wheat flour (Control); B=90% wheat flour, 5% cowpea flour, 5% carrot powder; C=85% wheat flour, 10% cowpea flour, 5% carrot powder; D=80% wheat flour, 10% cowpea flour, 10% carrot powder; E=75% wheat flour, 15% cowpea flour, 10% carrot powder

The chemical composition of the biscuit samples are presented in Table 2. Significant differences ($p < 0.05$) were observed in moisture, crude protein, crude fat, ash and carbohydrate contents of the biscuit samples. The moisture content of the biscuit samples ranged from 7.60-5.50% with the control sample having the lowest value. The protein content of the samples varied significantly ($p>0.05$) with increasing levels of cowpea flour. It ranged from 9.27-10.06% with the control sample (A) having the lowest value, while the sample (E) with 15% cowpea flour inclusion having the highest value (10.05%). Significant differences ($p > 0.05$) existed in the crude fibre content of the unfortified and fortified biscuit samples. Results indicated that as the level of cowpea flour inclusion increased, the crude protein, fibre and fat content also increased. The fat content of biscuits varied significantly $p < 0.05$ ranging from 15.45 and 19.81%. This was in consonance with the findings of Akubor (2003) who observed increase in protein, fat, fibre and ash contents when supplemented with soyabean flour for biscuit production. A significant reduction ($p < 0.05$) was observed in the carbohydrate content, which ranged from 60.61% to 68.803% with the highest value in the control sample and the lowest value in sample D (80% wheat flour; 10% of cowpea flour and 10% carrot powder).

Results also indicated that Energy values of the developed biscuits increased as the levels of inclusion increased compared to the control sample. This might probably be due to the increases in protein and fat contents. A significant difference ($p > 0.5$) existed in the ash contents of the samples. The increased ash content which is an index of mineral content was due to high percentage of minerals content present in carrot powder.

The carotenoid content ranged from 1.54- 7.5 mg/kg with the highest value found with the 10% carrot powder inclusion while the lowest value was found in the control sample. A significant increase ($p > 0.05$) was observed in the carotenoids content of the biscuit samples as the level of carrot powder inclusion increased. The increase observed in the carotenoid content as the carrot powder levels increased confirmed the claims of previous workers (Sharma *et al,* 2012, Adeola *et al*, 2012) that carrot powder has a good residual amount of carotenoids. Carotenoids have been implicated in the enhancement of immune system, decreased risk of degenerative diseases such as cancers, cardiovascular disease, prevention of muscular degeneration and cataract formation (Faulks and Southon 2001, Kinsky, 1994).

Table 2. *Chemical Composition of Developed Biscuits.*

Parameter % (w/w)	A	B	C	D	E
Moisture	5.50^{a}	7.60^{c}	6.90^{b}	6.90^{b}	5.70^{a}
Crude Protein	9.27^{a}	9.67^{b}	9.74^{b}	9.94^{c}	10.06^{c}
Crude Fibre	0.28^{b}	0.85^{a}	0.94^{a}	0.92^{a}	0.92^{a}
Crude Fat	15.45^{a}	19.32^{c}	19.28^{c}	19.81^{d}	18.94^{bc}
Ash	1.47^{a}	1.40^{a}	1.57^{b}	1.82^{c}	1.80^{c}
Carbohydrate	68.03^{c}	61.16^{a}	61.57^{a}	60.61^{a}	62.58^{b}
Energy(kCal)	448.25^{c}±0.35	457.20^{b}±0.3	458.76^{b}±0.3	460.49^{a}±0.2	461.02^{a}±0.2
Carotenoids (mg/kg)	1.54±0.08	2.22±0.31	2.92±0.17	7.5±0.25	7.1±0.42

Means values in the same row with the same superscript are not significantly different ($p<0.05$).

Key: A=100% wheat flour (Control); B=90% wheat flour, 5% cowpea flour, 5% carrot powder; C=85% wheat flour, 10% cowpea flour, 5% carrot powder; D=80% wheat flour, 10% cowpea flour, 10% carrot powder; E=75% wheat flour, 15% cowpea flour, 10% carrot powder.

The mean sensory scores on the organoleptic preference for different biscuit samples are shown in Figure 2. The mean sensory scores for different levels of cowpea flour and carrot powder incorporated biscuits, for all the sensory attributes evaluated were more than the minimum acceptable score of 6. The result revealed that there were no significant differences in all the sensory attributes evaluated except the taste and the overall acceptability of the biscuits. This suggests that all the samples maintained a high level of acceptability by the panelists. This is comparable with the results obtained by some authors using non wheat composite flours for the production of biscuits (Mridula, 2011)

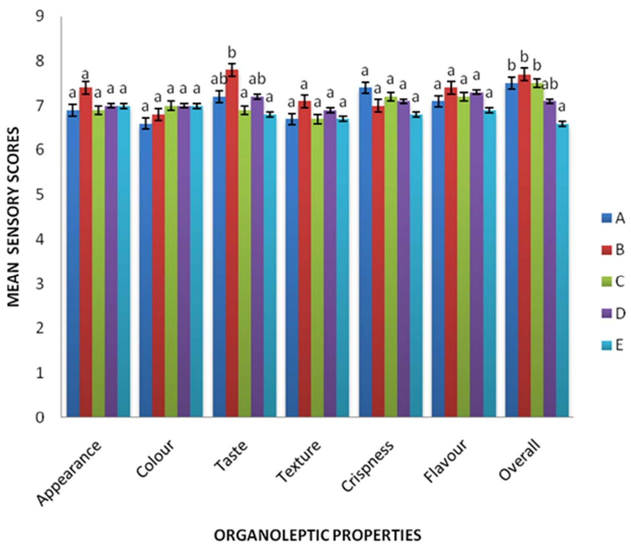


Figure 2. *Mean sensory rating of developed biscuit supplemented with cowpea flour and carrot powder.*

Key: A=100% wheat flour (Control); B=90% wheat flour, 5% cowpea flour, 5% carrot powder; C=85% wheat flour, 10% cowpea flour, 5% carrot powder; D=80% wheat flour, 10% cowpea flour, 10% carrot powder; E=75% wheat flour, 15% cowpea flour, 10% carrot powder.

5. Conclusion

The study showed that development of value added biscuits could be produced with carrot powder and cowpea flour. The inclusion of cowpea flour in the biscuits improved the protein content which could serve as relief of malnutrition while on the other hand, the inclusion of carrot powder was found to significantly improve the carotenoids content a potent antioxidants which helps in neutralizing the effects of free radicals. This could serve as an easiest mean of tackling and reducing vitamin A deficiency and improve the health status of the vulnerable groups. It is noteworthy to say that the organoleptic properties evaluation results showed that a highly acceptable biscuit could be obtained from the different levels of inclusion studied. These studies have shown the potential of developing proteineous and vitamin A-rich biscuits in order to increase the nutritional quality of biscuits consumed by the target groups.

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